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

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January 2, 2026

We use bond-level data to study how US banks managed securities portfolio risk during the 2022–23 interest rate surge. Rising yields lengthened the effective duration of callable bonds (especially agency MBS) and triggered deposit outflows. Exposed banks reduced both the volume and duration of bond purchases, but rarely sold existing bonds and did not expand qualified accounting hedges. Two frictions constrain adjustment: first, banks systematically avoid realizing losses, especially banks that exclude unrealized losses from regulatory capital. Second, hedging capacity is limited by fixed costs and callable bond complexity. Instead, banks reduced *measured* exposure by classifying high-risk bonds as held-to-maturity.

Keywords: banks, securities, interest-rate risk, trading, hedging, capital regulation

JEL classification: G11, G21, G23, G28

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*Fuster: EPFL, Swiss Finance Institute and CEPR. Paligorova: Federal Reserve Board. Vickery: Federal Reserve Bank of Philadelphia. We thank Ben Charoenwong, Stefanos Delikouras, Mark Flannery, Quirin Fleckenstein, Björn Imbierowicz, Elena Loutskina, Xu Lu, Ralf Meisenzahl, Christoph Memmel, Asani Sarkar, 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, ECB, EFA Annual Meeting, EFI Workshop Brussels, Federal Reserve ASSA Day-Ahead Conference, Federal Reserve Board, Fed System conference, Goethe University/SAFE, INSEAD Finance Symposium, New York Fed/NYU Stern Financial Intermediation Conference, Singapore Management University, SITE (Stanford), Texas A&M, Tilburg, UCL, UNSW, University of Bonn, University of Cyprus, University of South Carolina FIFI Conference, University of Sydney, UVA McIntire, University of Wisconsin, University of Zurich, and Wharton for helpful comments. We are also very grateful to Omar Ahmad, Zhixun Chen and Shawn Kimble for outstanding research assistance. Views 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 US 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 use their securities portfolio to manage risk 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 significant deposit outflows as well as increases in banks' interest-rate risk exposure, especially for banks with large holdings of bonds with embedded call options that extended in maturity as rates went up.

We find that bank portfolios adjusted on some margins but not others to the shifting environment. Specifically, banks actively reduced the volume and duration of new bond purchases, and also limited *measured* risk by classifying risky bonds as "held-to-maturity," even before rates went up. But we observe little active management on two key margins: bond sales, which were in fact unusually low in 2022-23, and derivatives-based hedging. We identify financial frictions related to the costs of realizing unrealized losses and the use of hedge accounting that help explain banks' inertia on these two margins. Reflecting limited active portfolio management, banks holding callable bonds *ex ante* experienced a larger net increase in interest-rate risk as rates rose, and at the bank level, a larger decline in mark-to-market asset values.

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 total banking 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 mortgage-backed securities (MBS) and other "callable" bonds.[1] Further, we develop a methodology to use the Y-14 data to infer bank trading at the bond level and present new stylized facts on bank trading behavior. We supplement these bond-level data with bank regulatory filings and 10-K disclosures, among other sources.

We begin by documenting features of the rising-rate environment that generated incentives for banks to actively manage the size and composition of their securities portfolios. First, many banks faced deposit outflows, creating pressure to reduce asset growth. Second, higher rates increased the duration of assets with embedded call options, most importantly MBS backed by fixed-rate loans with a prepayment option. Such callable bonds make up about 60% of security holdings for our sample, and as rates went up, these bonds significantly extended in maturity (e.g., mortgage prepayment fell to very low levels). The change in duration also varied substantially across banks due to variation in their *ex ante* holdings of callable bonds.[2]

Studying bank responses, we find that banks actively scaled back bond purchases as deposit growth slowed, from a peak purchase rate of around 20% of portfolio value per quarter in 2021 to only 3-4% per quarter over most of 2022-23, with a significant number of banks reducing purchases to de minimis levels. Banks also reduced the duration of bond purchases, consistent with a desire to reduce exposure to interest-rate risk.

On the other hand, banks did not actively sell securities in significant quantities to rebalance risk or to shrink the balance sheet. In fact, bond sales were unusually *low* in 2022-23 both on average and for a very high share of the banks in our sample. In the cross-section, bond sales were also insensitive to deposit flows, unlike purchases, and there is at best weak evidence that banks experiencing rising duration rebalanced by selling long-term bonds to replace them with cash or short-term bonds.

We also find that banks did not increase their use of derivatives to dynamically hedge the rising risk of callable bonds. While banks use "qualified" interest-rate derivatives

[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* before maturity (e.g., municipal bonds 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 refinance).

[2] E.g., at the 80th percentile of banks, portfolio duration peaked at 6.0 in 2022:Q3 compared to 4.5 in 2021:Q4 and only 3.3 in 2020:Q4. But at the 20th percentile, duration barely increased in 2022, and by 2023 was well *below* 2021:Q4 levels. Our analysis shows that these divergent outcomes are driven by the share of callable bonds held by the bank ex ante, measured at the end of 2019.

throughout the sample, hedging did not significantly increase in 2022-23, and banks with a high share of callable bonds did not hedge more risk either before or after rates rose.

As an alternative to selling or hedging risky bonds, banks reduced the *measured* exposure of book equity and regulatory capital to interest-rate risk by classifying the riskiest bonds as “held-to-maturity” (HTM).[3] In particular, even prior to 2022, bonds classified as HTM disproportionately had high duration and negative convexity (that is, duration would increase further if rates rose). These patterns suggest banks were cognizant of the nonlinear risks of MBS and other callable bonds.

Reflecting limited dynamic management, we show that the increase in a bank’s portfolio duration in 2022-23 is closely tied to its holdings of callable bonds, measured ex ante in 2019:Q4. Further, this increase in securities duration was not neutralized by natural hedges elsewhere on the balance sheet—using data from 10-Ks we find that banks with a high share of MBS experienced a larger fall in *total* mark-to-market equity after interest rates rose, and higher forward-looking exposure to rising rates as measured by the rate sensitivity of the economic value of equity.

Considering several interpretations of these facts, we conclude that bank behavior was shaped, at least in part, by financial and accounting frictions that made it costly to sell or hedge risky bonds. This can explain why many banks were at a corner solution where they stopped purchasing bonds but did not sell bonds outright, and why banks exposed to rising callable bond duration did not rebalance by selling or hedging risky securities. An alternative explanation that banks simply wanted to take more risk after 2022 is hard to reconcile with the sharp reduction in the duration of bond purchases, or with the tight link between the change in bank risk and ex ante portfolio mix. (We also show that banks’ holdings of callable bonds—the key driver of the change in risk—are not correlated with standard measures of risk-shifting incentives.) These facts, as well as the shift to HTM, also speak against the related hypothesis that banks took duration risk because they assumed interest-rate risk going forward was low or rates would fall; such an explanation is also not consistent with high interest-rate volatility at the time based on professional forecasters and option markets. A third story—that bank asset risk was

[3] As discussed in Section 2.1, 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.

hedged by the deposit franchise—is certainly relevant but does not explain why callable asset holdings predict total bank losses and risk. Conceptually, it is also unclear how low-beta deposits would dynamically hedge the nonlinear risks of such assets. Finally, the idea that banks were unaware of the risks of negative-convexity callable bonds is inconsistent with banks' classification of exactly such bonds as HTM before rates rose.

In the second half of the paper, we present micro evidence on the nature of these frictions in selling and hedging risky bonds, identifying factors related to unrealized losses and the use of hedge accounting that help explain observed inertia in bank portfolios.

First, we show 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, which in a rising-rate environment are exactly the bonds with high duration. We identify these effects based on within-bank variation in which individual bonds were underwater, finding that in 2022-23, banks were 3-4 times more likely to sell a bond at par, and 8-9 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. Investigating mechanisms, we find that banks' aversion to realizing losses is motivated by a desire to reduce regulatory capital volatility—the effect is about twice as strong for banks that do not recognize unrealized losses in regulatory capital. Strategic trading is also amplified for banks with low price-to-book ratios, suggesting banks may be concerned about negative market reactions to realizing losses.

Second, we find that fixed costs and limits on which bonds may be easily hedged constrain banks' capacity to hedge interest-rate risk through "qualified" accounting hedges. (Such qualified hedges are preferred to prevent unwanted volatility in net income and regulatory capital, see Section 5.1 for discussion.) Specifically: (i) even for our sample of the largest banks, about half are at a corner solution of zero qualified hedging; (ii) non-hedging is more common for small banks, and is also extremely persistent from quarter to quarter, suggestive of fixed costs of setting up a qualified hedging program; (iii) electing hedge accounting seems significantly easier for "plain vanilla" Treasury securities than for more complex bonds—e.g., in 2022-23, banks hedged 61% of AFS Treasury duration but only 11% of AFS MBS duration; (iv) as a result, and given that HTM bonds do not qualify for hedge accounting, about 30% of the banks that do hedge were close to "maxing out" their hedging capacity as measured by their AFS Treasury holdings.

To sum up, we find that banks *do* actively manage their securities portfolios in response to risk and funding shocks, but financial and regulatory frictions limit banks' capacity to sell or hedge risky securities, particularly in a rising-rate environment. 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 and McPhail et al., 2023 show that small banks are less likely to use derivatives).

From a financial stability perspective, the limits to dynamic risk management we identify could in principle be mitigated by changes in accounting and regulatory policies, such as greater use of market values for capital regulation, limits to HTM accounting, facilitating hedging (either via derivatives or by encouraging banks to hold natural hedges), or adjusting risk-weights on callable assets to take extension risk into account. Of course, such changes would give rise to a range of costs and benefits that would need to be assessed collectively (Begenau et al., 2025a; Greenwald et al., 2024; Hanson et al., 2024).

Related literature. Our paper contributes to several strands of the literature. First, we contribute to research on the drivers of banks' securities holdings (e.g., Kashyap and Stein, 2000; Hanson and Stein, 2015; Hanson et al., 2015, 2024; Rosen and Zhong, 2022; Stulz et al., 2022; Drechsler et al., 2024a) and how they affect the transmission of shocks and monetary policy to the real economy (e.g., Abbassi et al., 2016; Peydró et al., 2023; Orame et al., 2024; Giannetti et al., 2025). Closest to us, Greenwald et al. (2024) use Y-14Q data to study how unrealized securities losses in 2022-23 affected bank lending to firms. We instead focus on how banks manage portfolio composition and risk in response to external shocks. A particular contribution of our paper is to emphasize the nonlinear risks of banks' significant holdings of MBS and other assets with embedded options.[4]

Second, we extend existing research on the margins of adjustment used by financial firms in managing their securities portfolios, and the role of regulation and accounting rules (e.g., Barth et al., 1995; Laux and Leuz, 2009; Huizinga and Laeven, 2012; Bischof et al., 2021). For instance, accounting research has documented strategic trading behavior by banks in order to manage reported earnings (e.g., Barth et al., 2017; Dong and Zhang, 2018; Aland and Burks, 2023).[5] Ellul et al. (2015) identify "gains trading" by insurance companies that use historical cost accounting. Turning to other adjustment margins, several papers study how banks strategically classify securities as AFS or HTM, and how this

[4]While we study implications for bank risk, Hanson (2014) and Malkhozov et al. (2016) instead study how shifts in MBS duration influence the term structure of yields, term premia, and interest rate volatility.

[5]This literature shows that realized net gains/losses at the bank level are related to earnings net of these gains and losses. We are instead able to observe trading and gain or loss realization at the *security* level, and can therefore quantify gain/loss selling within a bank at a point in time. Furthermore, we show that banks' unwillingness to realize losses leads to higher interest-rate risk in a rising-rate environment.

choice is affected by regulatory capital management (Chircop and Novotny-Farkas, 2016; Fuster and Vickery, 2018; Kim et al., 2019, 2023). Most closely related, Granja et al. (2024) document banks' shift to HTM during the rising-rate episode to minimize measured exposure to unrealized losses, and show that hedging is very limited. This latter finding is in line with McPhail et al. (2023), who use swap-level data for 2017-19 to document limited interest-rate hedging via swaps for US banks. Our results are consistent with these papers, although we emphasize the role of callable bonds; are the first to present security-level evidence on trading, HTM classification and qualified hedging; and provide evidence on previously undocumented accounting frictions that limit hedging.

Third, our paper relates to research on how banks match the duration of assets and liabilities and implications for monetary transmission and bank fragility (Drechsler et al., 2017, 2021, 2024b; DeMarzo et al., 2024; Begenau et al., 2025b).[6] Recent evidence suggests that bank "deposit betas" increase as rates rise, reducing the effective duration of liabilities (Greenwald et al., 2023; Kang-Landsberg et al., 2023; Emin et al., 2025; Hirtle and Plosser, 2025). We highlight a different nonlinearity that *increases* asset duration in a rising-rate environment, thereby contributing to a potential duration mismatch, and shed light on frictions that may prevent banks from dynamically hedging this nonlinear risk.

Finally, we contribute to literature on the 2023 US banking turmoil (e.g., Choi et al., 2023; Flannery and Sorescu, 2023; Dursun-de Neef et al., 2023; Jiang et al., 2024; Metrick, 2024). Cipriani et al. (2024) use interbank payments to identify which banks experienced a run; consistent with our findings, affected banks borrowed more rather than selling securities (see also Glancy et al., 2024). Fischl-Lanzoni et al. (2024) find that stock prices were insensitive to unrealized securities losses prior to March 2023, arguably limiting pressure on banks to manage risk. Nevertheless, we present evidence linking banks' trading decisions to equity valuations, since sales of underwater bonds can be salient events, as illustrated by the 2023 run on Silicon Valley Bank.

2 Institutional setting and data

Securities held for long-term investment made up 26% of commercial bank assets at the start of the 2022-23 interest rate tightening cycle (source: 2021:Q4 Call Reports). These portfolios primarily consist of agency MBS and US Treasuries, with smaller shares of other fixed income instruments such as municipal bonds and corporate bonds, as well as

[6] 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).

a very small volume of equities. Below, we briefly describe necessary details about the accounting and regulatory treatment of investment securities, and then describe our data.

2.1 Accounting and regulatory environment

Investment securities are classified for accounting purposes as either as "held-to-maturity" (HTM) or "available-for-sale" (AFS).[7] HTM consists of securities that the bank has the positive intent and ability to hold until maturity, while AFS reflects bonds that may be sold in the intermediate term. The distinction between AFS and HTM is important for how realized and unrealized losses affect bank earnings, financial ratios and regulatory capital (as summarized in Table A.1). For our purposes, we highlight several key points:

1. Accounting for HTM securities is similar to a loan. The investment is recorded at amortized cost rather than at market value[8], and unrealized gains and losses due to shifts in interest rates do not affect net income, assets, equity, or regulatory capital.
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.) In contrast, banks can quite freely reclassify AFS securities as HTM.
3. AFS securities are recorded at market value, not amortized cost. But unrealized gains and losses still do not flow through net income. Instead, they accrue in a component of equity called "accumulated other comprehensive income" (AOCI).
4. Most banks exclude unrealized AFS losses and gains from regulatory capital, a treatment known as the "AOCI filter." However, the largest banks are not permitted to use the filter, and some other banks have elected not to use it.[9] Regulatory capital for these banks is effectively "marked to market" as bond values fluctuate.

Due to these rules, selling securities at a loss to book value will have significant financial implications: specifically, an AFS sale will reduce net income in the quarter of sale (as

[7]Banks also hold securities for short-term trading and market-making, primarily in the dealer bank subsidiaries of the largest bank holding companies (BHCs). For accounting purposes, such trading assets are marked-to-market, with gains and losses reflected in net income and retained earnings as they occur. We do not include trading assets in our analysis.

[8]Amortized cost is a security's carrying value, reflecting the purchase price adjusted for the gradual write-down of any premium or discount at the time of purchase. The market value, or fair value, is the current trading price of the security. Finally, the face value is the bond's principal amount to be repaid at maturity.

[9]The set of banks excluded from using the AOCI filter has changed over time, but during the 2020-23 period it includes banks with at least $700 billion in total assets or significant cross-border exposures.

losses are transferred from AOCI to retained earnings), and will reduce regulatory capital for banks using the AOCI filter. Any sales from HTM would further lead to a drop in equity capital as well as accounting (and possibly regulatory) implications of tainting.

2.1.1 Hedging

Banks can use swaps and other derivatives to hedge the risks of their securities portfolios, typically 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 asset.[10] This is important because otherwise, even a perfect hedge would generate income volatility, since gains (losses) on the derivative would be recorded in net income while the offsetting losses (gains) on the underlying bond would not.

Electing hedge accounting is not straightforward or automatic (PricewaterhouseCoopers, 2024). The hedge position must meet several criteria (e.g., it must be highly effective at offsetting the specified risk); this effectiveness must be documented and is subject to audit. Qualified hedging of assets with prepayment options (e.g., MBS) is particularly complex since the asset may not exist for the duration of the hedge. Finally, banks cannot elect hedge accounting for interest-rate risk on HTM securities (since these are held at amortized cost). We analyze bank hedging and the effect of these constraints in Section 5.

2.2 Security risks and negative convexity

Bank securities portfolios primarily consist of fixed-rate bonds that are sensitive to interest-rate risk. *Duration*—the percentage change in value for a 100 bp change in yield—measures current exposure to interest-rate risk, while *convexity* reflects the sensitivity of duration to interest rates (see e.g., Fabozzi, 1988).[11] Convexity is an important metric for dynamic risk management because portfolio risks can change significantly as rates fluctuate.

Standard fixed-coupon bonds have positive convexity, meaning that increases in yields have progressively smaller effects on price. For such bonds, duration typically declines as interest rates rise. However, banks also hold large quantities of bonds and other assets with embedded call or prepayment options, for which an increase in interest rates

[10] Specifically, the gain or loss on *both* the hedging instrument and the hedged asset are recognized in earnings. To the extent that 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.

[11] More precisely, convexity measures the curvature of the price–yield relationship. Modified convexity is defined as $C = \frac{1}{P}\frac{\partial^2 P}{\partial y^2}$, and it is related to modified duration D via $C = D^2 - \frac{\partial D}{\partial y}$.

increases the effective life of the security, because the call or prepayment option moves out of the money. This extension raises the bond's interest rate sensitivity, so its duration increases rather than decreases with rates, and it may have *negative* convexity.

The largest class of callable bonds held by banks consists of MBS backed by fixed-rate mortgages with a prepayment option. Intuitively, when interest rates rise, it becomes unattractive for borrowers to refinance or sell their homes, reducing mortgage prepayment and increasing the effective maturity of the MBS held by investors. These effects were particularly pronounced in 2022-23 due to the sharp rise in rates (Fonseca and Liu, 2024). As shown below, agency MBS make up over half of securities holdings for our sample; banks also hold (unsecuritized) fixed-rate mortgages that are similarly exposed to "extension risk." Banks additionally hold smaller quantities of municipal bonds and other securities that can be called by the obligor at a fixed price. One reason why banks may prefer to hold MBS or other callable bonds over Treasuries is that the former pay a higher yield to compensate for the embedded option, and, in the case of MBS, prepayment risk (since prepayment is uncertain for a given rate incentive; e.g., Fuster et al., 2023).

Bank securities are also subject to other risks, including credit risk. Credit risk is limited for our sample, however, since credit-sensitive holdings (e.g., sovereign and corporate bonds) are a fairly small share of bank portfolios and are typically highly-rated.

2.3 Data

Our analysis is based on security-level data on the investment security holdings of US banking organizations with at least $100 billion in total assets, reported at a quarterly frequency in FR Y-14Q Schedule B.1, encompassing banks' AFS and HTM portfolios.[12] Y-14Q filers represent 77% of total commercial bank assets and 78% of total securities as of 2021:Q4. The number of banks that file the Y-14Q fluctuates between 30-35 over our sample period (see Table A.2). In 2023:Q4, the Y-14Q sample includes 34 banks, of which 11 do not employ the AOCI filter. These are largest banks, and hold 65% of Y-14Q securities (weighted by market value) in that quarter.

Y-14Q data include, for each individual position, the amortized cost, market value,

[12] Y-14Q filers include US bank holding companies (BHC) 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.

face value, purchase date, accounting classification (AFS or HTM), and security type (e.g., agency MBS, US Treasuries[13], municipal bonds etc.). We merge these data by CUSIP and quarter with security characteristics from ICE Data Pricing & Reference Data (ICE) and MSCI's RiskMetrics RiskManager (MSCI), including maturity, coupon, duration, convexity, coupon type (fixed or floating), rating, paydown factor, and callable status. ICE and MSCI data are combined as explained in Appendix B, which also shows that the duration measures from the two vendors are closely aligned. We further merge the position-level data with information on qualified accounting hedges from FR Y-14Q schedule B.2. Key fields include the fraction of the position hedged, the type of hedged risk (e.g., interest rate, exchange rate), the hedge type (e.g., fair value, cash flow) and hedge horizon.

We also develop a novel methodology to identify outright sales of investment securities from these matched data. While purchase date is reported directly in the FR Y-14Q, sales are less straightforward to measure because we only observe end-of-quarter snapshots of banks' portfolios. If a security disappears within a quarter, this may be due to a sale, but could also reflect a bond maturing, being called or paid down, or being subject to an exchange or resecuritization that results in a new CUSIP. We use data on security characteristics to rule out these alternative cases; our approach is described in detail in Appendix B. For US Treasuries and agency MBS (where we have reliable and complete paydown factors), we also identify partial sales where only a fraction of the position is sold. Appendix B also reports cross-validation analyses using aggregate realized securities gains and losses from the FR Y-9C that indicate our method works well.

Our analysis also makes use of a variety of other data sources, including Call Report and FR Y-9C regulatory filings; eMBS; S&P Capital IQ Pro; banks' annual and quarterly reports (Forms 10-K/10-Q); bank deposit betas from Drechsler et al. (2021); Interest Rate Risk Statistics Reports from the Office of the Comptroller of the Currency (OCC); and Freddie Mac MBS exchange data. Again, see Appendix B for details of these data.

2.4 Summary statistics

The total amortized cost of securities held by banks in our sample increased slowly over 2015-18 before almost doubling between 2019:Q1 and 2022:Q1 when it peaked at $4.65 tr (see Figure A.1). Throughout this period, agency MBS comprised more than half of banks' holdings, with another 20-35% in US Treasuries, increasing over time.

[13] The reported category in the Y-14Q is "US Treasuries & Agencies," which includes Treasuries as well as bonds from various government agencies. Over 97% of volume in this category reflects Treasury bills and bonds. For the rest of the paper, we will, for simplicity, use "Treasuries" to refer to the combined category.

Table 1 presents security-level summary statistics for the period 2020-23.[14] Panel A reports a portfolio breakdown by security type. As already noted, agency MBS and Treasuries account for about 88% of holdings; the third-largest category is municipal bonds at 3.2%. Panel B then presents summary statistics by bond type. Among other things, it shows that almost all agency MBS, as well as more than half of municipal bonds, are callable; as a result remaining maturity is much higher than effective duration for these categories.[15] About 55% of securities are classified as AFS, but less than half for MBS and corporate bonds/CLOs. The share of hedged securities varies significantly by type; it is highest for US Treasuries at 26% and lowest for MBS at 3% and corporate bonds/CLOs at 1%. Finally, the quarterly sales hazard over this period averages 1.6%, again with substantial variation across security types (e.g., Treasuries are traded more than other bonds).

3 The rising rate environment and bank responses

3.1 Rising rates and rising risks

The 2022-23 period saw a historic rise in interest rates and large unrealized losses on bank securities and other assets. The rapid shift in rates also created unusually strong incentives for banks to actively manage the size and composition of their securities portfolios. First, many banks faced significant deposit outflows, creating a need to reduce asset growth—since bonds are liquid, they are a natural margin for implementing such adjustments.[16] Second, as we discuss below, the spike in rates significantly shifted interest rate *risk* for many banks, such as banks with substantial holdings of callable bonds. Active rebalancing is a natural way for a bank to offset these shifts in risk if desired (e.g., replacing long-term bonds with Treasury bills or cash). Interest-rate risk was amplified in 2022-23 by high option-implied interest rate volatility (e.g., Sarisoy, 2024).

Figure 1 summarizes key developments during this period. Panel A shows that the

[14] Appendix Table A.3 provides the same statistics for the entire period from 2015 to 2023. Tables A.4 and A.5 further break out the main categories—agency MBS and US Treasuries—into subcomponents (e.g. standard residential MBS pools, CMOs and CMBS; Treasuries, GSE debt and FHLB debt).

[15] One implication of these facts is that contractual maturity is a poor proxy for duration risk, producing measurement error that is both large and time-varying. See Figure A.2 for the time series of weighted-average duration and remaining maturity in the pooled data.

[16] Loans are less liquid than bonds because they require active monitoring, are subject to adverse selection, and are often tied to active long-term customer relationships. Banks could also respond to deposit outflows by borrowing or reducing cash and reserves. However, shrinking the balance sheet in a balanced way requires selling a mix of short-term and long-term assets; just reducing cash would increase asset duration and reduce liquidity buffers.

Federal Reserve rapidly raised the fed funds rate from near-zero in March 2022 to a 5.25-5.5% range by July 2023. Long-term yields also increased sharply over 2022, after rising moderately in 2021 in anticipation of Fed rate hikes.

As rates increased, the (mostly fixed-rate) bonds in bank portfolios rapidly lost value, as shown in panel B. This figure plots, at the security level, the cumulative density of the ratio of market value to amortized cost ("MV/AC"). MV/AC above 1 means the bond has unrealized gains, while a value below 1 means it is "underwater." In mid-2021, portfolios were roughly balanced between unrealized gains and losses. But by mid-2022, nearly all securities were underwater, with about one-third (value-weighted) having unrealized losses in excess of 10%.[17] Losses increased further by mid-2023. The small share of bonds at and above par included a mix of floating-rate bonds, hedged securities, negative-duration bonds (e.g., MBS interest-only strips), and recent purchases.

Panel C shows that higher rates led to deposit outflows, reflecting the deposit channel of monetary policy (Drechsler et al., 2017) and the March 2023 banking turmoil. For the median bank, year-on-year deposit growth was negative by mid-2023, in contrast to very strong growth in 2020-21.[18] Deposit outflows put pressure on banks to either increase deposit rates or raise wholesale funding—both costly options. Alternatively, banks could shed assets by selling AFS securities.

Finally, panel D shows that rising rates shifted banks' exposure to *future* interest rate shocks. This figure plots the interest-rate sensitivity of bank "economic value of equity" (EVE, the fair value of assets minus the fair value of liabilities) as measured internally by each bank and aggregated by the Office of the Comptroller of the Currency (OCC).[19] The figure shows that bank equity was significantly more exposed to an upward shift in interest rates in 2022-23 than in 2020-21. E.g., in 2021 the median bank with assets >$10bn projected an *increase* in EVE if the yield curve shifted by +300 bp, but in 2022-23 projected almost a 10% *decrease* in EVE under the same scenario. Risk increased even more at

[17] As shown in Appendix Figure A.3, total unrealized securities of US banks reached about $675bn by 2022:Q3, with slightly more than half of these losses in HTM securities. Y-14 banks accounted for about $500bn of these industry losses, with a disproportionate share in the HTM portfolio.

[18] This figure reflects the universe of commercial banks, but the dynamics are similar for Y-14 filers—see Appendix Figure A.4, which also shows that deposit outflows were more pronounced for uninsured deposits.

[19] The figure is based on the semi-annual OCC Interest Rate Risk Statistics report, which provides distributional statistics on EVE sensitivities in response to a parallel shift in the yield curve of between -200 bp and +400 bp. Panel D of Figure 1 focuses on the scenario of a +300 bp parallel increase in interest rates, although the evolution is qualitatively similar for +100 bp or +200 bp shocks. The OCC reports EVE sensitivities for a number of different bank size groups; we focus on the largest size class reflecting banks with >$10bn in assets. Additional details on the OCC data are discussed in Appendix B.

other points in the distribution. We also confirm these patterns using hand-collected EVE sensitivities from bank 10-K filings (see Appendix C).[20] Further, this evidence matches findings in Emin et al. (2025) and Hirtle and Plosser (2025) that bank stock prices and bank economic capital were more vulnerable to positive interest rate shocks after 2022.

One driver of this apparent increase in the duration of bank equity is that deposit betas tend to increase over a rate hiking cycle, shortening deposit duration (Greenwald et al., 2023; Kang-Landsberg et al., 2023). A second factor, as we have discussed, is that banks hold assets with embedded call options that extend in duration when rates rise, particularly mortgages and MBS. Combined, these effects imply that the duration of assets and liabilities can become mismatched as rates increase, absent dynamic risk management.

3.1.1 Risk in bank securities portfolios

Figure 2 examines more specifically how risk evolved in bank securities portfolios during this period. First, panel A documents a substantial increase in both the average *level* and the *cross-bank variation* of interest-rate risk in bank portfolios as rates rose. For example, at the 80th percentile, duration increased from just over 3 years in 2020 to 6 years by mid-2022, while for banks at the 20th percentile, the increase in risk was much more modest and almost fully reversed by the end of 2023.

At the same time, there was a sharp divergence in the riskiness of callable and non-callable bonds (panel B). Noncallable bond duration fell significantly in 2022-23, reflecting positive convexity and a shift towards shorter-term bond purchases after rates went up. In contrast, callable bond duration *increased* sharply in 2022, from about 4 to 6, and stayed high through the end of 2023, as MBS and other callable bonds extended in maturity.

In Section 3.4 we find that these two sets of facts are connected. Specifically, at the bank level, the increase in portfolio duration is closely tied to a bank's holdings of callable bonds measured ex ante, well before interest rates started to rise.

3.2 Margins of adjustment

Next, we study how banks managed their securities portfolios in response to these changes in the interest-rate environment. We study four margins of adjustment:

[20] These hand-collected data address one limitation of the OCC data, which is that they do not reflect the interest-rate risk exposures of the very largest banks. The patterns in the 10-K data are very similar to panel D of Figure 1, indicating that bank EVE became discretely more vulnerable to rising interest rates in 2022-23 than was the case prior to interest rate liftoff. This increase in EVE sensitivity in the 10-K filings is similarly pronounced for banks in different size categories, as shown in Appendix C.

(i) *Purchases.* Banks may reduce the volume and/or duration of bond purchases, to reduce balance sheet growth or to offset the rising risk of existing callable assets.

(ii) *Sales.* Similarly, banks could increase outright bond sales in order to reduce interest-rate risk and/or to shrink assets in response to deposit outflows.

(iii) *Hedging.* Banks could use derivatives to hedge rising interest-rate risk, in particular through "qualified" hedges that reduce risk without generating volatility in earnings and regulatory capital.

(iv) *Accounting classification.* Banks could respond by classifying risky (high duration and/or negative convexity) securities as HTM. This does not affect actual risk, but can make risk less visible and reduce the volatility of regulatory capital (for banks without the AOCI filter) and accounting ratios based on book equity.

We begin by presenting aggregate descriptive evidence on each of these four margins. We then study behavior at the bank level in a simple regression framework.

3.2.1 Purchases and sales

Figure 3 presents evidence on the purchases and sales margins by plotting the aggregate volume of both types of trades scaled by portfolio value in the prior quarter.

Panel A shows that banks actively scaled back bond purchases as rates increased and deposit growth slowed, from a peak rate of 20% per quarter in 2021 to only 3-4% per quarter in most of 2022-23.[21] Purchases fell close to zero for a significant share of banks (Figure A.5). However, banks did not step up outright sales of securities to shrink assets and/or rebalance their portfolios. In fact, surprisingly, sales activity was also *lower* in 2022-23 than at any earlier point in the sample.[22]

Panel B shows that this drop in bond sales activity was broadly based across Y-14 banks, with sales activity close to zero for about half the banks in each quarter during

[21] Note that bond purchases always significantly exceed sales. This is partially because bank deposits and assets were generally growing over the sample period (especially in 2020-21), but also reflects the replacement of bonds in the portfolio as they mature.

[22] Figure A.6 provides supplementary evidence that bond sales were low in 2022-23, without relying on our method for identifying sales at the security level. The figure relies on Call Reports, which do not report the volume of securities sold, but do report the realized gains/losses. The incidence of realized gains of *exactly* zero dollars (a proxy for zero sales) rises sharply after 2021:Q4, consistent with our findings from the Y-14 data. Furthermore, the distribution of quarterly realized gains/losses in 2022-23 is tightly bunched around zero, and surprisingly symmetric, even though nearly all bonds were trading well below book value. This indicates that there were few large sales. These facts hold both for Y-14 filers and the full bank population.

2022-23. Sales were particularly low in the second half of 2022, before the banking turmoil of March 2023, indicating that the policy response, notably the Bank Term Funding Program (BTFP; see Glancy et al., 2024) was not the cause of low sales.[23]

3.2.2 Hedging

Figure 4 studies whether banks responded by increasing qualified interest-rate hedging. Panel A shows that, while qualified hedging consistently reduced the duration of bank portfolios (by roughly 10-15%, or 0.4-0.6 years), the duration absorbed by hedging did not meaningfully increase from 2020 to 2023.[24] Thus, the increase in securities duration is similar whether measured gross or net of hedging.

Panel B of Figure 4 instead examines how qualified hedging affected the evolution of portfolio risk across banks. If the banks experiencing the largest rise in duration responded by hedging more, we would expect to see a tighter distribution of duration across banks after taking hedging into account. This is not what we observe, however; if anything, cross-bank variation in 2022-23 is slightly *higher* on a post-hedging basis (the solid lines in panel B). We study hedging further at the security level in Section 5.

Is it possible that banks layered on additional interest-rate hedges that did not qualify for hedge accounting? While we do not have detailed position-level data on nonqualified hedges, Figure A.8 presents Call Report data on the fair value of banks' non-trading interest-rate derivatives positions suggesting that such nonqualified hedging was small. Specifically, while the gross positive and negative fair values of banks' positions both increased in 2022, the aggregate *net* value was little changed and remained very small relative to banks' unrealized securities losses, indicating a low "hedge ratio."[25]

3.2.3 Accounting classification

While banks did not hedge more, Figure 5 shows that banks *did* insulate accounting values and regulatory ratios against interest-rate risk by classifying a larger share of bonds as HTM rather than AFS.[26] In aggregate, the HTM share for the Y-14 sample reached about

[23] Section 4.1 shows that the cross-sectional patterns we find are also not driven by the events of March 2023.

[24] Appendix Figure A.7 shows that the share of banks' AFS portfolio with a qualified hedge increased significantly but this was essentially offset by an increase in the share of bonds classified as HTM, such that the overall share of bank portfolios hedged only increased by about 2 percentage points from 2019 to 2023.

[25] These facts are also consistent with Granja et al. (2024), who find little evidence of significant interest rate hedging in 2022-23, and the detailed evidence on banks' swap positions for 2017-19 in McPhail et al. (2023).

[26] This increase in the HTM share is also documented in Kim et al. (2023), Granja et al. (2024) and Greenwald et al. (2024). Relative to this prior work, our main novel contribution is to analyze exactly which bonds

55% by late 2023 (panel A). The HTM share was also persistently higher for banks that count unrealized AFS losses towards regulatory capital, consistent with banks' use of the HTM classification to reduce regulatory capital volatility.[27]

Panel B of Figure 5 shows that individual securities with higher interest-rate risk were more likely to be classified as HTM, especially from 2022 onward. (Thus, the HTM share in panel A understates the fraction of portfolio duration that was classified as HTM.) Banks' classification of long-term bonds as HTM prior to 2022 indicates that banks were cognizant of the duration risk of these securities well before rates rose. We analyze banks' AFS versus HTM decisions in more detail in Section 6.

3.3 Bank-level analysis

The evidence so far suggests that banks reacted on some margins but not others to the higher-rate environment: banks sharply reduced bond purchases and classified more bonds as HTM, but did not sell bonds outright or hedge more. Next, we unpack these trends by studying these four margins—purchases, sales, hedging and bond classification—at the bank-quarter level in a simple regression framework using Y-14 data over 2020-23. This allows us to test in the cross-section whether individual banks most affected by deposit outflows and bond extension risk adjusted their portfolios more actively as the rate environment changed. We estimate models of the form:

$$response_{bt} = \delta_b + \kappa_t + \alpha \cdot deposit\ growth_{bt} + \beta \cdot callable\ share_b \times post + \gamma \cdot X_b \times post + \varepsilon_{bt},$$

where $response_{bt}$ is one of four margins of adjustment: security purchases, security sales, duration removed by hedging, and the share of the portfolio classified as HTM; δ_b and κ_t are bank and time fixed effects; $deposit\ growth_{bt}$ is quarterly deposit growth at the bank level; $callable\ share_b$ is the share of the bank's portfolio that is callable (measured ex ante in 2019:Q4), X_b is a set of other bank characteristics also measured ex ante, and *post* is a dummy equal to 1 in the high-rate period (2022:Q1 onwards).

were classified as HTM and how that relates to bond risk (duration and convexity) and the availability of hedging as an alternative margin to mitigate risk. (See panel B of of Figure 5 as well as Section 6.)

[27] This group, labeled as "AOCI in capital" banks in the figure, steadily increased the HTM share well before the rate hike period, whereas for the remainder of our sample the HTM share rises rapidly only starting in late 2021. Note that the marked drop in the HTM share for the "AOCI not in capital" banks between 2019:Q4 and 2021:Q4 partly reflects the effects of a 2019 regulatory reform ("tailoring rules") which raised the size threshold for including AOCI in regulatory capital. Specifically, banks that no longer counted AOCI in capital were permitted to reclassify bonds from HTM to AFS on a one-time basis and actively chose to do so (see Kim et al. 2023 for extensive discussion).

Estimates are reported in Table 2.[28] Panel A focuses on the drivers of bond purchases and sales (scaled by portfolio value lagged one quarter). Columns 1 and 5 confirm our graphical evidence that purchases *and* sales declined significantly in 2022-23. Columns 2 and 6 show that within-bank (i.e., conditioning on bank fixed effects), the volume of bond purchases responded strongly to deposit growth both before and after rates went up, but bond sales did not. Decomposing these effects, columns 3 and 7 show that bond purchases responded strongly to positive deposit growth but not negative growth—this makes sense because purchases are bounded below at zero. On the other hand, bond sales did not respond to deposit inflows *or* outflows. These patterns look similar if we include additional bank controls interacted with a post-2022 dummy (columns 4 and 8).

In addition to buying fewer bonds after rates rose, banks also shifted to buying bonds with lower interest-rate risk. As shown in Table A.7, the duration of new purchases fell by around 1 year, concentrated in Treasury purchases.[29]

Columns 2-4 and 6-8 in panel A of Table 2 also examine whether banks experiencing rising duration on callable bonds traded securities more actively in an attempt to dynamically rebalance portfolio risk. We measure each bank's exposure to extension risk using their ex-ante holdings of callable bonds in 2019:Q4. The coefficients on *Callable Bond Share* × *Post*-2022 in columns 6-8 are positive and sometimes significant, providing some evidence of additional rebalancing by banks with large holdings of callable bonds. However, the effects are quantitatively small and only marginally statistically significant (10% level in columns 6 and 7, not significant in column 8).[30]

Panel B of Table 2 studies hedging and bond classification. Column 1 finds little or no

[28]Summary statistics for the bank-quarter dataset used to estimate the model are reported in Table A.6. Since we use 2019:Q4 values as right-hand-side variables (e.g., callable share), the regression sample is restricted to banks that are present in the Y-14 data in 2019:Q4. We also note that in our purchases and sales regressions we winsorize the top 2.5% of values to limit the influence of outliers, which primarily reflect banks with small investment securities portfolios as a share of total assets.

[29]There is likely more scope to adjust Treasury duration because of the wide availability of bonds across the maturity spectrum. We do however still find a decline in the duration of MBS purchases of about 0.5 in 2022-23 compared to 2020-21 (panel C of Table A.7); moreover this may underestimate the true effect given that we only observe duration at the end of the quarter, not on the purchase date, and therefore our estimates are affected by within-quarter extension of MBS duration in 2022-23 as rates rose. Directionally, we also find in Table A.7 that banks reduced the duration of bond purchases more if they had a higher ex-ante concentration of callable bonds, although the effect is not significant in most of the columns.

[30]Reflecting limited sales and slow mortgage principal paydown, banks' agency MBS holdings shrank more slowly than Treasury holdings in 2022-23. As shown in Figure A.14, the face value of bank Treasuries fell about 15% peak-to-trough from mid-2022 to late-2023; for agency MBS the corresponding decline was less than 5% (in contrast to a large drop in the *market* value of these bonds). Note that amortized cost for agency MBS declined more than face value, due to accretion of premia paid for these bonds relative to par.

change in the duration absorbed by qualified hedging as rates and rate volatility rose in 2022-23. We also find no evidence in columns 2 or 3 that banks with a lot of callable bonds hedged more in 2022-23 to offset higher duration, as a dynamic hedging strategy would call for (Fabozzi, 1988); the coefficient on *Callable Bond Share* × *Post*-2022 is not significant and the point estimate is negative, not positive. Column 2 also shows banks holding callable bonds did not hedge more risk before rates rose.

Turning to bond classification, column 4 confirms that banks classified a larger share of bonds as HTM in 2022-23. Column 5 further shows that, in the cross-section, banks holding a lot of callable bonds also classified more bonds as HTM both before and after rates rose. This suggests that banks were cognizant of the dynamic risks of these securities and hoped to insulate accounting ratios (and, for banks without the AOCI filter, regulatory capital) against losses from higher rates.[31]

In short, while banks actively managed bond purchases and used the HTM classification, we find little evidence that hedging or outright bond sales were used to offset deposit outflows or rebalance risk in 2022-23. One implication of a reluctance to sell bonds outright is that the overall size of a bank's securities portfolio may adjust more slowly to deposit outflows than inflows. In Appendix D, we indeed find evidence of such an asymmetry, particularly in 2022-23. Here, Silicon Valley Bank (SVB) is an interesting case study; SVB's bond portfolio (mainly agency MBS) absorbed a high share of deposit inflows in 2020-21, but barely shrank in 2022 as deposits flowed out in the quarters prior to the bank's failure. These findings are also consistent with Cipriani et al. (2024), who find no response of the securities portfolio by banks subject to runs in March 2023.

3.4 Drivers of portfolio duration

Given limited dynamic portfolio management, the change in a bank's securities duration in 2022-23 is likely to be closely tied to its ex ante holdings of callable bonds. To test this hypothesis, we regress portfolio duration at the bank-quarter level (either gross or net of hedging) on a post-2022 dummy, a post dummy interacted with the callable bond share as well as other bank characteristics (as of 2019:Q4), and bank and time fixed effects.

Estimates in Table 3 show that the coefficient on *post* × *callable bond share* is consistently positive and highly significant, regardless of the set of controls used and whether

[31] This column controls for bank log assets and whether the bank includes AOCI in regulatory capital, both in levels and interacted with a post-2022 dummy, because these are also important determinants of the share of bonds classified as HTM.

securities duration is measured net of hedging. Quantitatively, a one-standard deviation (0.29) increase in the ex ante callable bond share is associated with a 0.4-0.5 larger increase in duration in 2022-23. This is equivalent to about two-thirds of the overall sample average rise in duration (as reported in columns 1 and 5).[32]

Thus, the higher dispersion of securities duration in 2022-23 can be well explained by differences in the types of bonds banks held before rates went up. Banks holding callable bonds ex ante experienced a significant extension in maturity on these securities, and did not make significant enough adjustments to their portfolio composition to offset these effects. The table also shows that portfolio duration increased more for banks whose regulatory capital is shielded from mark-to-market changes in security values through the AOCI filter, and for larger banks.

Of course, callable bond shares are not random across banks, so a natural question is how the callable share correlates with other bank characteristics. Table A.8 shows that for banks in our sample as of 2019:Q4, the callable share is uncorrelated with bank size, profitability, deposit beta and the uninsured deposit share, while it is positively correlated with mortgages/assets—i.e., banks that hold more MBS and other callable bonds also hold more mortgages, which also have prepayment risk.[33]

3.5 Implications for overall bank risk

Our results indicate that the interest-rate risk of bank portfolios increased in 2022-23, especially for banks with high concentrations of callable bonds. 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 deposits) provide a natural hedge for the extension risk on callable bonds. We now show, however, that the data indicate otherwise.

We first study whether fair-value losses on securities, and especially MBS (which experienced higher losses due to negative convexity), were offset by lower losses on other bank assets. To do so, we use data on fair-value adjustments reported by publicly traded banks in their 10-Q/10-K disclosures.[34] For each bank, we construct quarterly mark-to-

[32]The estimate is slightly larger when considering duration net of hedging, consistent with our earlier result that banks with more callable bonds directionally increased hedging relatively *less* post-2022.

[33]In a panel version of the same regression, only recent profitability (but not mortgages/assets) is marginally significantly associated with the callable share—see panel B of Table A.8.

[34]These data (collected by S&P Global, formerly SNL) are available for 187 banks for the entire sample period (172 to 183 banks in a given quarter). Among those, between 50 and 62 (depending on the quarter) are

market (MtM) equity ratios based on the fair value of assets (adjusting book values to reflect the fair value of HTM securities and net loans reported at amortized cost).[35] We then test in the cross-section whether banks with a high ratio of securities to assets, and MBS to assets in particular, saw a larger decrease in the MtM equity ratio in 2022-23 relative to the prior two years. Such a result would imply that high securities portfolio risk exposures were not offset by lower duration on other assets.

Results are reported in Table 4. In the first column, we simply regress banks' MtM equity ratio on a post-2022 dummy. The coefficient indicates that banks' mark-to-market equity ratios fell by 3.1 percentage points (pp) in 2022-23, relative to a sample average of 10%. The remaining columns show that MtM losses were significantly larger for banks with a high share of securities, and especially MBS, as a fraction of total assets. In particular, columns 3-7, which split bank security holdings into MBS and non-MBS components, show that *only* MBS holdings are significantly associated with a larger decline in the MtM equity ratio. This is consistent with our earlier findings that banks had trouble managing the progressive increase in MBS duration as interest rates rose.[36]

One potential concern is that these MtM equity ratios measure liabilities at book value and thus do not account for changes in the value of the deposit franchise—e.g., perhaps banks holding MBS had particularly low-beta depositors or deposits less exposed to deposit beta convexity. To control for this possibility, we add either a deposit beta (as estimated by Drechsler et al., 2021) interaction or quarterly deposit interest rates to the regression (columns 6 and 7). These controls barely affect our coefficients of interest.[37]

While these results show that banks with larger securities holdings and especially larger MBS holdings experienced larger overall mark-to-market losses, 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. However, as previously shown in Section 3.1,

among the top-100 US banks based on bank assets.

[35] This mark-to-market approach is similar to Jiang et al. (2024), although our estimates are based directly on banks' own calculations of the fair market value of their assets, rather than external estimates of fair values based on asset composition and aggregate price indices.

[36] Since MBS holdings may be correlated with ownership of whole mortgages, columns 5-7 control separately for *post-2022* $\times$ *Mortgages/Assets*. As can be seen, this control leaves the coefficient on MBS/Assets almost unchanged, although banks with high mortgage holdings (which also carry extension risk) also experienced a larger decline in the MtM equity ratio, albeit with a smaller coefficient, perhaps because banks disproportionately keep adjustable-rate mortgages in portfolio (Fuster and Vickery, 2014).

[37] The positive coefficient on *post-2022 /times Deposit Beta* indicates that banks with higher deposit betas experienced smaller fair-value losses on their assets as rates rose. This is consistent with these banks holding shorter-duration assets to match their less "sticky" deposits, as in Drechsler et al. (2021).

the sensitivity of banks' EVE to rising interest rates became significantly more negative in 2022-23, speaking against this hypothesis. Furthermore, in Appendix C we use data on EVE sensitivities reported in banks' 10-K disclosures to show that that banks with high shares of MBS and/or mortgages on their balance sheet became differentially more exposed to interest rate increases after 2021, in line with our argument that banks did not dynamically hedge the increasing duration of callable assets as rates increased.

Finally, one could argue that, by late 2022, banks no longer needed to insulate their portfolios against interest-rate risk because "the damage had already happened" and further rate increases were unlikely. However, this view is not borne out either by the high interest rate volatility implied by option markets at the time (e.g., Sarisoy, 2024) or the rate predictions of professional forecasters—see Appendix E for further analysis and discussion. Our earlier findings are also consistent with banks being concerned about the risk of further rate increases, particularly the fact that banks reduced their bond purchases, shifted purchases to shorter-duration securities, and classified more securities, especially long-duration bonds, as HTM.

4 Strategic trading

We have shown that outright bond sales played very little role in bank portfolio management in 2022-23—aggregate sales activity actually *fell* significantly, and sales, unlike purchases, were insensitive to bank deposit flows. In this section, we investigate a simple explanation for these facts, which is that banks did not want to crystallize unrealized losses by selling underwater bonds at a discount to book value.

Industry sources suggest anecdotally that a reluctance to sell underwater bonds was an important constraint on portfolio management in 2022-23 (Santander, 2024; American Banker, 2023; S&P Global, 2023).[38] Such reluctance could be driven by several factors. First, such sales will reduce regulatory capital for banks employing the "AOCI filter", as discussed in Section 2.1. Second, there will be an immediate negative impact on net income in the quarter of sale.[39] Third, banks may be concerned that bond sales could draw

[38] E.g., Santander (2024) describes banks' challenges in managing the nonlinear risks of MBS, writing that *"The news from Truist and other banks points to a clear interest in reducing duration and possibly the hard-to-manage negative convexity of MBS ... [but] For now, significant selling of MBS by banks is constrained by an unrealized mark-to-market loss of nearly $200 billion"*, while S&P Global (2023) writes that *"Most institutions seem hesitant to sell underwater bonds, even for restructuring"*.

[39] The initial shock to income and capital will be gradually offset by higher interest income as sale proceeds are reinvested at higher yields. Anecdotally, banks are keenly aware of this tradeoff, e.g., American Banker

attention to unrealized losses (e.g., in the case of SVB, an announced sale of underwater bonds was highly salient and triggered the bank's failure). Fourth, behavioral factors may play a role, akin to the "disposition effect" documented for retail investors (Odean, 1998). Fifth, banks may simply not want to sell because they believe these underwater bonds have high expected returns (e.g., because interest rates are expected to soon fall).

Below, we use security-level data to test systematically whether banks did indeed trade strategically to avoid selling underwater bonds. We also use data on bond and bank characteristics to disentangle motivations for strategic trading discussed above.

4.1 Strategic trading in 2022-23

We estimate various models to test whether an underwater bond was less likely to be traded, holding fixed the bank identity and a rich set of bond characteristics, of the form:

$$sale_{cbt} = f(market\ value/amort.\ cost)_{cbt} + \delta_{bt} + \gamma X_{ct} + \varepsilon_{cbt}, \quad (1)$$

where $sale_{cbt}$ is the fraction of the bond position sold in the following quarter for CUSIP c held by bank b in quarter t;[40] $f(.)$ is a function applied to the bond's ratio of market value to amortized cost ("MV/AC"); δ_{bt} are bank-time fixed effects included in some specifications (while other models just include bank and/or time dummies); and X_{ct} is a vector of security characteristics at date t including duration, convexity, remaining maturity, security type, a floating rate dummy, and the number of quarters since the bond was purchased. We estimate the model on banks' AFS portfolios only, given the restrictions on sales of HTM securities (as discussed Section 2).[41]

To begin, Figure 6 presents binned scatter plots of the relationship between MV/AC and the sale propensity using data from 2022-23, allowing this relationship to take a flexible non-parametric form. The plots are quite striking, and show that bond sales are much more likely among securities trading at or above book value than bonds that are underwater. Quantitatively, the raw quarterly sales propensity for above-water securities is

(2023) quotes a bank CFO as saying: *"We're very similar to a lot of banks where the whole portfolio is underwater." Reinvesting into higher-yielding options would "create a much better run rate going forward, but the capital hit would be significant."*

[40] The sales propensity captures complete sales of a CUSIP (in which case the dependent variable is equal to 1) and, for Treasuries and agency MBS, also partial sales, in which case the dependent variable is equal to the fraction sold, between 0 and 1.

[41] We weight observations by amortized cost in most specifications, and double-cluster standard errors by bank-quarter and CUSIP. In our main analysis, we limit the sample to 2022-23; that is when t is between 2021:Q4 and 2023:Q3 given that our outcome variable reflects sales in the following quarter. We report evidence for a longer 2015-2023 sample period in Appendix F.

around 9%, while for underwater securities, it is only around 1% (panel A). The pattern looks very similar when we condition on bank-by-quarter fixed effects—so we study variation within a bank at a point in time, thus holding its overall sales propensity fixed—and security-level controls (panel B).

Next, we present regression estimates to better quantify these differences in sales propensities and assess their statistical significance. Since the graphical evidence suggests that what mainly matters is whether a security is underwater (while "how deeply underwater" seems to have little effect), we group CUSIPs into three bins: $MV/AC < 0.99$ ("underwater"), $MV/AC \in [0.99, 1.01]$ ("around par"), and $MV/AC > 1.01$ ("above-water"). We define underwater securities as the base category in the regressions.

Linear probability results are reported in panel A of Table 5. In column 1, which includes no controls or weighting, bonds trading around or above book value are 1.4-1.9 pp more likely to be sold, relative to a baseline quarterly sale propensity for underwater securities of 0.91%. Weighting CUSIPs by amortized cost substantially increases both coefficients (column 2), and for the rest of the analysis, we focus on weighted results since they better reflect the economic importance of the different securities held by banks. Columns 3-5 indicate that adding time or bank-by-time fixed effects and controlling for security characteristics leaves the results qualitatively unchanged.

Finally, our most saturated model (column 6) includes bank-by-time and CUSIP-by-time fixed effects, meaning we compare sale likelihood for the same bond in the same quarter across banks where MV/AC differs (e.g., due to different purchase dates or hedging). This substantially reduces the number of observations, but the results are if anything even more pronounced. This shows that the lower sales propensity of underwater securities is not due to bond characteristics such as liquidity.[42]

Panel B repeats the analysis using logit models, where the reported coefficients are odds ratios and the outcome variable is equal to 1 if the position is entirely sold.[43] In our preferred specification in column 4, the odds of a security being sold are 3.2 times higher for a security around par than for an underwater security, and 8.5 times higher

[42]Liquidity differences likely plays a fairly small role in bank trading decisions given that Treasuries and agency MBS, which make up the vast bulk of bank portfolios, are among the most liquid fixed-income instruments. As a further robustness check, Table A.9 shows that results are robust if we restrict the sample to Treasuries only, where liquidity differences across bonds are smallest.

[43]We have also experimented with fractional logit models that allow for partial sales. These often do not converge, particularly in later regressions with interaction effects. However, for this set of regressions, the fractional logit estimates look similar to the bivariate logit results (see Table A.10).

for an above-water security.[44] The logit model is restricted in the number of fixed effects that can be estimated; 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 more realistic, and will be particularly helpful in the coming subsections where we use interaction terms.[45]

Finally, the results in this section are qualitatively unchanged if we restrict the sample to 2022 only (see columns 3 and 4 in Table A.9). This shows that bank strategic trading is not driven by the banking turmoil of March 2023 or the policy reaction that followed.

4.2 What drives strategic trading?

In this section use bank and security-level data to disentangle different explanations for the strategic trading observed in the data.

First, our estimates speak against the idea that banks refrained from selling underwater bonds because they anticipated high ex-post returns. Such a hypothesis would predict trading is driven by duration and convexity, which determine exposure to a shift in the yield curve. However, these two controls are not statistically significant in the regressions reported in Table 5[46], while our estimates of the effect of being underwater are almost unchanged after controlling for these factors and other bond characteristics (or even bond-by-quarter fixed effects). The idea that banks were simply betting on lower rates is also at odds with the drop in duration for new purchases documented above.

Next, we consider whether trading was motivated by regulatory capital management, specifically the fact that selling bonds at a loss will reduce regulatory capital for banks using the AOCI filter (essentially for all but the very largest banks, which are not permitted to use the filter). We test this hypothesis in panel A of Table 6 by comparing banks with and without the filter in place. As above, we estimate logit models, but now include only a single dummy for $MV/AC > 0.99$ ("not underwater") to simplify the analysis.

[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.

[45] Whenever we use logit models, we report 95% confidence intervals for the estimated odds ratios, rather than standard errors (which are not easily interpreted).

[46] The estimates are omitted from the table to save space, but the coefficients (t-statistics) on the duration and convexity controls in column 5 of Table 5 panel A are -0.000141 [t=-0.16] and 0.000188 [t=0.23], respectively. Coefficients on duration and convexity in the logit model in panel B are also not statistically significant.

Column 1 shows that, without any controls, bonds that are not underwater are 4.8 times more likely to be sold than bonds that are underwater; in column 3, which includes bank and time fixed effects and security controls, the coefficient is 4.2. In columns 2 and 4, we then interact the not-underwater dummy with an indicator for whether the bank excludes AOCI from capital. In both cases interaction term is positive and economically large, and, while not quite statistically significant in column 2, it is significant at $p < 0.05$ in the preferred specification in column 4 with bank and time fixed effects.[47] Quantitatively, the column 4 estimates imply that banks with the AOCI filter in place were 7.9 times more likely to sell a security if not underwater ($7.9 = 3.09 \times 2.57$), compared to only 3.1 times for banks not using the filter.

Finally, column 5 addresses a potential confound, namely that banks not using the AOCI filter are also larger, and size itself might also affect willingness to sell underwater bonds (e.g., due to different capital or liquidity requirements). To test this, we add the log of bank assets to the regression and interact it with the not-underwater dummy. This asset size interaction term is not statistically significant, while the interaction coefficient of interest (on MV/AC $> 0.99\times$ AOCI not in capital) remains significant and in fact slightly larger in magnitude (albeit estimated less precisely).

Next, we use a similar approach to study other potential drivers of strategic trading (panel B of Table 6). First, we study whether banks with a lower regulatory capital buffer, measured by whether the bank has a CET1/RWA buffer (relative to its capital requirement) below the sample median in that quarter, are particularly averse to realizing losses. Columns 1 and 6 show that banks with low capital buffers are directionally less willing to sell underwater bonds, but the effect is not statistically significant.[48]

Second, the negative net income and signaling effects of selling bonds at a loss may be particularly salient for banks whose stock is already "under pressure." We proxy this in two ways: a dummy if the bank has a price-to-book (PB) ratio below the bank sample median in that quarter, and a dummy for whether the year-over-year stock return is below

[47] The uninteracted coefficient on "AOCI not in capital" of 0.297 in column 2 indicates that for securities that are underwater (the base category in the regression), banks that include AOCI in capital are almost 3.5 times (1/0.297) 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. Also note that the uninteracted coefficient on "AOCI not in capital" in column 4 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.

[48] Here and in other columns we control for MV/AC $> 0.99 \times$ *AOCI not in capital*, given its importance as shown in panel A of Table 6. All regressions also include the uninteracted bank characteristics that we use for our interaction terms; however, we do not report them to keep the table readable.

median.[49] We find that banks with a low PB ratio display a much stronger disposition effect, with an odds ratio of 4.3 in column 2 (significant at $p < 0.01$) and 3.2 in column 6 which includes all interactions at the same time ($p < 0.05$). In contrast, column 3 indicates that strategic trading is not related to recent stock returns.

Third, we investigate proxies for liquidity risk in columns 4 and 5. Column 4 shows that banks that hold low central bank reserves compared to the size of their securities portfolio are significantly more likely to avoid selling underwater bonds, perhaps consistent with concerns about liquidity risk (although the effect is no longer significant in column 6, which includes all interaction terms simultaneously). Furthermore, column 5 finds no evidence that strategic trading is more pronounced for banks with a higher proportion of uninsured deposits, arguably a better proxy for run risk.

To sum up, we identify significant variation in the extent to which banks traded strategically to avoid selling underwater bonds in 2022-23. Our results suggest that strategic trading is amplified when securities losses are not marked-to-market in bank regulatory capital, and when a bank is viewed critically by the stock market. We do note, however, that while these factors appear quite robust to various controls, the bank characteristics we examine are not randomly assigned and may be correlated with omitted factors that affect banks' trading behavior.

Finally, Appendix F studies strategic trading over a longer sample period, 2015-23. We show that banks also traded strategically prior to 2022, but were most likely to sell bonds trading close to book value (rather than those at a premium). Taken together, the patterns suggest that trading in the 2022-23 period was driven more by income and capital maximization, while in previous years, banks prioritized income smoothing, consistent with evidence from accounting research (e.g., Dong and Zhang, 2018).

5 Frictions in hedging

Hedging is a second margin which played surprisingly little role in bank risk management in 2022-23. To summarize our earlier findings: (i) the overall amount of qualified interest-rate hedging was little changed as rates rose, (ii) banks holding MBS and other callable bonds did not dynamically hedge as the duration of their bond positions extended, and (iii) there is no evidence that banks increased *non-qualified* hedging.

[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.

In this section, we present evidence that the above facts can at least partly be explained by frictions that constrain banks' ability to hedge interest-rate risk through qualified hedging. These frictions include not just the transaction costs and margin requirements of the hedge position, but also the administrative costs and risks of documenting hedge effectiveness, and constraints on which securities are eligible for hedge accounting.[50]

5.1 Background on qualified hedging

In a qualified hedge, gains (losses) on the derivative are netted out against offsetting losses (gains) on the underlying bond. As discussed in Section 2.1, hedge accounting addresses an accounting mismatch—derivatives are marked-to-market with gains and losses reflected in net income, but securities are not—enabling the bank to avoid misleading volatility in net income and, for most banks, regulatory capital.[51] Thus, if possible, banks prefer to employ hedge accounting when hedging risk.

Electing hedge accounting is not automatic, however, and involves costs and risks. To qualify, 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). The bank must document hedge effectiveness and monitor it over time, and this documentation is subject to audit (e.g., PricewaterhouseCoopers, 2024). E.g., J.P. Morgan Chase's 2024 10-K describes using both statistical and nonstatistical methods to assess the effectiveness of each hedge at least quarterly (see Appendix G). In short, as PricewaterhouseCoopers (2024) writes, *"the qualifying criteria for hedge accounting are rigorous and require a commitment of time and resources."*

Hedge accounting is especially complex for callable bonds because the life of the asset is uncertain. Since 2017, "last-of-layer" and more recently "portfolio-layer" approaches allow the bank to hedge one or more layers of a bond portfolio expected to remain outstanding for the designated hedge period (e.g., the first $300m on a $1bn agency MBS portfolio). While adoption of such approaches has increased in recent years (Figure A.7),

[50] Prior research finds that small banks typically 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; McPhail et al., 2023; Granja et al., 2024). Our key contribution is to present new evidence on the *sources* of the frictions involved in banks' use of derivatives to hedge risk.

[51] E.g., assume a bank has a $1bn Treasury portfolio hedged perfectly against interest-rate risk using swaps. Now rates fall, generating $100m in Treasury gains offset by a $100m loss on the swap. While the economic value of the bank is unchanged, the accounting impact would be a $100m loss, because the derivatives loss is reflected in net income but the bond gain is not. Regulatory capital would also fall if the bank employs the AOCI filter. With hedge accounting, the offsetting gains/losses on the bond and derivative will be netted out, matching the accounting treatment with the economic impact.

these methods add complexity and offer only partial hedging for agency MBS and other callable bonds, which as we have shown make up a large share of bank portfolios.

A further key constraint is that HTM securities do not qualify for hedge accounting. This is particularly important in our sample period given the shift from AFS to HTM and the fact that risky (high-duration) bonds are disproportionately classified as HTM.

5.2 Evidence

We now conduct several tests of whether financial and accounting frictions constrained qualified hedging activity before and during the rise in rates in 2022-23.

First, we test whether qualified hedging is more difficult for more "complex" securities, including bonds with call/prepayment risk (e.g., MBS) and credit risk (e.g., sovereign or corporate bonds). To do so, we estimate a security-level regression of the share of bond value hedged against interest-rate risk on duration, convexity, security type dummies and, in some specifications, bank-by-time fixed effects. (The regression sample is limited to AFS securities, given that HTM securities do not qualify for hedge accounting.)

Results are reported in panel A of Table 7, and show that Treasuries—the omitted base category in the regressions—are indeed much more likely to be hedged than any other major security type. Columns 1-3 study the 2022-23 period; focusing on column 3, which includes bank-by-time fixed effects, the hedge percentage is 30.4 pp and 39.7 pp lower, respectively, for agency MBS and municipal bonds (the security types with the highest fraction of callable bonds) compared to a Treasury bond with the same risk as measured by duration and convexity. These differences are very large compared to the sample average Treasury hedge percentage of 46%. Corporate/CLO, sovereign, and "other" bonds are also much less likely to be hedged.[52] The table further shows, not surprisingly, that hedging is more common for bonds with higher duration. Convexity is not significantly related to hedging intensity after conditioning on security type.

Columns 4-6 of Table 7 show proportionately similar differences in hedging by security type in 2020-21.[53] It is also notable in this period that bonds with negative convexity—

[52]The differences can also be seen in the summary statistics reported in Table A.11. 46% of banks' AFS Treasury holdings are hedged against interest-rate risk in 2022-23, compared to only 9% for agency MBS. Taking duration into account, qualified hedges offset 61% of the total duration of banks' AFS Treasury holdings, versus only 11% for agency MBS. (These statistics account for both full and partial hedges.)

[53]The sample average hedge percentage is higher in 2022-23 than 2020-21. This is not due to an increase in overall hedging activity though. Instead, it simply reflects that a higher share of bonds were classified as HTM in 2022-23; such HTM bonds are excluded from the Table 7 regression sample because they do not qualify for hedge accounting.

which later extended in duration—were *less* likely to be hedged both unconditionally and even conditional on security type dummies. These results are consistent with the idea that dynamically hedging the nonlinear risks of MBS and other callable bonds is complex in practice due to challenges in applying "last-of-layer" accounting methods.

5.2.1 Bank-level analysis

Next, we study qualified hedging at the bank level, with a focus on two questions. First, given the complexity of hedge accounting, is there evidence of significant fixed costs and scale economies in bank hedging activities? Second, given that qualified hedging is not permitted for HTM securities, and seems more difficult for non-Treasury bonds, are there banks that effectively "maxed out" their hedging capacity as measured by their AFS Treasury holdings? Evidence on these two points is presented in panel B of Table 7, which reports simple but revealing summary statistics on bank hedging behavior over 2020-23. (Separate statistics for the 2020-21 and 2022-23 subperiods are reported in Table A.12.)

Panel B of Table 7 highlights several facts consistent with fixed costs and scale economies in hedging. First, even within our sample of the largest banks, there is a large mass of banks at a corner solution of zero qualified hedging activity—hedging is zero in 54% of bank-quarter observations. Second, whether a bank hedges is strongly related to bank size—66% of banks with above-median assets engage in hedging, but only 22% of below-median banks do so.[54] Third, as shown in rows 2 and 3 of the table, the decision to engage or not engage in hedging is extremely persistent. If a bank did not hedge in quarter *t-1*, the probability that it starts doing so in quarter *t* is only 3%. Conversely, banks that *did* hedge in quarter *t-1* were almost certain to keep doing so (98.7% probability).

Finally, the table reports the fraction of banks that hedge all or almost all of the interest-rate risk in the 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 24% of active hedgers hedge out at least 80% of AFS Treasury duration. This rises to 31% in 2022-23 when more of banks' portfolios is classified as HTM (see Table A.12). In other words, it seems that a subset of banks were indeed close to "maxing out" their Treasury hedging capacity. In the cross-section, large banks are more likely to be constrained (30% for the sample overall, compared to only 7% for below-median-size banks).[55]

[54] We do not see similar differences on the intensive margin, however. While smaller banks hedge less overall (row 4), they hedge slightly more conditional on hedging at all (row 5), although the difference is not statistically significant. Average duration removed by hedging (conditional on some hedging) is 0.7 years.

[55] Here we reach a different conclusion to Granja et al. (2024), who conclude that banks had significant "head-

6 Bond classification

While banks did not hedge more, an alternative margin we have shown *was* widely used was to classify more bonds as HTM rather than AFS. Even though HTM losses are still publicly reported (in Y-9C and Call Reports, and in notes to 10-Q/K filings), classifying risky bonds as HTM may have several benefits. First, securities losses may be less salient since they do not directly appear on the balance sheet. Second, accounting ratios based on book equity will be less volatile and interest-rate sensitive; this applies, for instance, to tangible common equity, which rating agencies, Federal Home Loan Banks, equity analysts, regulators and others used during our sample period to help assess bank risk and solvency (Federal Home Loan Bank of Boston, 2022; Federal Reserve Bank of Kansas City, 2023). Third, regulatory capital will be less volatile for banks not using the AOCI filter. On the other hand, classifying bonds as HTM may constrain the bank's capacity to manage risk and liquidity, because HTM bonds cannot be sold or hedged.

In this section, we extend prior research by studying at the security level the determinants of which bonds are classified as HTM, and in particular whether banks classified risky but "hard to hedge" bonds as HTM as a substitute for hedging. To proceed, we estimate a linear model for whether a bond is classified as HTM as a function of the same variables used to study qualified hedging, namely measures of interest-rate risk (duration and convexity), security type dummies, and in some models bank-by-time fixed effects. As in our hedging analysis, we examine the 2020-21 and 2022-23 periods separately.

Estimates are reported in Table 8. We highlight three main findings. First, bonds with more interest-rate risk are more likely to be classified as HTM, regardless of whether we condition on security type dummies or bank-by-time fixed effects. The relationship between duration and HTM classification is most pronounced in 2022-23: within-bank, an additional year of duration increases the probability of HTM classification by 3.6 pp compared to 1.5 pp in 2020-21 (focusing on the "within-bank" specifications in columns 3 and 6). Second, agency MBS, which we previously argued have nonlinear risks and are difficult to hedge, are significantly more likely to be classified as HTM compared to Treasuries, by 21 pp in both sub-periods when we condition on risk and bank-time fixed

room" to increase AFS hedging further in 2022-23. One reason why is that we measure how much duration is represented by remaining unhedged bonds, rather than just the fraction of securities that are hedged or unhedged. (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 these securities represent.) Second, we take into account the fact that applying hedge accounting to non-Treasury securities appears more difficult and costly for banks, a point not previously established in the literature to our knowledge.

effects.[56] Third, and closely related, in 2020-21 banks were also more likely to classify the most negatively-convex bonds as HTM (e.g., MBS coupons most exposed to extension risk if rates went up), even conditional on security type.

These results suggest that banks indeed used the HTM classification to reduce *measured* exposure to bonds with high and nonlinear risks that were difficult to hedge. Moreover, the fact that banks classified negatively-convex bonds as HTM during 2020-21—prior to the rise in interest rates—indicates that banks were aware of the risks of such securities in a rising-rate environment.

From a financial stability perspective, while qualified hedging and HTM accounting both reduce the volatility of regulatory capital and book equity, they of course do not have equivalent effects on the fundamental risk borne by the bank. The disconnect between rising interest-rate risk in bank portfolios and the falling portion of this risk captured in book equity and (for the banks without the AOCI filter) regulatory capital is illustrated in Figure 7. The top line shows pooled duration for banks in our sample. The middle line shows net duration after hedging—arguably the most economically relevant quantity. The bottom line shows the portion of net duration that is in AFS portfolios and thus may affect book equity and regulatory capital. While gross and net duration increased significantly from 2020 to 2022, the shift to HTM meant that "visible" duration decreased to a historically low level by 2023:Q4.

7 Conclusions

Bank securities portfolios consist of liquid instruments that in principle can play a key role in risk management. Studying the 2022-23 rising-rate period—a episode that featured significant deposit outflows as well as rising duration on bonds with embedded call options—we find that banks do indeed use securities to manage risk and liquidity, but that financial frictions put important constraints on dynamic portfolio management. Specifically, we find that banks are highly averse to selling underwater bonds at a discount to book value, and face fixed costs and other constraints in using qualified hedging instruments to manage risk. Instead of selling or hedging, banks increasingly classified

[56]Other security types were also typically more likely to be classified as HTM than Treasuries, although not universally. Focusing on column 6, in 2020-21, municipal, corporate and "other" bonds were statistically more likely to be classified as HTM, while for sovereign bonds there is no statistically significant difference relative to Treasuries. In 2022-23, after rates rose, corporate and other bonds are still more likely to be classified as HTM, but municipal and sovereign bonds are less likely. These differences suggest there may be some security-type specific factors that also influence the HTM decision.

the riskiest bonds as HTM—a maneuver that reduces measured interest-rate risk exposure without altering the underlying economic risk.

From a broader perspective, our results show how the regulatory and accounting framework can shape bank risk-taking and overall systemic risk. For instance, while there are costs and benefits to the use of market value accounting, such a framework can reduce frictions in banks' active management of securities and other assets. Our results also highlight banks' significant exposure to callable assets, particularly agency MBS. These bonds are challenging to manage in a volatile interest-rate environment—as we illustrate, they decline quickly in value and increase in duration when rates rise, while being complex to hedge. Therefore, holding a high concentration of such assets (as opposed to, e.g., Treasury bonds with the same initial duration) makes it difficult for a bank to keep its assets and liabilities duration-matched when rates rise.

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Table 1: Summary statistics

A. Composition of security types

Security Type	Dollar-weighted Share (%)	Observations (000s)	Observation Share (%)
Agency MBS	57.72	1082.42	70.24
US Treasuries	29.97	42.57	2.76
Municipal Bond	3.19	259.85	16.86
CLO	3.00	19.15	1.24
Sovereign Bond	1.19	10.82	0.70
CMBS	1.10	23.22	1.51
Corporate Bond	0.89	39.96	2.59
Student Loan ABS	0.80	11.22	0.73
Domestic Non-Agency RMBS	0.58	28.39	1.84
Auto ABS	0.49	6.72	0.44
Credit Card ABS	0.38	1.77	0.12
Other ABS	0.31	4.77	0.31
All Other	0.37	10.25	0.66
Total	100	1541.11	100

B. Summary statistics by security type

	Agency MBS	US Treasuries	Municipal Bonds	CLO/ Corporate	Sovereign Bonds	Other	Total
Coupon (%, annual)	2.58	1.31	3.66	2.95	1.43	2.47	2.22
	(0.93)	(0.92)	(1.41)	(2.25)	(1.14)	(1.66)	(1.23)
Fixed Rate (%)	92.11	99.55	86.15	17.69	76.06	43.72	89.07
	(26.96)	(6.71)	(34.54)	(38.16)	(42.67)	(49.60)	(31.20)
Callable Bonds (%)	94.65	1.38	72.07	11.66	0.18	0.57	57.80
	(22.50)	(11.65)	(44.87)	(32.09)	(4.26)	(7.52)	(49.39)
Remaining Maturity (years)	23.80	4.43	16.67	9.14	3.06	19.74	16.85
	(8.04)	(4.13)	(8.06)	(3.65)	(1.98)	(14.82)	(11.54)
Effective Duration (years)	4.65	3.95	5.97	0.73	2.18	2.37	4.21
	(2.17)	(3.35)	(4.67)	(1.78)	(1.82)	(2.54)	(2.84)
Convexity (years)	-0.79	0.30	-0.04	0.05	0.67	0.06	-0.34
	(1.50)	(0.70)	(2.57)	(0.51)	(3.71)	(4.22)	(1.67)
AFS (%)	49.13	63.75	58.83	45.52	95.86	81.31	55.55
	(49.24)	(44.46)	(49.17)	(49.34)	(19.60)	(38.34)	(48.19)
Hedged (%)	3.20	26.16	10.04	1.21	19.86	10.51	10.71
	(15.20)	(40.29)	(29.40)	(10.87)	(38.72)	(30.29)	(28.55)
Mkt 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)
Quarterly Sales (%)	1.10	2.63	2.51	0.83	1.23	1.49	1.62
	(10.27)	(33.15)	(15.64)	(9.06)	(11.04)	(12.12)	(20.32)

Notes: The table reports summary statistics for different security types. The sample covers the 2020:Q1-2023:Q4 period. US Treasuries include Treasury bills, notes, bonds, and agency debt. In panel A, *All Other* is a collective category including covered bonds, preferred stock, CDOs, foreign RMBS, mutual funds, cash equivalents, municipal income funds/trusts, commercial paper, collateral trust notes, note purchase agreements, and uncategorized securities. In panel B, *Other* in column 7 includes CMBS, corporate bonds, student loan ABS, domestic non-agency RMBS, Auto ABS, credit card ABS, other ABS, and *All Other* as defined in panel A. *Quarterly Sales* includes full and partial sales. Standard deviations are reported in parentheses. All values are weighted by security amortized cost. Sources: FR Y-14Q, Schedule B; ICE; MSCI.

Table 2: Bank-level responses to rising interest-rate risk

A. Purchases & sales

	Purchases				Sales			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2022	-0.065***				-0.012***			
	(0.012)				(0.004)			
Callable Bond Share × Post-2022		-0.035	-0.035	-0.019		0.020*	0.020*	0.027
		(0.034)	(0.034)	(0.046)		(0.011)	(0.011)	(0.021)
Deposit Growth		0.437***		0.446***		-0.010		-0.010
		(0.105)		(0.102)		(0.029)		(0.028)
Deposit Growth × Post-2022		0.288		0.261		0.030		0.045
		(0.180)		(0.168)		(0.045)		(0.045)
Deposit Growth x (Growth > 0)			0.731***				0.010	
			(0.113)				(0.029)	
Deposit Growth x (Growth < 0)			-0.046				-0.025	
			(0.173)				(0.061)	
Obs.	496	496	496	496	496	496	496	496
Time FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	No	No	Yes	No	No	No	Yes
DV average pre-2022	0.14	0.14	0.14	0.14	0.020	0.020	0.020	0.020

B. Hedging & HTM classification

	Hedging			HTM Classification		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-2022	0.095			0.123***		
	(0.059)			(0.033)		
Callable Bond Share		0.118			0.316***	
		(0.372)			(0.091)	
Callable Bond Share × Post-2022		-0.296	-0.399		0.006	0.052
		(0.222)	(0.243)		(0.112)	(0.120)
Deposit Growth		-0.209	-0.025		0.121	-0.228
		(0.290)	(0.169)		(0.222)	(0.144)
Deposit Growth × Post-2022		-0.195	-0.265		-0.403	0.041
		(1.051)	(0.335)		(0.655)	(0.195)
Obs.	496	496	496	496	496	496
Time FE	No	Yes	Yes	No	Yes	Yes
Bank FE	Yes	No	Yes	Yes	No	Yes
Controls: Log(Assets) and AOCI	No	Yes	Yes	No	Yes	Yes
Controls: Other	No	No	Yes	No	No	Yes
DV average pre-2022	0.27	0.27	0.27	0.21	0.21	0.21

Notes: The table shows estimates of bank×quarter regressions of purchases, sales, hedging activity, and HTM classification on bank characteristics. The sample covers the 2020:Q1-2023:Q4 period. In panel A, purchases and sales are scaled by each bank's securities portfolio size in the previous quarter (ratio winsorized at the top 2.5th percentile). In panel B, hedging is measured as the market-value-weighted average of the bank's gross minus net duration across all bonds; HTM classification is the market-value weighted average of a dummy variable equal to 1 if a bond is classified as HTM. *Callable Bond Share* is measured as of 2019:Q4. *Deposit growth* is the quarterly log change in deposits. Controls in both regressions include uninsured deposit share, log(Assets), and securities share to total assets (all measured as of 2019:Q4) interacted with a *post* dummy. We also include a contemporaneous indicator for *AOCI not in Capital*. *Time FE* indicates year×quarter fixed effects. Standard errors, reported in parentheses, are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All variables are summarized in panel A of Table A.6. Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Table 3: Bank-level determinants of duration

	Gross Duration				Net Duration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2022	0.856***				0.761***			
	(0.158)				(0.165)			
Post-2022 × Callable Bond Share		1.761***	1.344***	1.459***		1.958***	1.630***	1.857***
		(0.368)	(0.411)	(0.365)		(0.414)	(0.511)	(0.463)
Post-2022 × AOCI Not in Capital			0.694***	0.615***			0.562**	0.450*
			(0.218)	(0.211)			(0.258)	(0.223)
Post-2022 × Log(Assets)			0.331**	0.310**			0.286**	0.273**
			(0.127)	(0.129)			(0.128)	(0.118)
Obs.	496	496	496	496	496	496	496	496
Time FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	No	No	Yes	No	No	No	Yes
DV average pre-2022	3.3	3.3	3.3	3.3	3.1	3.1	3.1	3.1

Notes: The table shows estimates of bank × quarter regressions of duration, defined as the market-value-weighted average security duration, on bank characteristics. The sample covers the 2020:Q1-2023:Q4 period. *Gross duration* (used in columns 1–4) refers to duration before hedging; *Net duration* (columns 5–8) is after hedging. Bank characteristics are defined as of 2019:Q4, except for *AOCI Not in Capital* which is contemporaneous. *Post-2022* is a dummy variable equal to one for the period 2022:Q1–2023:Q4 and zero otherwise. Controls include uninsured deposit share and securities share to total assets, each interacted with a *post* dummy. *Time FE* indicates year×quarter fixed effects. Standard errors, reported in parentheses, are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. All variables are summarized in panel A of Table A.6. Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post-2022	-0.0311***	-0.0178***	-0.0168***				
	(0.002)	(0.004)	(0.004)				
Post-2022 × Securities/Assets		-0.0830***					
		(0.023)					
Post-2022 × Non-MBS Sec./Assets			-0.0287	-0.0282	-0.0383	-0.0378	-0.0474
			(0.029)	(0.029)	(0.029)	(0.030)	(0.029)
Post-2022 × MBS/Assets			-0.1380***	-0.1381***	-0.1441***	-0.1466***	-0.1535***
			(0.031)	(0.032)	(0.031)	(0.030)	(0.031)
Post-2022 × Mortgages/Assets					-0.0429**	-0.0139	-0.0507***
					(0.018)	(0.020)	(0.018)
Post-2022 × Deposit Beta						0.0427**	
						(0.019)	
Deposit Expense							-0.0067**
							(0.003)
Obs.	2681	2681	2681	2681	2681	2681	2681
Time FE	No	No	No	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DV average	0.100	0.100	0.100	0.100	0.100	0.100	0.100
DV standard dev.	0.035	0.035	0.035	0.035	0.035	0.035	0.035

Notes: The table shows estimates of bank × quarter regressions of mark-to-market equity on a *Post*-2022 dummy variable and a set of interactions with measures of bank balance sheet composition. Sample consists of banks for which forms 10-Q/10-K are available, collected via S&P Global. It covers 187 banks for the 2020:Q1-2023:Q3 period. The dependent variable mark-to-market equity is calculated as (fair value of assets − book value of liabilities)/(fair value of assets). *Post-2022* is a dummy variable equal to one for the period 2022:Q1–2023:Q4 and zero otherwise. Balance sheet composition measures are as of 2019:Q4. Deposit betas in column 6 are from Philipp Schnabl's website and based on Drechsler et al. (2021). Deposit expense in column 7 is defined as 400*(quarterly flow of interest expense on deposits/average of total deposits between quarters t and $t-1$). *Time FE* indicates year×quarter fixed effects. Standard errors, reported in parentheses, are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. All variables are summarized in panel B of Table A.6. Sources: Call Reports; Forms 10-Q/10-K.

Table 5: Strategic trading in 2022-23

A. Linear probability model

	(1)	(2)	(3)	(4)	(5)	(6)
MV/AC $\in$ [.99-1.01]	0.014***	0.033***	0.039***	0.028***	0.028***	0.029**
	(0.004)	(0.009)	(0.010)	(0.008)	(0.008)	(0.014)
MV/AC $>$ 1.01	0.019***	0.079***	0.088***	0.077***	0.078***	0.121***
	(0.006)	(0.019)	(0.020)	(0.018)	(0.019)	(0.046)
Obs.	474,365	474,365	474,365	474,363	474,363	72,477
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
Share Sold for MV/AC $<$ 0.99	0.0091	0.013	0.013	0.013	0.013	0.015

B. Logit

	(1)	(2)	(3)	(4)
MV/AC $\in$ [.99-1.01]	3.438***	3.743***	3.174***	3.217***
	[2.0,5.8]	[2.3,6.2]	[1.8,5.5]	[1.9,5.4]
MV/AC $>$ 1.01	9.870***	11.329***	8.999***	8.533***
	[5.7,17.2]	[6.2,20.5]	[5.0,16.1]	[4.5,16.0]
Obs.	474,365	473,393	455,449	454,584
Fixed effects	No	Time	Bank, Time	Bank, Time
Controls	No	No	No	Yes
Weights	Yes	Yes	Yes	Yes
P(sale) for MV/AC $<$ 0.99	0.0088	0.0088	0.0089	0.0089

Notes: The table shows estimates of security-level regressions of the quarterly likelihood of sale on dummies indicating a security's market value relative to its amortized cost (MV/AC). The dependent variable is the fraction of the security sold (full and partial sales) in panel A, and a dummy for whether the security was fully sold in panel B. The sample covers AFS portfolios over the 2022:Q1-2023:Q4 period. The omitted category of the independent variable is underwater securities (MV/AC $<$ 0.99). In panel A, the OLS coefficients can be interpreted as additive in terms of probabilities. In panel B, the reported coefficients represent odds ratios (i.e., multiplicative effects on odds). Controls include: security type, floating rate indicator, time since purchase, gross duration, convexity, and remaining maturity. *Time* indicates year$\times$quarter fixed effects. Observations are weighted by security amortized cost. Standard errors, reported in parentheses in panel A, are two-way-clustered by bank-quarter and by CUSIP. 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. Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Table 6: Drivers of strategic trading in 2022-23

A. AOCI filter

	(1)	(2)	(3)	(4)	(5)
MV/AC > 0.99	4.762***	3.121***	4.246***	3.092***	2.405*
	[3.0,7.6]	[1.8,5.4]	[2.6,6.9]	[1.7,5.5]	[0.9,6.6]
AOCI not in capital		0.297***		2.982	0.268
		[0.1,0.7]		[0.2,37.1]	[0.0,6.2]
MV/AC > 0.99 × AOCI not in capital		2.080		2.571**	3.203**
		[0.8,5.6]		[1.1,6.2]	[1.1,9.5]
Log(Assets)					0.074
					[0.0,2.6]
MV/AC > 0.99 × Log(Assets)					1.159
					[0.7,2.0]
Obs.	474,365	474,365	454,584	454,584	454,584
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 MV/AC < 0.99	0.0088	0.0088	0.0089	0.0089	0.0089

B. Other sources of heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
MV/AC > 0.99	1.785*	1.600	3.997***	1.573	3.146***	1.448
	[0.9,3.5]	[0.9,2.9]	[1.6,10.3]	[0.9,2.8]	[1.7,5.9]	[0.6,3.7]
MV/AC > 0.99 ×AOCI not in capital	3.354***	4.180***	2.569**	1.571	2.575**	3.012**
	[1.6,7.2]	[1.7,10.0]	[1.1,6.3]	[0.5,4.7]	[1.1,6.1]	[1.0,8.8]
MV/AC > 0.99 ×CET1 Buffer < Median	1.925					1.338
	[0.9,4.3]					[0.5,3.3]
MV/AC > 0.99 ×PB Ratio < Median		4.326***				3.157**
		[1.7,11.2]				[1.2,8.0]
MV/AC > 0.99 ×YoY Stock Ret < Median			0.694			0.540
			[0.2,1.9]			[0.2,1.8]
MV/AC > 0.99 ×Reserves/Securities < Median				4.269***		2.573
				[1.5,12.5]		[0.8,8.3]
MV/AC > 0.99 ×Uninsured Deposits Share > Median					0.964	0.956
					[0.4,2.4]	[0.4,2.5]
Obs.	454,584	454,584	454,584	454,584	454,584	454,584
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 MV/AC < 0.99	0.0089	0.0089	0.0089	0.0089	0.0089	0.0089

Notes: The table reports logit estimates of the quarterly likelihood of sale as a function of a dummy for whether a security is trading close to or above par (MV/AC >0.99) interacted with various bank characteristics. The dependent variable takes the value of one if a security is fully sold, and zero otherwise. The sample covers bank AFS portfolios over the 2022:Q1-2023:Q4 period. *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 a bank's available CET1 capital and its required CET1 capital in a given quarter. *PB ratio* is the bank's price-to-book ratio. Controls include: security type, time since purchase, gross duration, convexity, floating rate indicator, and remaining maturity. The coefficients are reported as odds ratios (i.e., multiplicative effects on odds). All regressions are weighted by security amortized cost. *Time* indicates year×quarter fixed effects. Standard errors are two-way-clustered by bank-quarter and by CUSIP; 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; ICE; MSCI; Call Reports.

Table 7: Interest-rate risk hedging

A. Security level

	2022-2023			2020-2021		
	(1)	(2)	(3)	(4)	(5)	(6)
Duration	0.016***	0.033***	0.036***	0.028***	0.027***	0.024***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)
Convexity	0.035***	-0.003	0.000	0.024***	0.007***	0.005***
	(0.009)	(0.003)	(0.003)	(0.005)	(0.002)	(0.002)
Agency MBS		-0.413***	-0.304***		-0.253***	-0.247***
		(0.039)	(0.032)		(0.042)	(0.033)
Municipal Bonds		-0.402***	-0.397***		-0.125*	-0.169***
		(0.044)	(0.037)		(0.070)	(0.065)
Corporate/CLO		-0.379***	-0.309***		-0.218***	-0.238***
		(0.035)	(0.028)		(0.043)	(0.032)
Sovereign Bonds		-0.177***	-0.214***		-0.106**	-0.112***
		(0.038)	(0.025)		(0.042)	(0.025)
Other		-0.305***	-0.258***		-0.128**	-0.174***
		(0.042)	(0.035)		(0.050)	(0.035)
Obs.	477,601	477,601	477,601	547,256	547,256	547,256
Fixed effects	No	No	Bank x Time	No	No	Bank x Time
Weights	Yes	Yes	Yes	Yes	Yes	Yes
UST average	0.46	0.46	0.46	0.33	0.33	0.33

B. Bank-level hedging statistics (2020-2023)

		By Bank Size [Below/Above Median]			
	All	Below	Above	Difference	p-value
	(1)	(2)	(3)	(4)	(5)
P(Hedging > 0)	0.440	0.220	0.660	0.441	0.000
P(Hedging > 0| No Hedging in t-1)	0.030	0.020	0.054	0.034	0.112
P(Hedging > 0| Hedging in t-1)	0.987	0.964	0.994	0.031	0.086
Duration Removed by Hedging	0.302	0.172	0.430	0.258	0.000
Duration Removed by Hedging | Hedging > 0	0.685	0.785	0.652	-0.133	0.104
P(AFS US Treasuries Hedge Share > 80%)	0.108	0.016	0.196	0.180	0.000
P(AFS US Treasuries Hedge Share > 80% | Hedging > 0)	0.240	0.069	0.297	0.228	0.000

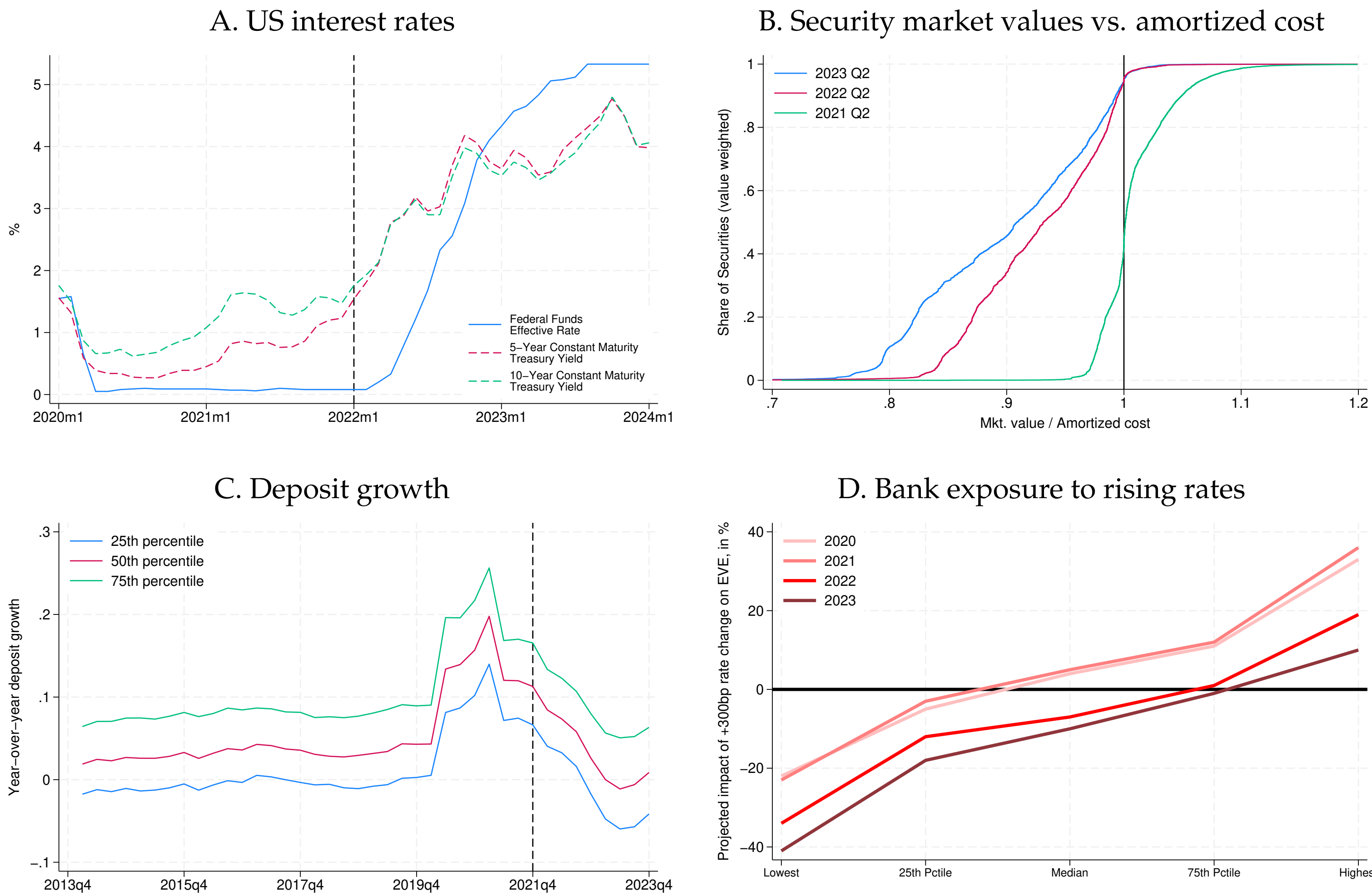
Notes: Panel A shows OLS estimates of security-level regressions of the share of a security that is hedged against interest-rate risk on the security's duration, convexity, and dummies for different security types. The omitted type is US Treasuries. The sample includes only AFS securities. Regressions are weighted by security amortized cost. *Time* indicates year×quarter fixed effects. Standard errors, reported in parentheses, are clustered by bank-quarter. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Panel B reports bank-level hedging statistics. Columns 2 and 3 split the sample in each quarter into two equally-sized groups based on banks' total assets; column 4 reports the difference between these groups and column 5 the *p*-value of the test that this difference equals zero. To calculate *Duration Removed by Hedging* and the *AFS US Treasuries Hedge Share*, observations are weighted by the security's market value. Source: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Table 8: Held-to-maturity classification

	2022-2023			2020-2021		
	(1)	(2)	(3)	(4)	(5)	(6)
Duration	0.041***	0.038***	0.036***	0.018***	0.019***	0.015***
	(0.008)	(0.005)	(0.005)	(0.005)	(0.006)	(0.003)
Convexity	-0.003	0.011	0.014	-0.055***	-0.045***	-0.025***
	(0.018)	(0.016)	(0.009)	(0.011)	(0.010)	(0.005)
Agency MBS		0.098***	0.215***		0.091**	0.212***
		(0.032)	(0.028)		(0.044)	(0.035)
Municipal Bonds		-0.080**	-0.080**		0.063	0.080**
		(0.040)	(0.039)		(0.039)	(0.033)
Corporate/CLO		0.316***	0.328***		0.234***	0.247***
		(0.041)	(0.041)		(0.057)	(0.059)
Sovereign Bonds		-0.321***	-0.124**		-0.184***	-0.043
		(0.037)	(0.052)		(0.030)	(0.038)
Other		-0.145***	0.090***		-0.089***	0.092***
		(0.027)	(0.020)		(0.028)	(0.028)
Obs.	807,434	807,434	807,434	733,656	733,656	733,656
Fixed effects	No	No	Bank x Time	No	No	Bank x Time
Weights	Yes	Yes	Yes	Yes	Yes	Yes
UST average	0.44	0.44	0.44	0.26	0.26	0.26

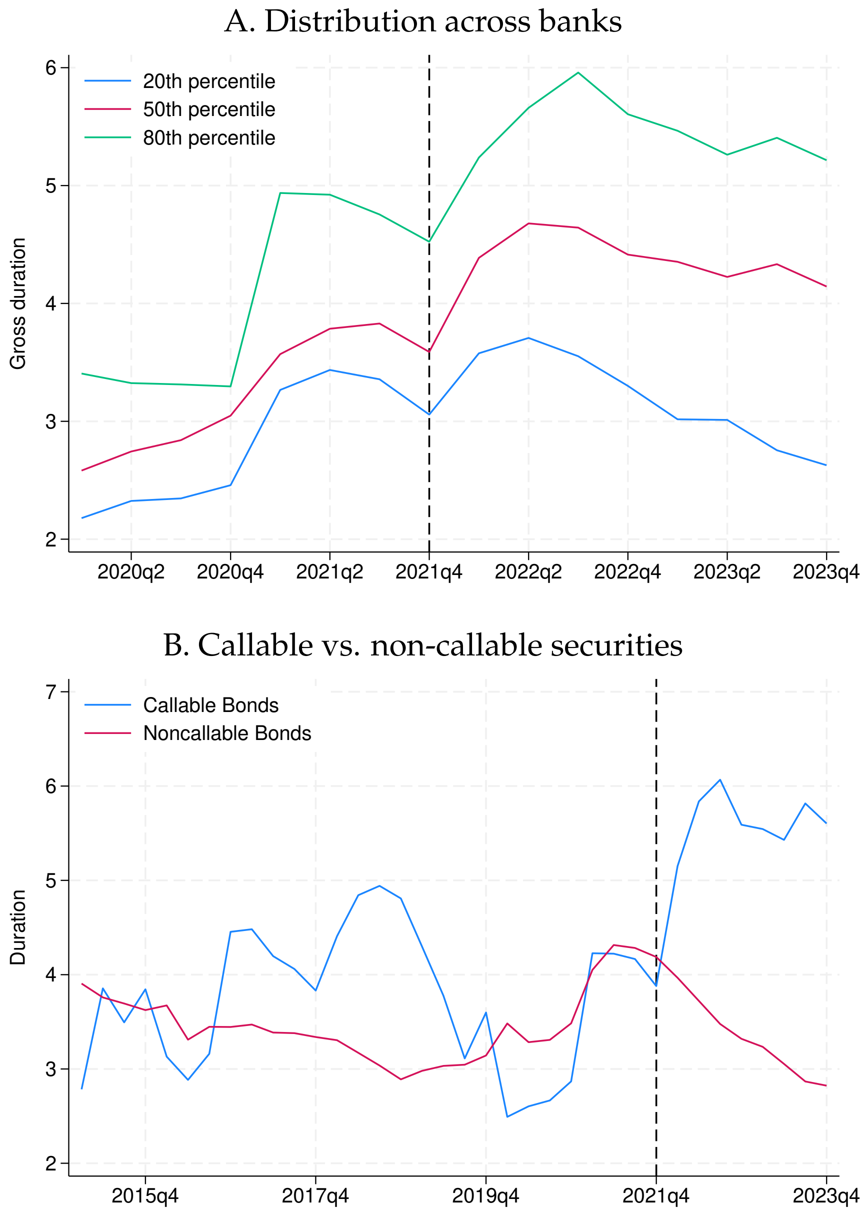
Notes: The table shows OLS estimates of security-level regressions of whether a security is classified as HTM (as opposed to AFS) on the security's duration, convexity, and dummies for different security types. The omitted type is US Treasuries. Regressions are weighted by security amortized cost. *Time* indicates year×quarter fixed effects. Standard errors, reported in parentheses, are clustered by bank-quarter. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Figure 1: The rising rate environment of 2022-2023



Notes: Panel A shows the evolution of US interest rates since 2020. Panel B displays the cumulative percentage of securities (weighted by amortized cost) that have a market value/amortized cost ratio less than or equal to the value indicated on the x-axis, shown for different reporting dates. Panel C shows percentiles of cross-sectional deposit growth across all commercial banks; deposit growth is log(deposits in quarter t) $-$ log(deposits in quarter $t-4$). Panel D shows the impact of a 300 bp parallel shift in the yield curve on banks' economic value of equity (EVE), based on projections from bank internal risk management systems aggregated by the OCC for banks with at least \$10bn in assets. For each year from 2020 to 2023, the graph shows the impact of higher rates at five different points of the bank distribution (as those are the points reported in the source data). As an example of how to read the graph: in 2020, the most negatively affected bank was projected to see a 22% reduction in EVE if interest rates increased by 300 bp; in 2023, the corresponding value was a 41% reduction in EVE. Sources: Panel A uses FRED (series FEDFUNDS, GS5, GS10). Panel B uses FR Y-14Q, Schedule B; ICE. Panel C uses Call Reports. Panel D uses the public OCC Interest Rate Risk Statistics Report, Spring 2021, 2022, 2023, 2024.

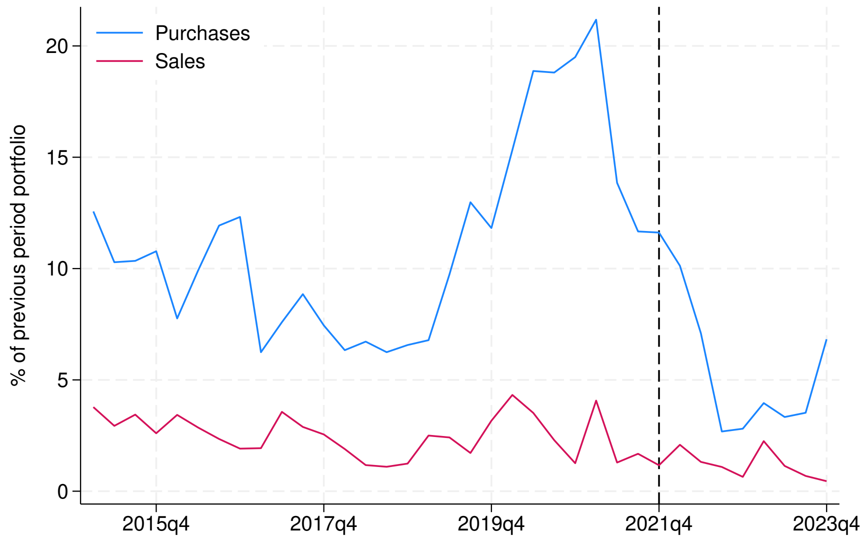
Figure 2: Duration of bank securities portfolios



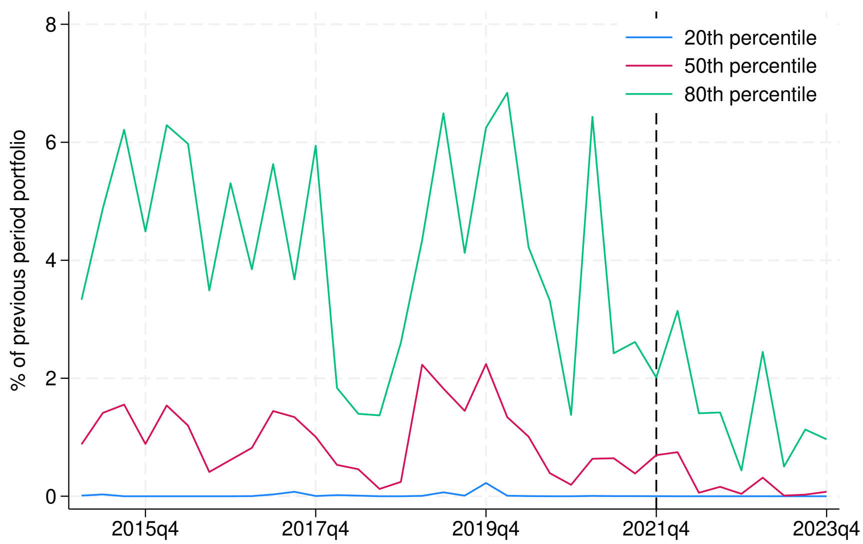
Notes: Panel A plots the evolution of bank-level portfolio duration, reported in years. For each bank and quarter, we compute the weighted average gross duration (for the combined AFS and HTM portfolio), without taking into account qualified hedges, and then plot the 20th, 50th and 80th percentile of the portfolio duration. Panel B plots the weighted average gross duration for callable and non-callable securities weighted by their market values, for the pooled AFS and HTM portfolio of all banks. Sources: FR Y-14Q, Schedule B; ICE; MSCI.

Figure 3: Purchases and sales of securities

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



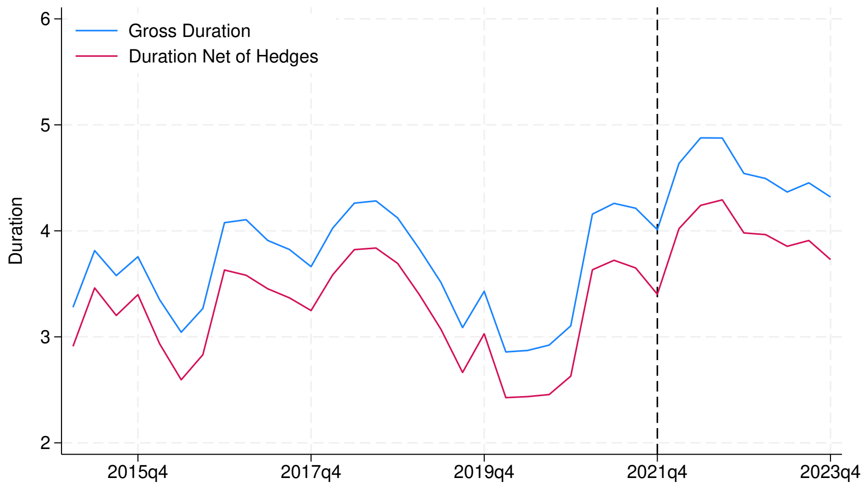
B. Distribution of sales (scaled by previous quarter's portfolio size) across banks



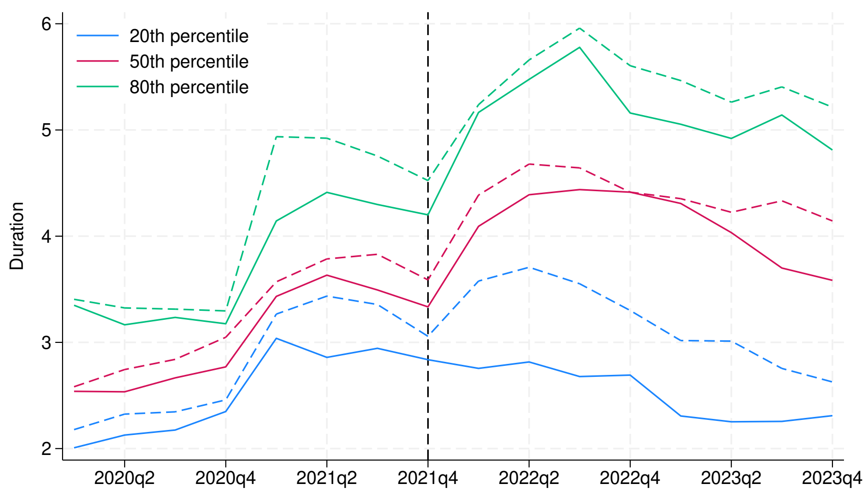
Notes: Panel A shows the evolution of purchase and sales propensities for the pooled portfolio of all banks. Purchases are defined by the purchase date with the purchase amount measured as the amortized cost. Sales include full and partial sales, identified when a security exits a bank's AFS quarterly portfolio, provided it satisfies additional criteria detailed in Appendix Section B.1. Sales amount is recorded at market value at the time of sale. In panel B, bank-level sales (defined as above) are first calculated for each bank; then, banks are equal-weighted to calculate the 20th, 50th and 80th percentile of sales activity within each quarter. Source: FR Y-14Q, Schedule B; ICE; MSCI.

Figure 4: Effect of qualified hedging on duration

A. Pooled sample



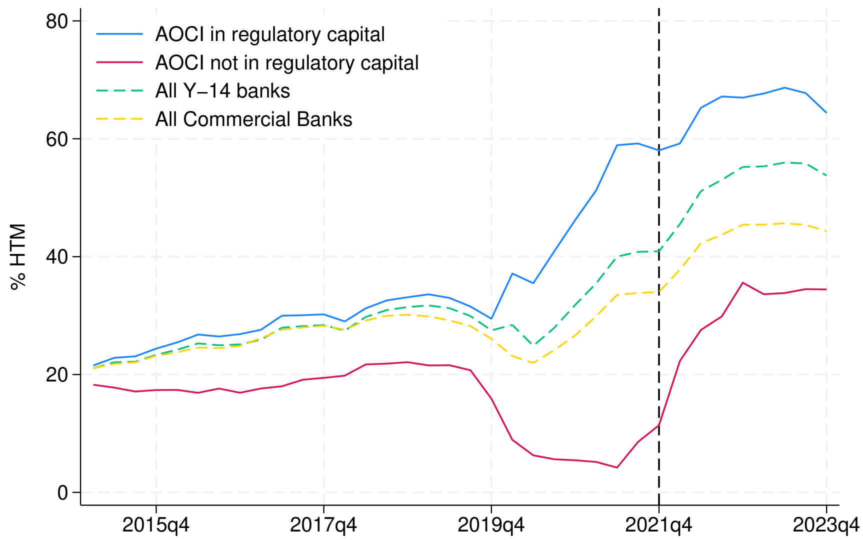
B. Gross duration (dashed lines) vs. duration net of hedging (solid lines): Distribution across banks



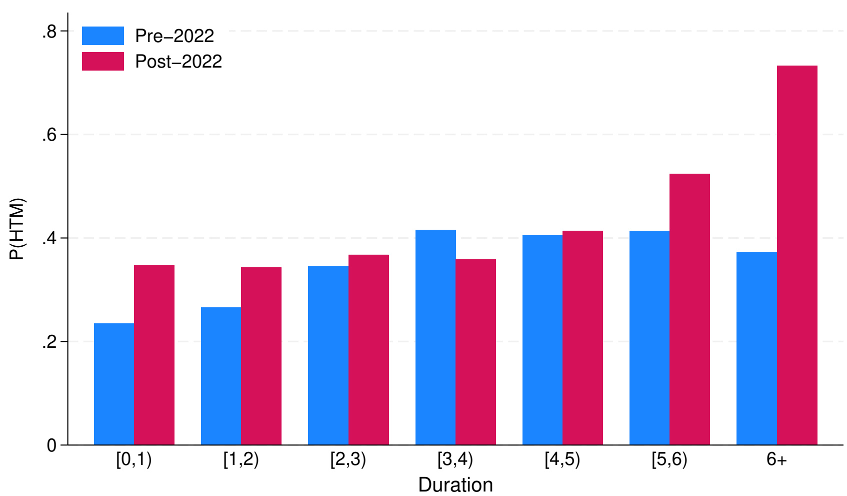
Notes: Panel A shows the weighted average gross and net duration (reported in years) of securities in the pooled AFS and HTM portfolio of all banks, where gross (net) refers to duration before (after) taking into account qualified accounting hedges. The weight is the market value of the security. Panel B shows the cross-bank evolution of gross (dashed lines) and net (solid lines) duration across banks. Market-value-weighted gross and net duration are first calculated for each bank; then, banks are equal-weighted to calculate the 20th, 50th and 80th percentile of duration within each quarter. Source: FR Y-14Q, Schedule B; ICE; MSCI.

Figure 5: Held-to-maturity classification

A. Share of securities classified as HTM



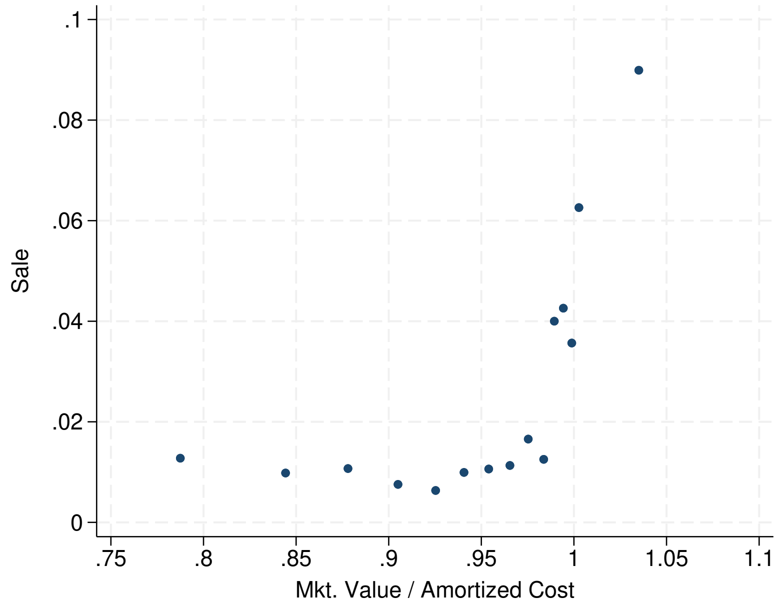
B. Probability of HTM classification vs. security duration



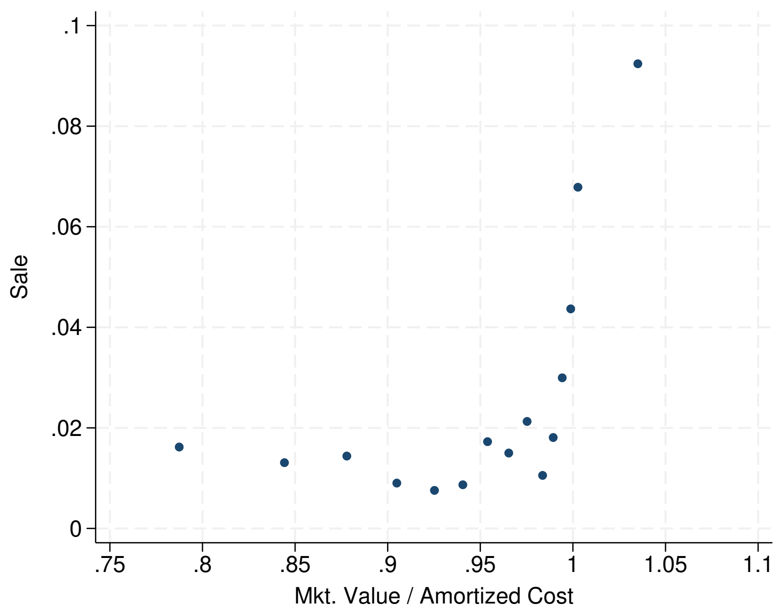
Notes: Panel A shows the evolution of the share of securities classified as HTM. The figure shows the share of HTM securities for all banks, and also splits between banks that include AOCI in their regulatory capital versus those that exclude it. Shares are measured based on amortized cost relative to the amortized cost of all securities. Panel B shows the weighted probability that a security is classified as HTM for different duration buckets, pre- and post-2022. The weight is security amortized cost. Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Figure 6: Sales propensities in the cross section of securities in 2022-23

A. Raw data

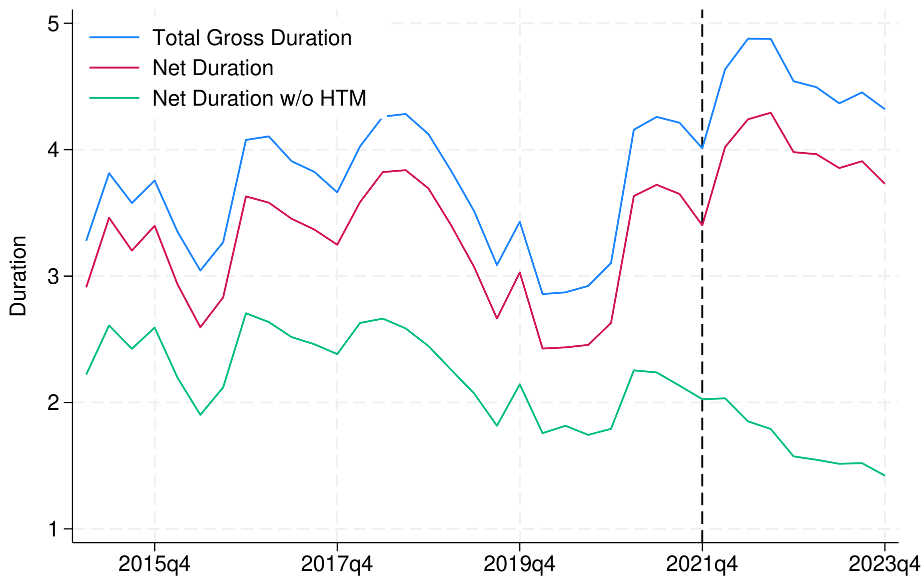


B. With bank × quarter fixed effects and security controls



Notes: Binned scatter plot relating a security's propensity to be sold over the following quarter to its ratio of market value to amortized cost. Sale indicator equals one if a security is completely sold over the course of the next quarter; for partial sales, the indicator takes values between 0 and 1. Security controls in panel B include: security type, floating rate indicator, time since purchase, gross duration, convexity, and remaining maturity. Sample restricted to AFS portfolios over 2022:Q1-2023:Q4. Each security is weighted by its amortized cost. Figure is constructed following Cattaneo et al. (2024) and using their "binsreg" package. Sources: FR Y-14Q, Schedule B; ICE; MSCI.

Figure 7: Total duration & AFS duration



Notes: This graph shows the market-value-weighted average gross and net duration (reported in years) in the pooled AFS and HTM portfolio of all banks. For the line labeled *Net Duration w/o HTM*, we set the gross and net duration of HTM securities equal to zero. Source: FR Y-14Q, Schedule B; ICE; MSCI.

Internet Appendices for Underwater: Strategic Trading and Risk Management in Bank Securities Portfolios

Not for publication

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January 2, 2026

A Additional Figures and Tables

Table A.1: Summary of 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 refers to those banking organizations that have voluntarily chosen not to adopt the AOCI filter. For further accounting details see Accounting Standards Codification (ASC) 320-10, issued by the Financial Accounting Standards Board (FASB), which provides guidance on the accounting and reporting of investments in equity securities and debt securities.

Table A.2: Banks in FR Y-14Q data

	First Qtr	Last Qtr	Num Qtrs in Data	Range of Qtrs	Present in 2020-2023
ALLY FNCL	2012q1	2023q4	48	48	Yes
AMERICAN EXPRESS CO	2012q1	2023q4	48	48	Yes
BANCWEST CORP	2016q2	2016q4	3	3	No
BANK OF AMER CORP	2012q1	2023q4	48	48	Yes
BANK OF NY MELLON CORP	2012q1	2023q4	48	48	Yes
BBVA USA BSHRS	2013q3	2021q1	31	31	Yes
BMO FNCL CORP	2013q3	2023q4	42	42	Yes
BNP PARIBAS USA	2016q4	2023q4	29	29	Yes
CAPITAL ONE FC	2012q1	2023q4	48	48	Yes
CHARLES SCHWAB CORP	2020q2	2023q4	15	15	Yes
CIT GROUP	2015q3	2018q1	11	11	No
CITIGROUP	2012q1	2023q4	48	48	Yes
CITIZENS FNCL GRP	2013q3	2023q4	42	42	Yes
COMERICA	2013q3	2018q1	19	19	No
DB USA CORP	2018q2	2023q4	23	23	Yes
DISCOVER FS	2013q3	2023q4	42	42	Yes
FIFTH THIRD BC	2012q1	2023q4	48	48	Yes
FIRST CITIZENS BSHRS	2023q1	2023q4	4	4	Yes
FIRST HAWAIIAN	2014q4	2016q1	6	6	No
FLAGSTAR FNCL	2023q4	2023q4	1	1	Yes
GOLDMAN SACHS GROUP THE	2012q1	2023q4	30	48	Yes
HSBC N AMER HOLDS	2013q3	2023q4	42	42	Yes
HUNTINGTON BSHRS	2013q3	2023q4	42	42	Yes
JP MORGAN CHASE & CO	2012q1	2023q4	48	48	Yes
KEYCORP	2012q1	2023q4	48	48	Yes
MORGAN STANLEY	2012q1	2023q4	48	48	Yes
MUFG AMERS HOLDS CORP	2013q3	2022q3	37	37	Yes
M&T BK CORP	2013q3	2023q4	42	42	Yes
NORTHERN TR CORP	2013q3	2023q4	42	42	Yes
PNC FNCL SVC GROUP	2012q1	2023q4	48	48	Yes
RBC US GRP HOLDS LLC	2016q4	2023q4	29	29	Yes
REGIONS FC	2012q1	2023q4	48	48	Yes
SANTANDER HOLDS USA	2013q3	2023q4	42	42	Yes
STATE STREET CORP	2012q1	2023q4	48	48	Yes
SUNTRUST BK	2012q1	2019q3	31	31	No
SVB FNCL GRP	2021q3	2022q4	6	6	Yes
SYNCHRONY FNCL	2020q2	2023q4	7	15	Yes
TD GRP US HOLDS LLC	2014q4	2023q4	37	37	Yes
TRUIST FC	2012q1	2023q4	48	48	Yes
U S BC	2012q1	2023q4	48	48	Yes
UBS AMERS HOLD LLC	2016q4	2023q4	29	29	Yes
WELLS FARGO & CO	2012q1	2023q4	48	48	Yes
ZIONS BC	2013q3	2018q1	19	19	No

Table A.3: Summary statistics: 2015-2023

A. Composition

Asset Class	Dollar-weighted Share (%)	Observations (000s)	Observation Share (%)
Agency MBS	57.86	2454.74	67.83
US Treasuries	26.32	97.45	2.69
Municipal Bond	4.75	657.92	18.18
CLO	3.20	40.89	1.13
CMBS	1.48	54.58	1.51
Sovereign Bond	1.24	20.19	0.56
Corporate Bond	1.13	114.36	3.16
Student Loan ABS	1.06	25.83	0.71
Domestic Non-Agency RMBS	0.86	84.92	2.35
Credit Card ABS	0.53	5.08	0.14
Auto ABS	0.51	14.57	0.40
Other ABS	0.37	10.80	0.30
All Other	0.69	37.56	1.04
Total	100	3618.89	100

B. Summary statistics by security type

	Agency MBS	US Treasuries	Municipal Bonds	CLO/ Corporate	Sovereign Bonds	Other	Total
Coupon (%, annual)	2.83	1.44	3.87	2.80	1.72	2.67	2.47
	(0.95)	(0.89)	(1.46)	(2.18)	(1.51)	(1.66)	(1.26)
Fixed Rate (%)	90.79	99.05	81.14	20.69	74.22	39.93	86.39
	(28.91)	(9.72)	(39.12)	(40.51)	(43.74)	(48.98)	(34.29)
Callable (%)	95.82	1.80	62.75	9.86	0.34	0.77	59.31
	(20.02)	(13.31)	(48.35)	(29.82)	(5.86)	(8.73)	(49.13)
Remaining Maturity (years)	23.91	4.47	17.15	8.79	3.17	19.01	17.41
	(7.73)	(4.23)	(8.25)	(4.14)	(1.97)	(13.66)	(11.33)
Effective Duration (years)	4.29	3.91	6.50	0.82	2.33	2.34	4.01
	(2.04)	(3.31)	(4.62)	(1.88)	(1.90)	(2.53)	(2.78)
Convexity (years)	-0.65	0.24	-0.09	0.05	0.57	0.04	-0.30
	(1.32)	(0.65)	(1.99)	(0.80)	(3.25)	(2.94)	(1.43)
AFS (%)	0.56	0.70	0.73	0.65	0.97	0.83	0.63
	(0.48)	(0.43)	(0.44)	(0.47)	(0.17)	(0.37)	(0.47)
Hedged (%)	0.02	0.23	0.17	0.04	0.29	0.13	0.09
	(0.13)	(0.39)	(0.37)	(0.20)	(0.45)	(0.33)	(0.27)
Mkt 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)
Quarterly Sales (%)	1.38	3.62	2.10	1.29	1.43	1.78	2.03
	(11.39)	(29.75)	(14.35)	(11.28)	(11.86)	(13.23)	(18.41)

Notes: The table reports bond-level summary statistics for different security types. The sample covers the 2015:Q1 to 2023:Q4 period. US Treasuries include Treasury bills, notes, bonds, and agency debt. In panel A, *All Other* is a collective category including covered bonds, preferred stock, CDOs, foreign RMBS, mutual funds, cash equivalents, municipal income funds/trusts, commercial paper, collateral trust notes, note purchase agreements, and uncategorized securities. In panel B, *Other* in column 7 includes CMBS, corporate bonds, student loan ABS, domestic non-agency RMBS, Auto ABS, credit card ABS, other ABS, and *All Other* as defined in panel A. *Quarterly Sales* includes full and partial sales. Values in panel B are weighted by security amortized cost. Standard deviations are reported in parentheses. Sources: FR Y-14Q, Schedule B; ICE; MSCI.

Table A.4: Summary statistics: Agency MBS by category, 2020-2023

A. Composition

Security Issuer	Dollar-weighted Share (%)	Observations (000s)	Observation Share (%)
RMBS: Pool	54.94	672.60	62.14
RMBS: CMO	22.01	219.80	20.31
RMBS: Resecur.	16.78	119.91	11.08
CMBS	5.35	64.67	5.97
Unknown	0.92	5.45	0.50
Total	100	1082.43	100

B. Summary statistics by type

	RMBS: Pool	RMBS: CMO	RMBS: Resecur.	CMBS	Unknown	Total
Coupon (%, annual)	2.68	2.23	2.76	2.44	2.94	2.58
	(0.78)	(1.22)	(0.86)	(0.93)	(0.89)	(0.93)
Fixed Rate (%)	99.47	71.14	98.42	93.94	28.12	92.11
	(7.26)	(45.31)	(12.45)	(23.86)	(44.96)	(26.96)
Callable (%)	100.00	100.00	100.00	0.00	100.00	94.65
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(22.50)
Remaining Maturity (years)	25.77	22.15	24.52	7.55	28.35	23.80
	(5.43)	(10.27)	(6.33)	(3.57)	(9.64)	(8.04)
Effective Duration	4.68	4.32	4.50	6.03	4.99	4.65
	(1.93)	(2.51)	(1.98)	(2.85)	(2.87)	(2.17)
Convexity	-1.03	-0.17	-0.90	-0.20	-1.03	-0.79
	(1.60)	(1.08)	(1.48)	(0.66)	(1.56)	(1.50)
AFS (%)	38.00	72.51	44.82	73.59	91.11	49.13
	(47.42)	(44.51)	(49.18)	(43.33)	(28.29)	(49.24)
Hedged (%)	1.43	5.32	1.78	17.57	0.01	3.20
	(8.73)	(20.14)	(9.11)	(36.59)	(0.80)	(15.20)
Mkt Value / Amortized Cost	0.94	0.96	0.95	0.97	0.98	0.95
	(0.09)	(0.08)	(0.09)	(0.09)	(0.07)	(0.09)
Quarterly Sales (%)	0.93	0.75	1.58	1.09	12.26	1.10
	(9.37)	(8.46)	(12.34)	(10.34)	(32.80)	(10.27)

Notes: Summary statistics for different types of agency MBS. The sample period is from 2020:Q1 to 2023:Q4. RMBS stands for residential mortgage-backed security. RMBS CMO stands for residential mortgage-backed security collateralized mortgage obligation. CMBS stands for commercial mortgage-backed security. In panel B, all values are weighted by security amortized cost. *Quarterly Sales* includes full and partial sales. Standard deviations are reported in parentheses. Source: FR Y-14Q, Schedule B; ICE; MSCI; eMBS.

Table A.5: Summary statistics: US Treasuries by category, 2020-2023

A. Composition

Security Issuer	Dollar-weighted Share (%)	Observations	Observation Share (%)
UST	97.21	25269	59.36
GSE	0.79	1616	3.80
FHLB	0.74	2380	5.59
SBA	0.55	9874	23.20
Farm Credit Agencies	0.51	2273	5.34
Other	0.20	993	2.33
HUD	0.00	162	0.38
Total	100	42567	100

B. Summary statistics by type

	UST	GSE	FHLB	SBA	Farm Credit	Other	HUD	Total
Coupon (%, annual)	1.29	1.14	1.77	3.01	1.89	1.34	4.46	1.31
	(0.89)	(0.86)	(0.87)	(1.68)	(1.24)	(1.71)	(0.82)	(0.92)
Fixed Rate (%)	99.91	97.28	99.38	61.97	80.42	87.07	100.00	99.55
	(3.04)	(16.28)	(7.88)	(48.55)	(39.69)	(33.56)	(0.00)	(6.71)
Callable (%)	0.00	69.81	56.17	53.96	21.06	1.26	86.65	1.38
	(0.00)	(45.92)	(49.63)	(49.85)	(40.78)	(11.17)	(34.11)	(11.65)
Remaining Maturity (years)	4.32	5.72	6.28	15.67	6.83	6.55	2.03	4.43
	(4.01)	(4.50)	(4.31)	(6.31)	(4.17)	(5.78)	(1.30)	(4.13)
Effective Duration (years)	3.94	4.07	4.47	4.22	4.77	4.33	0.28	3.95
	(3.35)	(2.82)	(2.88)	(3.69)	(3.25)	(4.17)	(0.27)	(3.35)
Convexity (years)	0.31	-0.26	-0.28	0.33	-0.20	0.44	-1.01	0.30
	(0.65)	(1.45)	(2.08)	(0.42)	(1.67)	(0.70)	(2.08)	(0.70)
AFS (%)	63.37	57.94	85.08	80.67	83.10	96.68	100.00	63.75
	(44.48)	(48.85)	(35.17)	(39.49)	(37.26)	(17.94)	(0.00)	(44.46)
Hedged (%)	26.77	6.27	4.16	0.00	8.47	5.03	0.00	26.16
	(40.54)	(23.07)	(19.39)	(0.00)	(27.80)	(20.02)	(0.00)	(40.29)
Mkt Value / Amortized Cost	0.97	0.96	0.95	0.98	0.96	1.00	1.01	0.97
	(0.06)	(0.06)	(0.09)	(0.06)	(0.09)	(0.04)	(0.01)	(0.06)
Quarterly Sales (%)	2.66	1.73	2.45	0.60	3.32	0.68	0.00	2.63
	(33.53)	(13.03)	(15.46)	(7.71)	(17.93)	(8.25)	(0.00)	(33.15)

Notes: Summary statistics for different types of US Treasuries (recall that this category includes obligations of the US Treasury as well as debt issued by various government and government-sponsored agencies). UST includes US Treasury bills, notes, and bonds. GSE stands for Government-Sponsored Enterprises (i.e., Fannie Mae, Freddie Mac). FHLB stands for debt issued by the Federal Home Loan Banks. SBA stands for debt issued by the Small Business Administration. HUD stands for the U.S. Department of Housing and Urban Development. The sample period is from 2020:Q1 to 2023:Q4. In panel B, all values are weighted by security amortized cost. *Quarterly Sales* includes full and partial sales. Standard deviations are reported in parentheses. Source: FR Y-14Q, Schedule B; ICE; MSCI.

Table A.6: Summary statistics for bank-level regressions

A. Variables used in Table 2 and Table 3

	Mean	Std. Dev.	25th Pctile	Median	75th Pctile
Purchases	0.109	0.104	0.028	0.084	0.150
Sales	0.014	0.026	0.000	0.002	0.017
Duration	3.757	1.339	2.834	3.606	4.780
Net Duration	3.440	1.331	2.503	3.307	4.527
Duration Removed by Hedging	0.317	0.504	0.000	0.000	0.533
% HTM	0.266	0.253	0.017	0.213	0.438
Deposit Growth	0.019	0.061	-0.012	0.009	0.039
AOCI Not in capital	0.645	0.479	0.000	1.000	1.000
Securities/Assets	0.173	0.090	0.120	0.169	0.210
Callable Bond Share	0.609	0.291	0.469	0.635	0.838
Uninsured Deposit Share	0.459	0.236	0.350	0.463	0.567
Log(Assets)	19.466	0.995	18.743	18.990	19.904

B. Variables used in Table 4

	Mean	Std. Dev.	25th Pctile	Median	75th Pctile
Securities/Assets	0.150	0.089	0.101	0.143	0.201
Non-MBS Sec./Assets	0.067	0.063	0.025	0.051	0.100
MBS/Assets	0.083	0.064	0.033	0.073	0.126
Mortgages/Assets	0.127	0.103	0.063	0.113	0.172
Deposit Beta	0.474	0.222	0.350	0.396	0.475
Deposit Expense	0.598	0.660	0.147	0.328	0.826

Notes: This table reports summary statistics for variables used in Table 2 and Table 3 (panel A) and Table 4 (panel B). In panel A, *Duration* and *Net Duration* are weighted by market-value, and purchases and sales (full and partial) are scaled by previous quarter's portfolio size (measured on a market-value basis). In panel B, deposit betas are from Philipp Schnabl's website, based on Drechsler et al. (2021). Deposit expense is defined as 400*(quarterly flow of interest expense on deposits/average of total deposits between quarters t and $t-1$). Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Table A.7: Bank-level duration of new purchases

A. All purchases

	Gross Duration				Net Duration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2022	-1.017***				-1.044***			
	(0.227)				(0.218)			
Post-2022 × Callable Bond Share		-0.288	-1.004	-0.514		-0.213	-1.326**	-1.065
		(0.755)	(0.882)	(0.892)		(0.718)	(0.642)	(0.715)
Post-2022 × AOCI Not in Capital			0.937*	0.684			1.460***	1.292***
			(0.543)	(0.584)			(0.355)	(0.451)
Post-2022 × Log(Assets)			0.148	0.112			0.237	0.198
			(0.283)	(0.290)			(0.199)	(0.219)
Controls	No	No	No	Yes	No	No	No	Yes
Time FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	486	486	486	486	486	486	486	486
DV average pre-2022	4.2	4.2	4.2	4.2	3.9	3.9	3.9	3.9

B. US Treasury purchases

	Gross Duration				Net Duration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2022	-1.473***				-1.225***			
	(0.419)				(0.346)			
Post-2022 × Callable Bond Share		-1.002	-1.470	-0.527		-0.411	-1.135	-0.238
		(1.216)	(1.526)	(1.609)		(1.095)	(1.260)	(1.510)
Post-2022 × AOCI Not in Capital			0.250	-0.364			0.625	0.011
			(0.820)	(0.800)			(0.723)	(0.786)
Post-2022 × Log(Assets)			-0.576	-0.715			-0.408	-0.554*
			(0.469)	(0.500)			(0.261)	(0.319)
Controls	No	No	No	Yes	No	No	No	Yes
Time FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	415	415	415	415	415	415	415	415
DV average pre-2022	4.2	4.2	4.2	4.2	3.4	3.4	3.4	3.4

C. MBS purchases

	Gross Duration				Net Duration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2022	-0.457*				-0.550**			
	(0.231)				(0.235)			
Post-2022 × Callable Bond Share		0.462	0.291	0.048		0.215	-0.311	-0.359
		(0.794)	(0.909)	(0.955)		(0.753)	(0.617)	(0.923)
Post-2022 × AOCI Not in Capital			1.452**	0.964			2.077***	1.905***
			(0.553)	(0.644)			(0.405)	(0.563)
Post-2022 × Log(Assets)			0.794***	0.635***			0.849***	0.796***
			(0.213)	(0.202)			(0.186)	(0.202)
Controls	No	No	No	Yes	No	No	No	Yes
Time FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	411	411	411	411	411	411	411	411
DV average pre-2022	4.7	4.7	4.7	4.7	4.5	4.5	4.5	4.5

Notes: The table shows estimates of bank×quarter regressions of the market-value-weighted average duration of newly purchased securities on bank characteristic, separately for all new purchases, US Treasuries and MBS purchases. The sample covers the 2020:Q1-2023:Q4 period. Gross (net) duration refers to duration before (after) hedging. Bank characteristics are defined as of 2019:Q4, exceptfor *AOCI Not in Capital* which is contemporaneous. *Post-2022* is a dummy variable equal to one from 2022:Q1 onward and zero otherwise. Controls include uninsured deposit share and securities' share to total assets, interacted with a *post* dummy. *Time FE* indicates year×quarter fixed effects. 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; ICE; MSCI.

Table A.8: Bank-level determinants of callable share of securities

A. 2019:Q4 Only

	(1)	(2)	(3)	(4)	(5)	(6)
ln(Assets)	-0.044					-0.045
	(0.053)					(0.046)
Deposit Beta		-0.506				-0.124
		(0.368)				(0.367)
Uninsured Deposit Share			0.120			0.117
			(0.244)			(0.239)
Mortgages/Assets				3.016***		2.928***
				(0.798)		(0.871)
ROA Avg.					-0.046	0.128
					(0.071)	(0.097)
Fixed effects	None	None	None	None	None	None
Time period	2019Q4	2019Q4	2019Q4	2019Q4	2019Q4	2019Q4
Obs.	32	32	32	32	32	32

B. 2020-2023

	(1)	(2)	(3)	(4)	(5)	(6)
ln(Assets)	-0.034					-0.021
	(0.051)					(0.041)
Deposit Beta		-0.480				-0.573
		(0.574)				(0.472)
Uninsured Deposit Share			0.142			-0.079
			(0.401)			(0.320)
Mortgages/Assets				0.998		0.677
				(0.933)		(0.748)
ROA Avg.					-0.088*	-0.085
					(0.050)	(0.059)
Fixed effects	Time	Time	Time	Time	Time	Time
Time period	2020-2023	2020-2023	2020-2023	2020-2023	2020-2023	2020-2023
Obs.	496	496	496	496	496	496

Notes: The table shows estimated of bank-level regressions of callable securities' share of total assets on bank characteristics. Panel A includes only 2019:Q4. Panel B covers 2020:Q1-2023:Q4, including banks present all 16 quarters. Deposit beta is not available for two banks; for those, we add a separate dummy. Return on assets (ROA Avg.) is measured as a 4-quarter moving average, using the current quarter and the previous 3 quarters. Time fixed effects are year×quarter fixed effects. Standard errors, reported in parentheses, are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Table A.9: Strategic trading in 2022-23: Robustness checks

	(1)	(2)	(3)	(4)
MV/AC $\in$ [.99-1.01]	2.909***	2.868*	3.179***	3.375***
	[1.3,6.4]	[1.0,8.6]	[1.7,6.0]	[1.8,6.2]
MV/AC $>$ 1.01	15.614***	13.321***	10.819***	10.397***
	[6.5,37.4]	[4.1,43.4]	[6.1,19.3]	[5.0,21.6]
Obs.	16,839	13,726	254,694	239,601
Fixed effects	No	Bank, Time	No	Bank, Time
Controls	No	Yes	No	Yes
Weights	Yes	Yes	Yes	Yes
P(sale) for MV/AC $<$ 0.99	.0087	.011	.0084	.0087
Sample	Treasuries	Treasuries	2022:Q1-2022:Q4	2022:Q1-2022:Q4

Notes: The table shows estimates of security-level logit regressions with the dependent variable taking the value of one if a security is sold in the next quarter and zero otherwise. MV: market value. AC: amortized cost. The independent variables are dummies for different bins of MV/AC; the omitted category is underwater securities (MV/AC $<$ 0.99). Controls include: security type, gross duration, convexity, floating rate indicator, remaining maturity and time since purchase. The coefficients are reported as odds ratios (i.e., multiplicative effects on odds). Columns 1 and 2 restrict the sample to only US Treasuries. Columns 3 and 4 include transactions from 2022:Q1 to 2022:Q4. *Time FE* indicates year×quarter fixed effects. 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; ICE; MSCI; Call Reports.

Table A.10: Strategic trading in 2022-23: Fractional logit

	(1)	(2)	(3)	(4)
MV/AC $\in$ [.99-1.01]	3.709***	4.399***	3.061***	2.949***
	[2.3,5.9]	[2.8,6.9]	[1.9,4.9]	[1.9,4.7]
MV/AC $>$ 1.01	7.774***	10.151***	6.806***	7.082***
	[4.4,13.8]	[5.5,18.8]	[3.7,12.6]	[3.6,13.8]
Obs.	474,365	474,365	474,365	474,365
Fixed effects	No	Time	Bank, Time	Bank, Time
Controls	No	No	No	Yes
Weights	Yes	Yes	Yes	Yes
Share Sold for MV/AC $<$ 0.99	.013	.013	.013	.013

Notes: The table shows estimates of security-level regressions with dependent variable defined as the share of a security sold (full and partial), estimated using a fractional logit model. MV: market value. AC: amortized cost. The independent variables are a set of dummy variables for different bins of MV/AC; the omitted category is underwater securities (MV/AC $<$ 0.99). Controls include: security type, floating rate indicator, gross duration, convexity, remaining maturity, and time since purchase. The coefficients are reported as odds ratios (i.e., multiplicative effects on odds). *Time FE* indicates year×quarter fixed effects. The numbers reported in square brackets show the 95% confidence interval for the odds ratio. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Sources: FR Y-14Q, Schedule B; ICE; MSCI; Call Reports.

Table A.11: Interest-rate hedging by security type: 2022-23

A. AFS portfolio

Security type	% Probability of Hedge	% Hedged	% Duration Hedged
Agency MBS	16.5	8.7	10.8
US Treasuries	50.3	45.7	61.0
Municipal Bonds	19.1	12.6	18.6
Corporate/CLO	1.3	1.2	4.1
Sovereign Bonds	25.3	22.8	33.6
Other	11.5	11.1	18.2
Total	27.6	21.8	27.4

B. Total portfolio (AFS + HTM)

Security type	% Probability of Hedge	% Hedged	% Duration Hedged
Agency MBS	8.0	3.5	3.8
US Treasuries	41.6	27.5	34.9
Municipal Bonds	10.0	6.5	8.2
Corporate/CLO	0.5	0.4	3.7
Sovereign Bonds	23.9	21.5	30.9
Other	8.6	8.3	13.0
Total	18.6	11.5	12.5

Notes: The table reports summary statistics on the weighted fraction of securities that are hedged against interest-rate risk, accounting for both partial and complete hedges. *% Probability of Hedge* in column 1 reports the likelihood that a security has a qualified hedge placed on it, weighted by the security's amortized cost. *Hedged* in column 2 reports the portion of securities' amortized cost that is hedged. In column 3, *Duration Hedged* reports the duration-weighted share of the security that is hedged. Note that banks are not permitted to use accounting hedges for bonds classified as HTM; as a result, the hedging percentage is zero and therefore is not separately reported. Source: FR Y14-Q, Schedule B.

Table A.12: Bank-level hedging statistics: 2020-21 vs. 2022-23

A. 2020-2021

	All	By Bank Size [Below/Above Median]			
		Below	Above	Difference	p-value
P(Hedging > 0)	0.395	0.211	0.579	0.368	0.000
P(Hedging > 0| No Hedging in t-1)	0.037	0.028	0.053	0.025	0.427
P(Hedging > 0| Hedging in t-1)	0.990	1.000	0.987	-0.013	0.574
Duration Removed by Hedging	0.256	0.157	0.355	0.198	0.000
Duration Removed by Hedging | Hedging > 0	0.649	0.746	0.613	-0.133	0.204
P(AFS US Treasuries Hedge Share > 80%)	0.064	0.023	0.105	0.083	0.006
P(AFS US Treasuries Hedge Share > 80% | Hedging > 0)	0.162	0.107	0.182	0.075	0.363

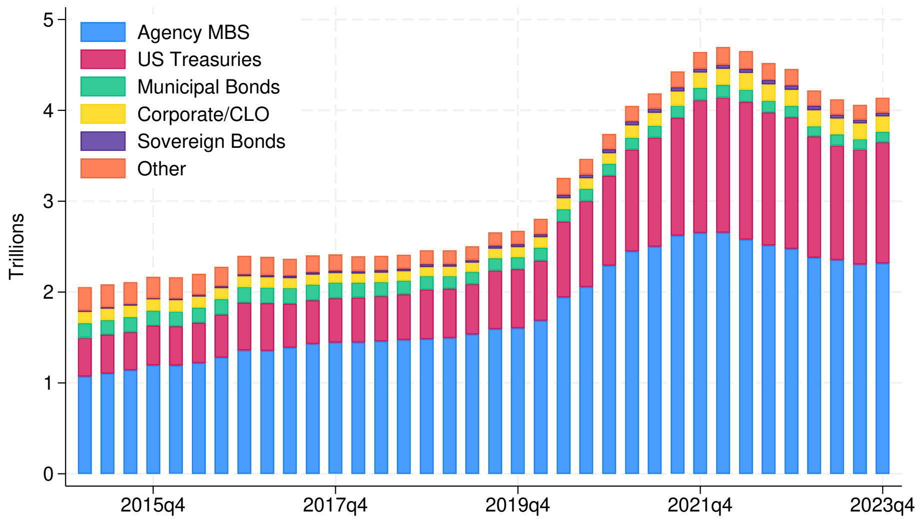
B. 2022-2023

	All	By Bank Size [Below/Above Median]			
		Below	Above	Difference	p-value
P(Hedging > 0)	0.487	0.229	0.742	0.513	0.000
P(Hedging > 0| No Hedging in t-1)	0.023	0.010	0.056	0.045	0.120
P(Hedging > 0| Hedging in t-1)	0.984	0.935	1.000	0.065	0.012
Duration Removed by Hedging	0.348	0.188	0.506	0.319	0.000
Duration Removed by Hedging | Hedging > 0	0.715	0.820	0.682	-0.138	0.260
P(AFS US Treasuries Hedge Share > 80%)	0.155	0.008	0.288	0.280	0.000
P(AFS US Treasuries Hedge Share > 80% | Hedging > 0)	0.305	0.033	0.388	0.354	0.000

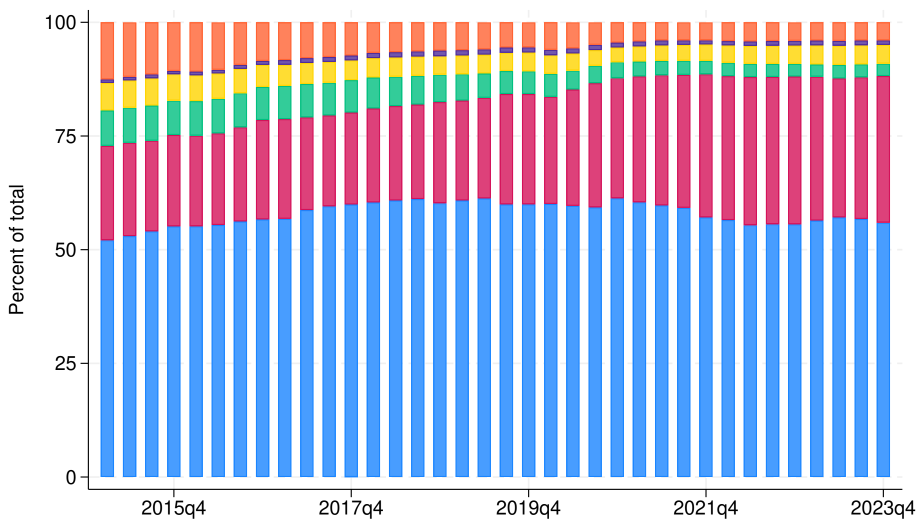
Notes: This table corresponds to Table 7 of the main text but shown separately for 2020-21 (panel A) and 2022-23 (panel B). Source: FR Y-14Q, Schedule B; ICE; MSCI.

Figure A.1: Total security portfolio

A. Volume of securities

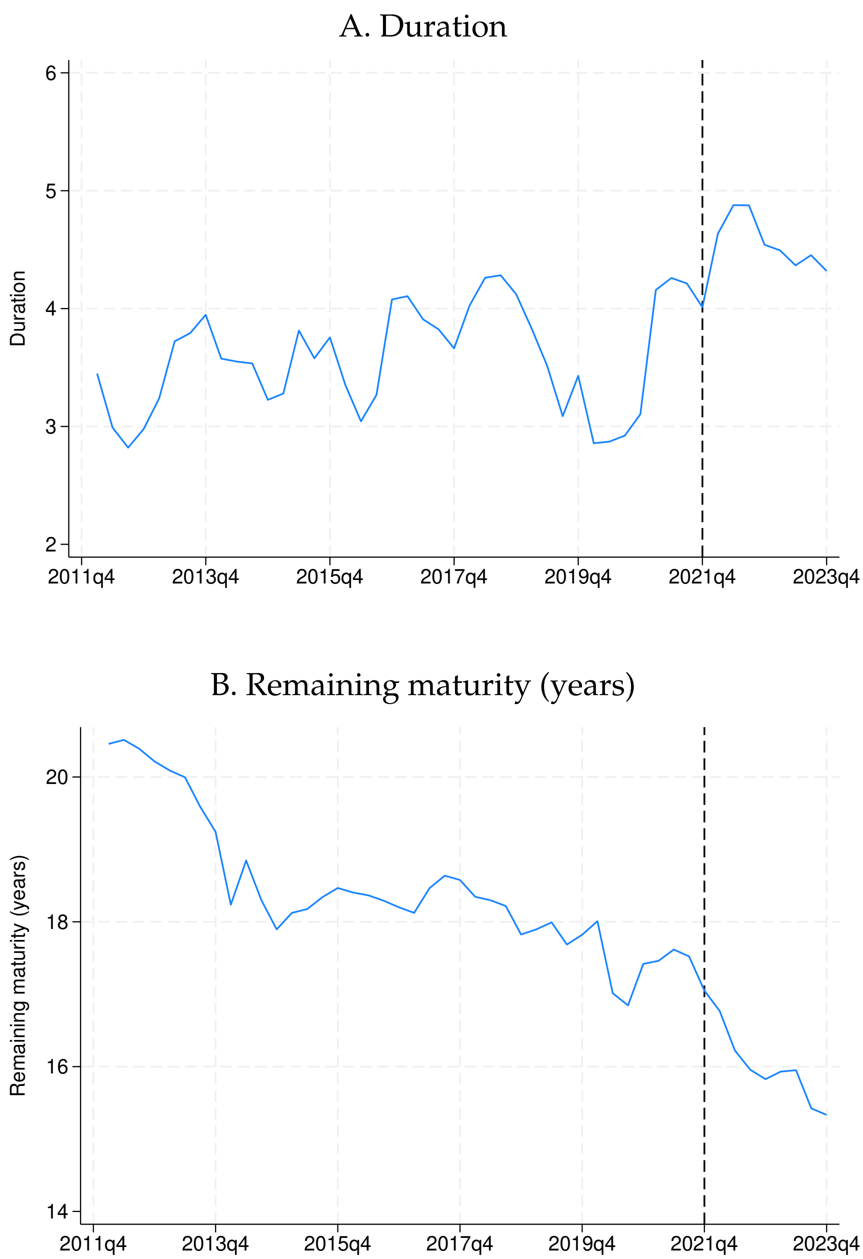


B. Composition of securities portfolio



Notes: Total outstanding amounts (amortized cost) of investment securities for banks that report to FR Y-14Q, Schedule B. Changes across quarters may partly reflect changes in the set of banks reporting (see Table A.2). "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.

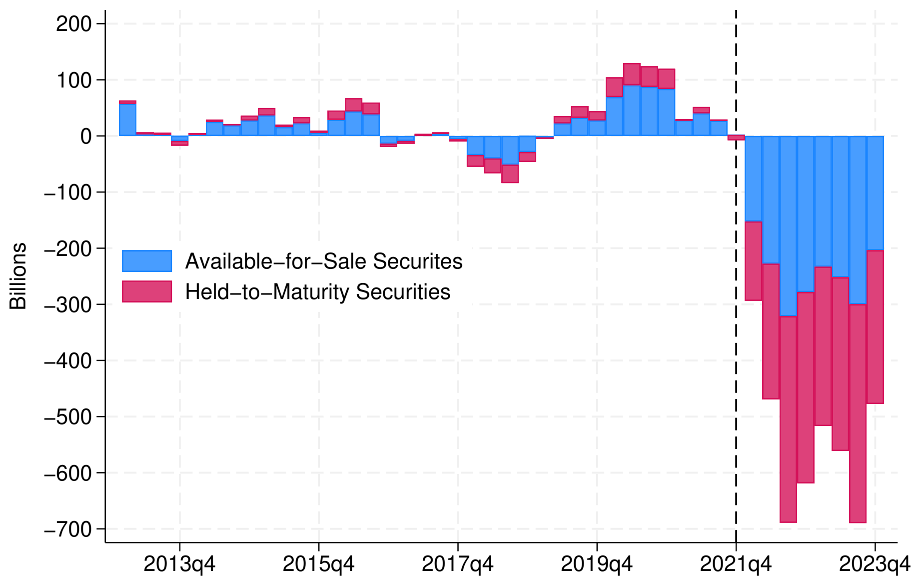
Figure A.2: Average duration and remaining maturity of bank securities portfolios



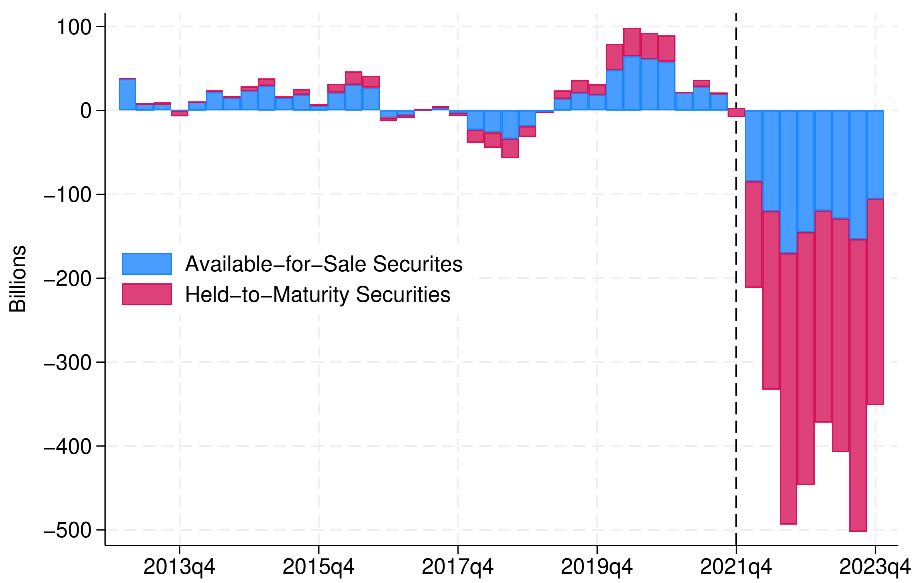
Notes: Panel A shows weighted average gross duration. Panel B shows weighted average remaining maturity. Both panels use the pooled AFS and HTM portfolio of all banks. Each security is weighted by its reported market value. The dashed line indicates 2022:Q1. Source: FR Y-14Q, Schedule B; ICE; MSCI.

Figure A.3: Unrealized gains/losses on securities

A. All banks



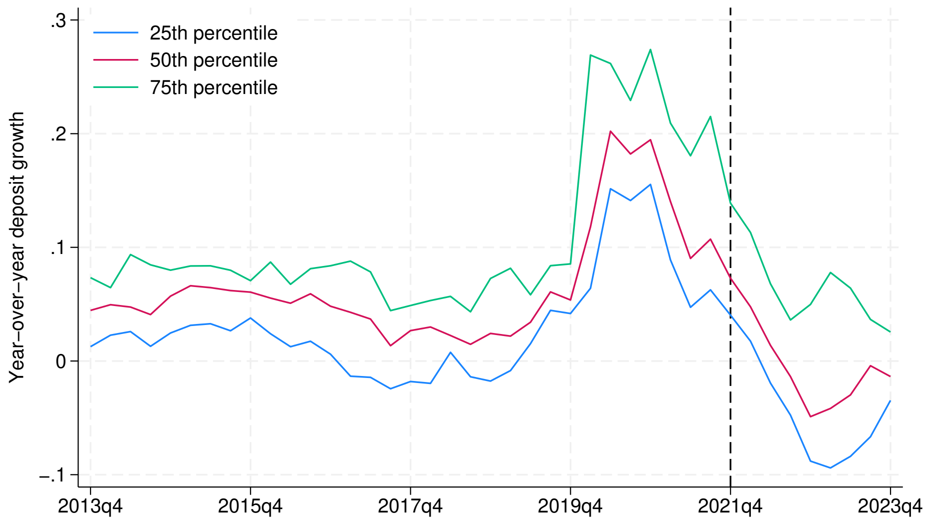
A. Y-14 filers



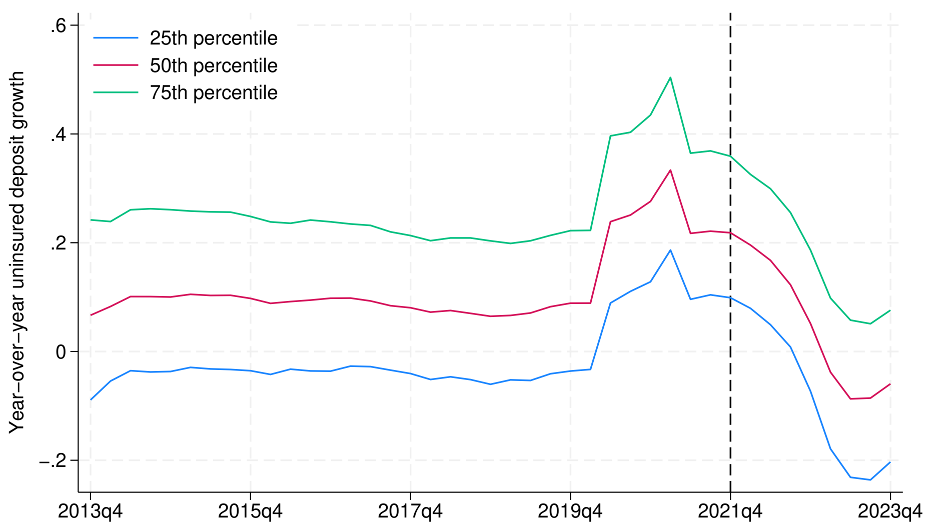
Notes: Unrealized gains and losses on securities, measured as the difference between the fair value and amortized cost of the AFS and HTM portfolios. Panel A reflects the universe of commercial banks. Panel B reflects Y-14 filers. Sources: FR Y-14Q, Schedule B; Call Reports.

Figure A.4: Deposit growth – additional evidence

A. Y-14 filers

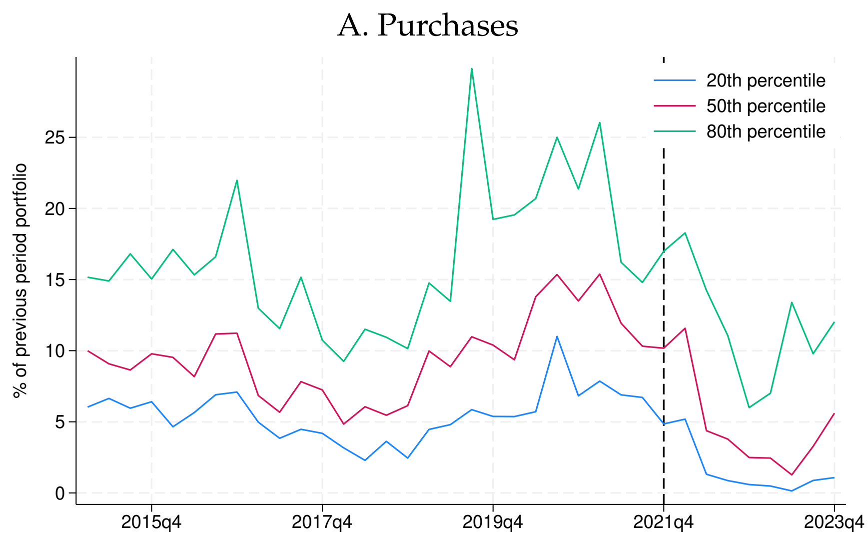


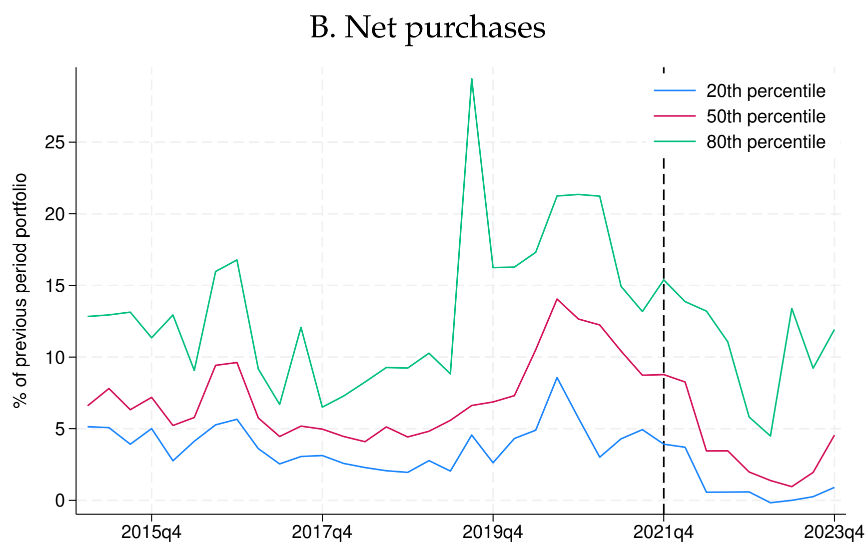
B. Uninsured deposits only (all banks)



Notes: Panel A plots the 25th, 50th, and 75th percentile of cross-sectional deposit growth (measured as log(deposits in quarter t) $-$ log(deposits in quarter $t-4$)) across Y-14 banks. Panel B plots the same percentiles for uninsured deposit growth across all commercial banks. Source: Call Reports.

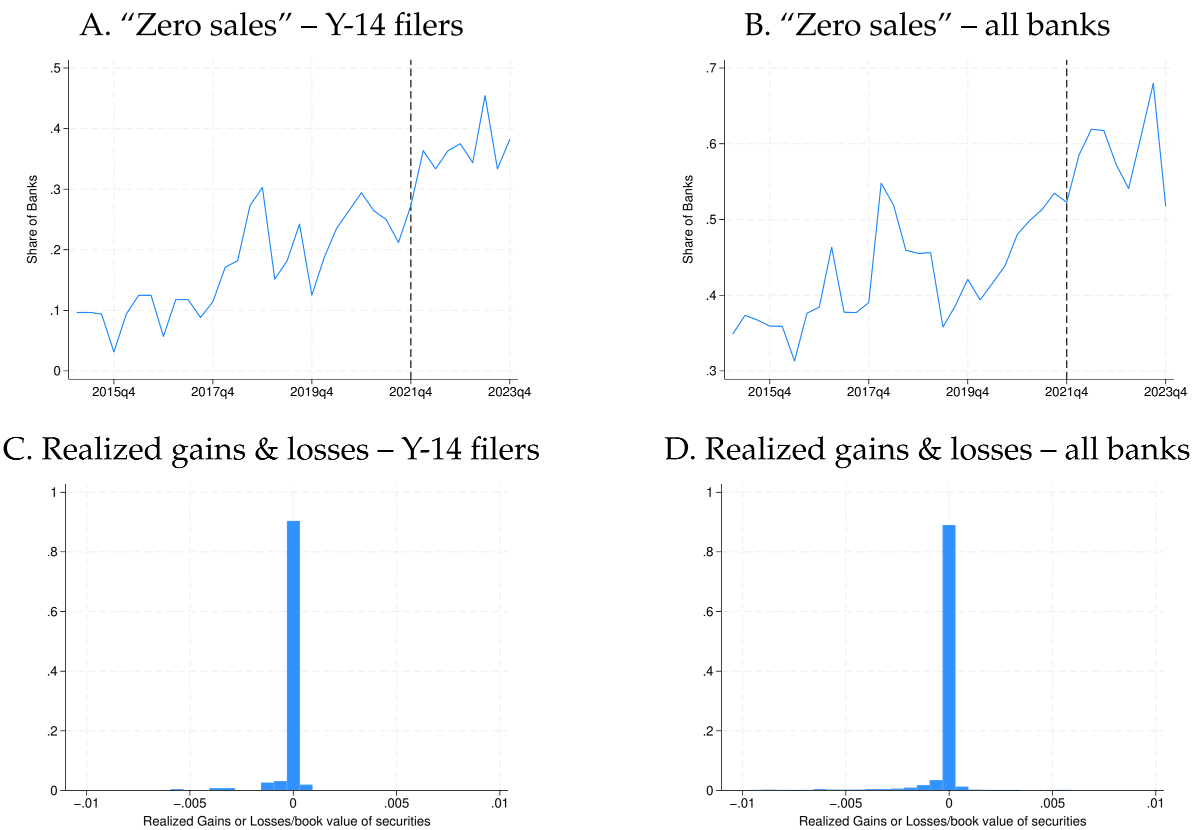
Figure A.5: Distribution of purchases and net purchases across banks





Notes: Purchases (panel A) and net purchases defined as purchases minus all 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; ICE; MSCI.

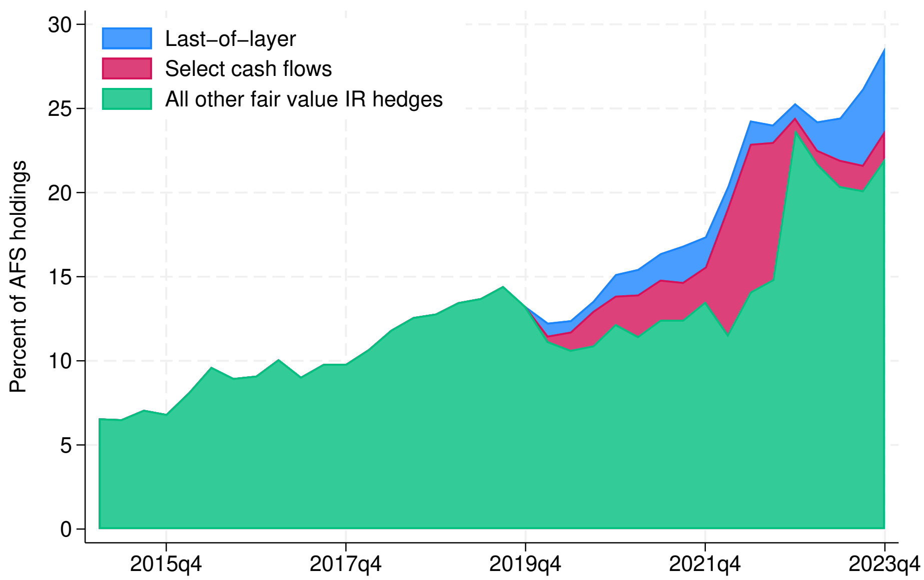
Figure A.6: Call Report evidence on trading



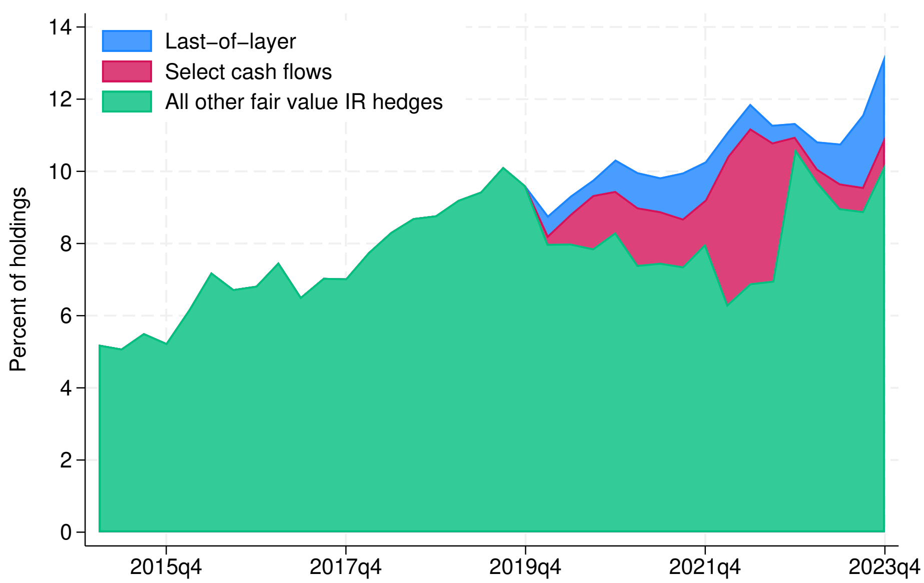
Notes: Panels A and B show the share of banks with "zero sales" over the total number of banks in each quarter (either for the Y-14 banks or for all banks with Call Reports), where "zero sales" are approximated with realized gains and losses equal to zero. The dashed vertical line indicates the post-2022 period. Panels C and D show the distribution of the ratio of quarterly realized gains and losses scaled by the amortized cost of securities for the period 2022:Q1-2023:Q4. Source: Call Reports.

Figure A.7: Fraction of securities portfolio covered by qualified interest rate hedge

A. AFS portfolio



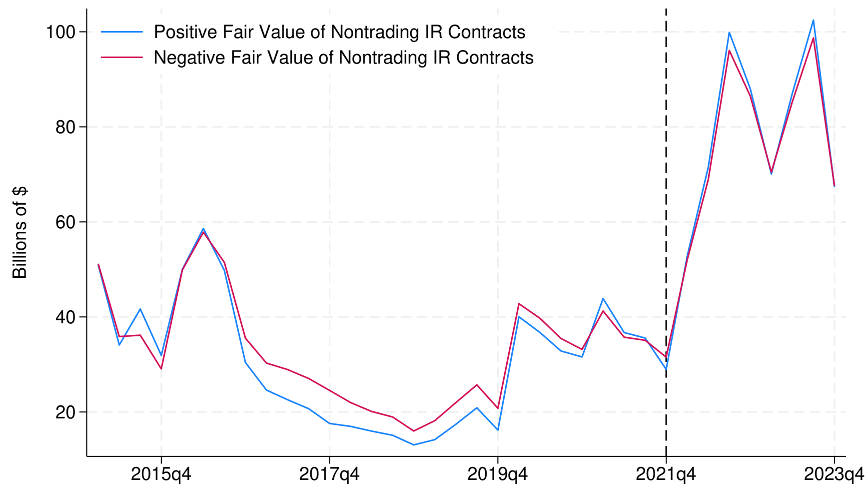
B. Total portfolio (AFS + HTM)



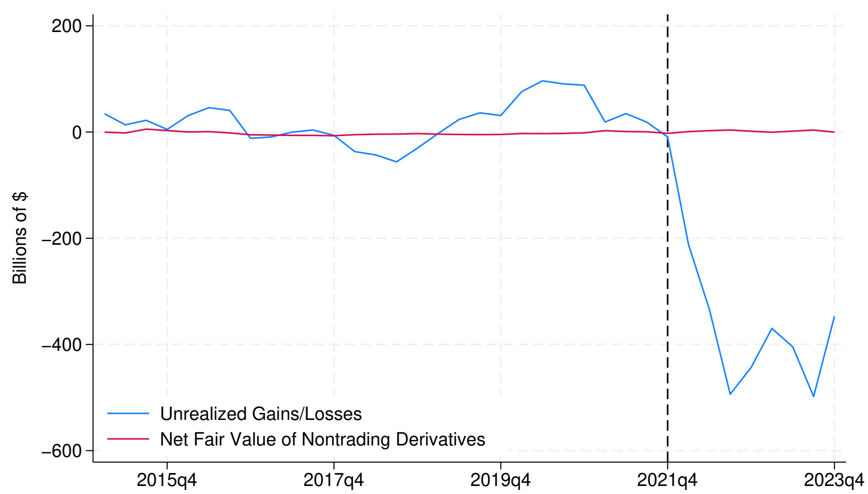
Notes: The graph shows the weighted fraction of securities that are hedged against interest-rate risk, accounting for both partial and complete hedges. Weight is amortized cost of security. Split by hedge accounting designation. Source: FR Y14-Q, Schedule B.

Figure A.8: Fair value of banks' nontrading interest rate derivatives contracts

A. Gross fair values



B. Securities losses and net fair value of interest rate derivatives



Notes: Panel A plots the gross positive and negative fair values of interest rate contracts held for purposes other than trading by commercial banks in the Y-14 sample (Call Report items RCFD 8741 and 8745, respectively). Panel B plots the net fair value of non-trading interest rate contracts alongside unrealized gains and losses on investment securities for the sample of Y-14 banks. Source: Call Reports.

B Data sources and dataset construction

In this appendix, we describe the different data sources we use throughout the paper.

Data on security holdings and characteristics. Data on bank security holdings are drawn from FR Y-14Q schedule B.1. The original data is at the security-position level, meaning that a bank may record the same security multiple times in a given quarter (e.g., because the bond was purchased on more than one date).[1] For the purpose of our analysis, we collapse the data into security-bank-quarter observations.[2] We identify securities based on a combination of CUSIP, ISIN, and SEDOL identifiers. If CUSIP is not available (usually the case for non-US securities), we use the ISIN (or, if missing, the SEDOL). CUSIPs are available for 98% of the securities.

Because FR Y-14Q does not include information on key security characteristics such as maturity, coupon type (fixed or floating), coupon rate, duration, convexity, credit rating, paydown factor, and callable status, we rely on the ICE Data Pricing & Reference Data and MSCI's RiskMetrics RiskManager for these fields. We merge ICE and MSCI data with the FR Y-14Q using security and time identifiers. Maturity and coupon rates are available only in ICE. Ratings and convexity, on the other hand, are available in MSCI. Although duration is available in both datasets, the ICE dataset offers better coverage (7.9% missing values) than MSCI (18.5% missing values). Importantly, the reported duration values are very similar across the two data vendors, as shown by the near-perfect alignment along the 45-degree line in the binscatter in panel A of Figure A.9, and the similar average duration over time shown in panel B. Correspondingly, we use ICE as the primary source for duration, but fill in missing values with data from MSCI. In the final sample, duration is missing for only 4% of observations.

Over the period 2015:Q1 to 2023:Q4, maturity and coupon are missing for 2.4%, and 3.9% of the Y-14Q observations, respectively; the share of missing data decreases over time. The missing information is concentrated in CLOs, CDOs, municipal bonds, and "other" securities. Missing values are dummied out in the regressions.

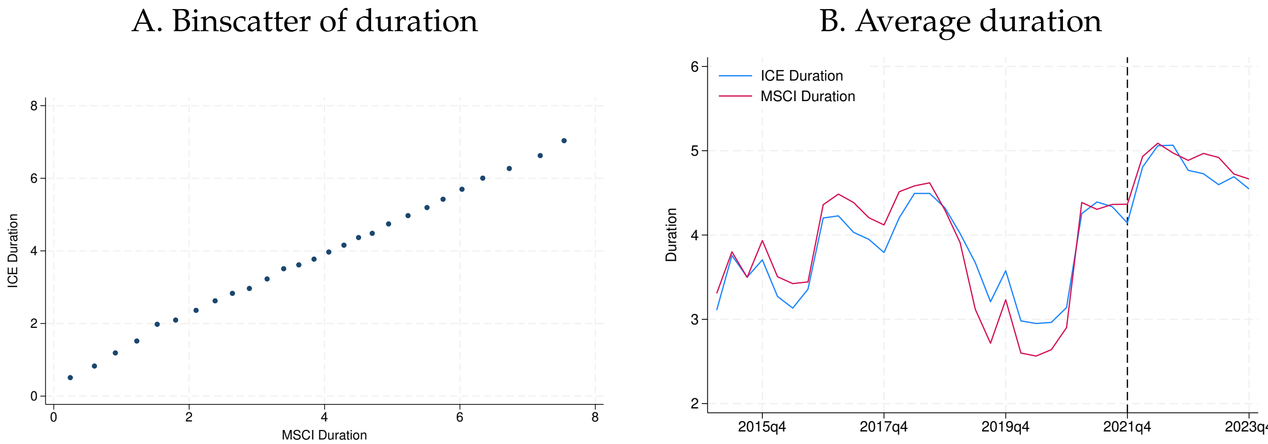
We also use data from Freddie Mac to identify whether MBS are involved in an exchange for mirror securities as part of the uniform MBS (UMBS) initiative. Historically, Freddie Mac issued securities with a 45 day payment delay, meaning investors would be paid 45 days after the mortgage payments were due. As part of the single-security initiative, Freddie Mac investors were permitted to swap legacy MBS for new UMBS-eligible mirror securities with a 55-day payment delay. The exchange file is the data file that tracks this conversion. It shows which of the old 45 day securities have been exchanged, providing details such as the original and new security CUSIPs and the exchanged amounts.[3]

[1] Multiple positions are reported for roughly 15% of the CUSIP-bank-quarter observations in the Y-14 data.

[2] We sum up the amounts of the same security positions for each bank-quarter, while prices are averaged.

[3] Exchange data files and more details can be found here: https://capitalmarkets.freddiemac.com/mbs/exchange/data-files.

Figure A.9: Validation of duration measure: ICE vs MSCI



Notes: Panel A: Binned scatter plot of security duration, comparing ICE and MSCI for securities where duration is reported by both vendors. Each observation is weighted by market value. Panel B: The graph shows weighted average duration. Each observation is weighted by its reported market value. Sources: ICE and MSCI.

Identifying whether a security is part of an exchange allows us to refine both our purchase and sale indicators. Because the security CUSIP changes upon exchange, we may incorrectly classify such security exchanges both as purchases and sales, because the exchanged security has a new CUSIP while the pre-exchange CUSIP disappears from the data—one of our conditions for considering that a security is sold. That is why, for a given CUSIP reported in the FR Y-14Q schedule B, we merge the pre-exchange CUSIP from the exchange activity file to map the post-exchange CUSIP. If a CUSIP in the FR Y-14Q schedule B is reported by a bank in period t but does not appear in period $t+1$, such that the bank subsequently acquires the post-exchange CUSIP in period $t+1$, we identify those cases as security exchanges.

Data on qualified hedges. Information on banks' qualified accounting hedges is provided by FR Y-14Q schedule B.2. Schedules B.1 and B.2 are linked through bank and security identifiers. For the purposes of our study, we focus on fair value interest-rate risk hedges that account for around 85% of all hedges. The remainder includes cash flow interest-rate risk hedges (less than 2% of total) and foreign exchange and credit risk hedges, which are not the subject of our analysis.

Based on the FR Y-14Q schedule B.2, we calculate the dollar amount hedged per security by multiplying the fraction hedged by the amortized cost of the security. Because one security-bank pair may have multiple hedges during the quarter, we sum all hedged dollar amounts per security-bank to aggregate schedule B.2 to the CUSIP-bank-quarter level. We find that 10.7% of the securities in our main 2020-2023 sample have qualified accounting hedges (see Table 1, panel B).

Bank characteristics. We measure bank characteristics—e.g., total assets, capital, deposits—by merging the quarterly bank balance sheet information from FR Y-9C and Call reports using the bank or bank holding company's RSSD ID. Banks' stock returns and market valuations, measured by stock price changes and price-to-book (PB) ratios, are retrieved from Wharton Research Data Services (WRDS) and the S&P Capital IQ Pro Platform. We rely on monthly equity prices, which are collapsed at the quarterly level by retaining end-of-quarter values. We calculate year-over-year percent changes to arrive at our stock return measure used for the analysis in Section 4.2. PB ratios are directly obtained from the S&P Capital IQ Pro Platform, which uses its own ticker-to-RSSD crosswalk to merge the market information with our bank-security dataset.

We use deposit betas from Drechsler et al. (2021) available at: https://pages.stern.nyu.edu/~pschnabl/data/data_deposit_beta.htm. Deposit betas measure the sensitivity of a bank's average deposit rate to changes in the short-term interest rate. It is estimated using domestic deposit expenses scaled by domestic deposits. The sample covers all commercial banks with at least 40 quarterly observations from 1984 to 2022.

Bank interest-rate risk exposure. Data on the interest-rate sensitivity of the economic value of equity (EVE) is collected from the semi-annual OCC Interest Rate Risk Statistics Reports for four years, Spring 2021-2024.[4] This report provides statistics on EVE sensitivities at different points of the distribution for different size classes of banks. We focus on the largest bank size class that is reported: banks with more than $10 billion in assets. We note however that the OCC data do not include "large banks" (typically those with more than $100 billion in assets) in the calculation, meaning that the banks we focus on in our securities-level analysis are not reflected 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. 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." We thus use the data reported in the spring of year t as an indication of EVE sensitivities in year t-1.

To complement the OCC data, we hand-collect the individual disclosed EVE interest-rate risk exposures of 62 publicly-traded US banks from their annual 10-K filings for 2020 to 2023. In these filings, banks typically disclose the year-end projected sensitivity of their economic value of equity and/or their net interest income to particular shifts of the yield curve. We focus on the projected EVE impacts of +100, +200, or +300 bps, which are the most commonly used rate-increase scenarios. Not all banks disclose EVE impacts for all scenarios in all years. Across the years 2020-2023, we have a total of 203, 204, and 136

[4] These reports are available at https://www.occ.gov/publications-and-resources/publications/interest-rate-risk-statistics-reports/index-interest-rate-risk-statistics-reports.html.

projections for the three scenarios: +100, +200, and +300. See Appendix C for detailed analysis of these data.

B.1 Measuring banks securities sales and purchases

We measure bank securities purchases using the date of acquisition, as reported in the FR Y-14Q schedule B. In the case of MBS, we remove cases that are classified as purchases, but they are actually exchanges. Since securities sales are not reported in the Y-14, we identify outright sales through the following steps:

1. We identify all instances where a bank-CUSIP pair exists in quarter t but does not exist in $t+1$. This provides the initial set of potential candidate sales in $t+1$ (Note: This initial step means that we restrict ourselves to examining "complete" sales for which the entire holding of the security is sold, rather than just a part of it. Partial sales are separately identified as described below).

2. Based on the maturity date, if the security matures in $t+1$, we reset the sale indicator to zero.[5]

3. Based on the security characteristics, if in $t+1$ the security is fully called, pre-refunded, escrowed to maturity, or suspended, we reset the sale indicator to zero.

4. Based on the information from the exchange activity file from Freddie Mac, if in $t+1$ the security is involved in a mirror exchange, we reset the sale indicator to zero.

5. For agency MBS, where paydown is reliably reported (as confirmed by comparing to eMBS), we reset the sale indicator to zero if the security is fully paid down (i.e., the survival factor — the fraction of the bond not paid down —- is equal to zero in $t+1$). We also reset the sale indicator to zero if the bond is more than 75% paid down in the quarter prior to sale, because such situations are likely to reflect a re-securitization (such as the aggregation of MBS into larger Giants or Megas by the GSEs to reduce custodial costs and enhance liquidity) rather than a true sale. [Note: we cross-validate this assumption by confirming that we observe an uptick in apparent sales for bonds that are close to fully paid down, even though such bonds are likely to be less liquid and thus less likely to be subject to a true sale; this uptick starts when bonds are more than 75% paid down].

6. If the bank is not an FR Y-14Q filer in quarter $t+1$ (e.g., because the bank is not subject to reporting, it is acquired, or it is the most recent period), we reset the sale indicator to missing.

[5] We reset the sale indicator to missing if the maturity is missing and the security is not subject to a paydown or an exchange.

7. 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 (because this would suggest an actual sale followed by a later purchase of the same bond).

B.1.1 Partial sales

For agency MBS and Treasuries, we also identify cases where only a part of the CUSIP is sold, but not the entire position. (Such partial sales make up 27% of total estimated sales volume in 2020-23). [*Note:* We do not measure partial sales for other security types due to the lack of reliable and complete reporting of the survival factor, which is required to accurately track the remaining principal balance of bonds with amortization or prepayment. These other security types are also quantitatively much less important than agency MBS and Treasuries.] Our methodology for identifying partial sales is as follows:

- **Agency MBS.** We compute the percent change in the current face value of the security between period t and t+1, and compare it to the predicted percent change in face value based on the percent change in the paydown factor of the security between period t and t+1. If the difference between the actual and predicted values is negative and larger than 5% of the security balance, we record this difference as a partial sale in period *t+1*.

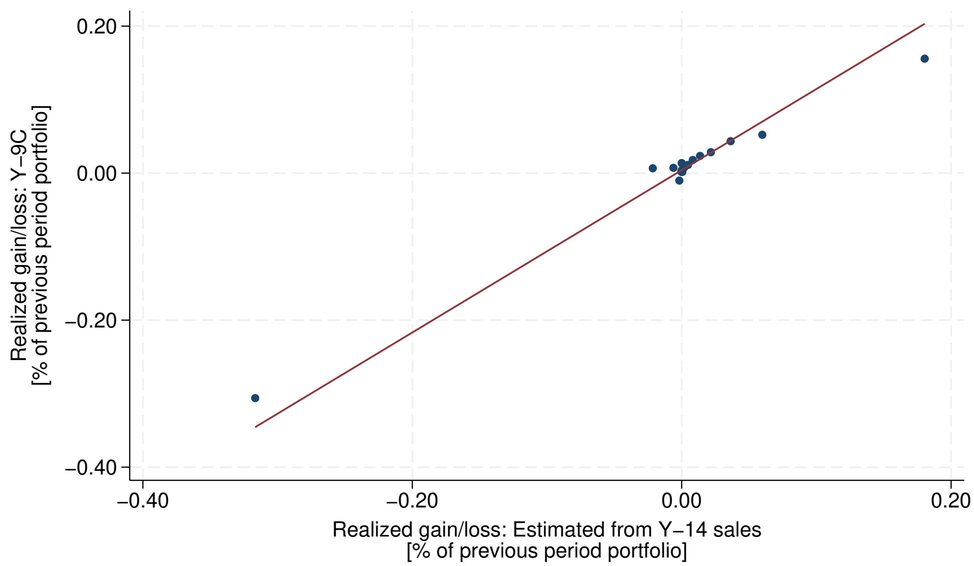
- **Treasuries.** We measure partial sales only for US Treasury bills, notes and bonds (which, as shown in Table A.5, account for over 97% of bonds in the US Treasury category). Since such obligations are non-amortizing and do not feature prepayments, any negative change in the face value of the security held by the bank is recorded as a partial sale. We reset the partial sale indicator to zero if t is the last quarter the security appears in the sample, or if the security appears in the bank's portfolio for less than three quarters.

B.1.2 Cross-validation

As a cross-validation exercise, we use the sale amounts constructed above 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 the 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 the realized gains and losses reported in Call Reports.

Although our measure of realized gains/losses based on the sales indicator is imprecise (e.g., because we do not know the exact timing of the sale within the quarter), it nevertheless matches, on average, the realized gains or losses as reported in Call Reports quite closely (see Figure A.10).

Figure A.10: Cross-validation of sales methodology using realized gain/loss (Y-9C vs Y-14Q)



Notes: Binned scatter plot using bank-quarter level data from 2015 to 2023. Estimate of realized gain and loss based on Y-14 data is rolled up from security-level sales as described in text. Source: FR Y-14Q, Schedule B; Y-9C.

C Banks' forward-looking interest-rate risk exposure: Evidence from 10-K filings

As described in Appendix B, we collect bank-level information on 62 publicly-traded banks' disclosed interest-rate risk exposure from their annual 10-K filings for 2020 to 2023. In these filings, banks typically disclose the year-end projected sensitivity of their economic value of equity (EVE) and/or their net interest income (NII) to particular shifts of the yield curve. This exercise complements the interest-rate risk exposures from the OCC reports, which are not at the bank level and exclude "large banks" (under the OCC's definition, banks with more than $100 billion in assets).

Panel A of Figure A.11 shows the 10th, 50th and 90th percentile of the projected EVE impacts across scenarios and years. We first note that in 2020, most banks projected that higher interest rates would benefit their EVE, and consequently, the distribution of EVE changes shifts toward more positive values (though with substantial heterogeneity) as the assumed rate shift becomes larger. At the end of 2021, the median projected impact was closer to zero. In contrast, in 2022 and 2023, banks' EVE became more negatively impacted by potential upward shifts of the yield curve, and larger rate shifts had more severe projected effects on EVEs. This is exactly in line with the OCC data shown in the main text.

In panel B of Figure A.11, we quantify the average change in EVE impacts across years by regressing them on bank $\times$ scenario fixed effects (in order to account for the fact that not all banks disclose all scenarios in all years). The displayed coefficients should be interpreted as the estimated changed in the average impact compared to the same scenario in 2020. The figure confirms that especially from 2022 onward, banks' EVE became much more negatively exposed to rate increases. For instance, compared to the effects of a +200 bp rate increase in 2020, by 2022 the estimated average impact was 15.4 percentage points more negative. In addition, the figure suggests that the impacts in 2022 and 2023 were very similar. For this reason, in what follows we will pool the observations from 2022 and 2023 when considering time variation, since this will increase our statistical power.

We next study whether banks in different size categories were differentially exposed to changes in interest rates, and whether any potential differential exposure varied across years. Recall that the OCC data from the main text covered banks with total assets (henceforth TA) between $10bn and $100 bn. We therefore define separate dummies for banks that are smaller (TA $<$ 10 bn) or larger (TA $>$100 bn) than this base category.[6]

Table A.13 presents results from regression where the EVE impact is regressed on these bank size dummies, potentially allowing for variation over time. In column 1, we absorb year $\times$ scenario fixed effects, so that the estimated coefficients on the bank size dummies can be interpreted as the average differential exposure across the years 2020 to 2023 relative to banks in the omitted base category (TA 10-100 bn). Both estimated coefficients

[6]Banks can move across size bins over time; in our sample, this happens for 8 banks. Overall, we have 37/23/7 unique banks that are in the smallest/middle/largest size group at some point over 2020 to 2023.

are negative, meaning that small and large banks were, if anything, more exposed to rate increases, though the coefficients are not statistically significant (based on standard errors clustered by bank).

In columns 2 and 3, we allow for the coefficients to change across years. Column 2 indicates that the differential exposure of large banks was most acute in 2020 and 2021; in 2022/23, they were equally exposed to rate increases as banks in the 10-100 bn category.[7] Column 3 attempts to isolate time-variation more precisely by adding bank $\times$ scenario fixed effects in order to control for variation in sample composition across years.[8] In that column, the estimated time variation is slightly smaller, and none of the coefficients are significant.[9] In sum, we find no evidence that the largest banks (with more than 100 bn USD in TA) were less exposed to interest rate increases, or became differentially less exposed over time, than smaller banks.

We finally turn to the question of how banks' balance sheet composition affected their EVE risk exposure. We focus in particular on the correlation with the share of mortgages in TA, the share of MBS in TA, and the share of other (non-MBS) securities in TA.[10] The results from our main analysis suggest that banks' EVE became more exposed to further rate changes in 2021 and 2022/23 compared to 2020 if a bank held a large share of its assets in mortgages and MBS, which feature extension risk (duration increasing in the level of rates). In our main specifications, we therefore regress projected EVE changes on balance sheet composition indicators interacted with year dummies. In some regressions, we further control for deposit betas from Drechsler et al. (2021) to test whether doing so might attenuate any effects; this reduces our sample size somewhat because betas are not available for all banks. All regressions include year $\times$ scenario fixed effects, and in some regressions we further control for bank $\times$ scenario fixed effects to account for sample composition changes.

Table A.14 shows the regression results. In columns 1 and 2, we simply pool across years to test whether on average, higher shares of mortgages or MBS in TA are associated with a more negative response of EVE to an increase in rates. The negative point estimates suggest that this is the case, although the estimated effects are not statistically significant once the deposit beta (itself also insignificant) is added as a control variable. In the subsequent columns, we further interact the balance sheet composition variables with year dummies to capture time-varying effects. The coefficients on the interaction terms with Mortgages/TA and MBS/TA are all negative, as hypothesized: from 2021 onward, banks with high shares of mortgages and/or MBS on their balance sheet became differentially more exposed to interest-rate increases. That said, our statistical power is limited

[7] This statement is based on adding the coefficient for 2020, -6.75, and the coefficient for 2022/23, +6.82.

[8] For instance, SVB is only in the sample in 2020 and 2021, when it disclosed large negative projected EVE impacts in case of rate increases; in 2022, it no longer disclosed EVE projections.

[9] Note that the uninteracted coefficients in the first two rows are only identified from the few banks that switch size category across years, and should therefore not be given a strong interpretation.

[10] "Mortgages" here refers to closed-end first-lien loans secured by 1-4 family residential properties. These are the mortgages that are most likely to have a fixed rate and a free prepayment option.

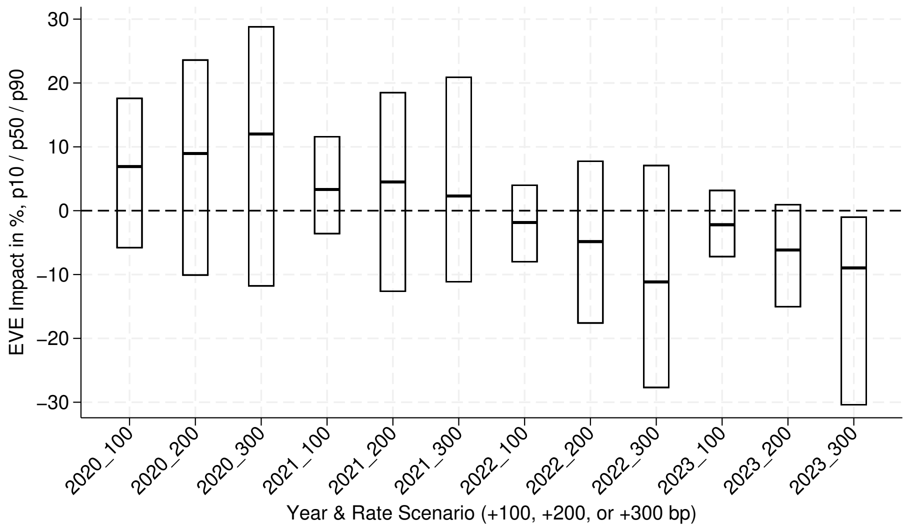
and most individual coefficients are not statistically significant.[11] To gauge the economic magnitude of the coefficients, we can scale them by the cross-bank standard deviation in the ratios; for both Mortgages/TA and MBS/TA, this standard deviation is 0.07. Thus, a coefficient of -50 implies that a bank with a one-standard-deviation higher share of Mortgages/TA or MBS/TA is predicted to see its EVE lowered by 3.5 percentage points more for a given interest rate increase, which is a sizable effect.

Notably, the interaction terms for non-MBS securities is positive, implying that other (mostly noncallable) securities did not have the same effect on interest-rate risk exposure, again in line with our main analysis. Finally, we note that controlling for deposit betas only has small effects on the estimated coefficients.

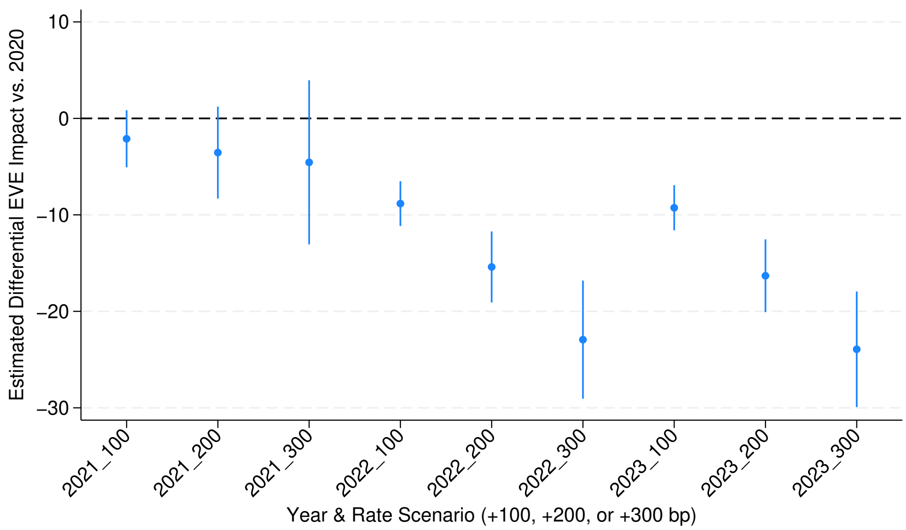
[11] Across columns 3 to 6, F-tests of the joint significance of the four interaction terms with Mortgages/TA and MBS/TA produce p-values between 0.04 and 0.15.

Figure A.11: Variation in projected EVE changes across years and rate scenarios

A. Raw distributions



B. Estimated differential effects compared to same rate scenario in 2020



Notes: Panel A shows the 10th, 50th and 90th percentiles of the cross-bank distribution in 2020, 2021, 2022 and 2023 of the projected impact of a 100, 200 or 300 bp rate increase on a bank's economic value of equity (EVE). Panel B shows estimated coefficients and 95% confidence intervals from panel regressions where the EVE impact is regressed on bank $\times$ scenario fixed effects and the respective scenarios in 2020 provide the omitted categories. Source: 10-K filings of 62 banks.

Table A.13: Projected EVE changes: Variation across bank size categories

	(1)	(2)	(3)
Under 10bn TA	-1.370	3.419	4.086
	(1.977)	(3.463)	(4.409)
Above 100bn TA	-4.536	-6.747*	7.551
	(2.945)	(3.842)	(5.078)
2021 × Under 10bn TA		-8.366	-7.448
		(8.541)	(8.766)
2021 × Above 100bn TA		-6.750	-6.102
		(7.924)	(8.059)
2022/23 × Under 10bn TA		-5.383	-4.406
		(3.701)	(3.386)
2022/23 × Above 100bn TA		6.822	1.074
		(4.672)	(2.807)
Year × Scenario FE	Y	Y	Y
Bank × Scenario FE	N	N	Y
Mean of Dep. Var.	-0.08	-0.08	0.00
St. Dev. of Dep. Var.	13.64	13.64	13.81
Observations	521	521	504

Notes: The table shows estimates of projected changes in economic value of equity (EVE) at the bank × year × rate-scenario level on bank-size indicators and their interaction with year indicators. Omitted size category are banks with total assets between 10 and 100bn USD; omitted year is 2020. Standard errors are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: 10-K filings of 62 banks.

Table A.14: Projected EVE changes: Variation across bank characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
Mortgages/TA	-38.04**	-25.20	-0.64	-14.19	19.16	-8.03
	(18.54)	(19.88)	(32.82)	(34.82)	(33.32)	(35.46)
MBS/TA	-20.18	-20.85	-0.48	35.75	0.16	73.06
	(17.22)	(16.99)	(31.53)	(54.11)	(31.47)	(63.05)
Non-MBS Sec./TA	9.10	8.73	-36.68	-38.24	-47.37*	-32.45
	(17.92)	(17.41)	(28.05)	(69.44)	(27.40)	(63.39)
Deposit Beta		10.69			-7.23	134.73
		(11.86)			(18.04)	(263.32)
2021 × Mortgages/TA			-59.70	-59.24	-62.56	-66.10
			(46.65)	(49.63)	(43.47)	(44.90)
2022/23 × Mortgages/TA			-43.03	-51.50**	-53.83**	-59.22***
			(26.17)	(20.48)	(26.32)	(18.31)
2021 × MBS/TA			-51.92	-62.83	-48.22	-72.58*
			(37.22)	(46.27)	(31.90)	(41.45)
2022/23 × MBS/TA			-6.82	-27.49	-8.20	-41.73
			(30.84)	(25.32)	(30.68)	(29.73)
2021 × Non-MBS Sec./TA			84.49*	84.79**	106.42**	114.63**
			(43.35)	(37.87)	(52.70)	(47.50)
2022/23 × Non-MBS Sec./TA			46.35	30.50	52.78	46.40
			(32.58)	(35.08)	(33.11)	(34.78)
2021 × Deposit Beta					57.11*	61.68*
					(32.05)	(31.36)
2022/23 × Deposit Beta					4.41	9.69
					(15.36)	(18.76)
Year × Scenario FE	Y	Y	Y	Y	Y	Y
Bank × Scenario FE	N	N	N	Y	N	Y
Mean of Dep. Var.	-0.08	0.48	-0.08	0.00	0.48	0.59
St. Dev. of Dep. Var.	13.64	13.69	13.64	13.81	13.69	13.88
Observations	521	463	521	504	463	446

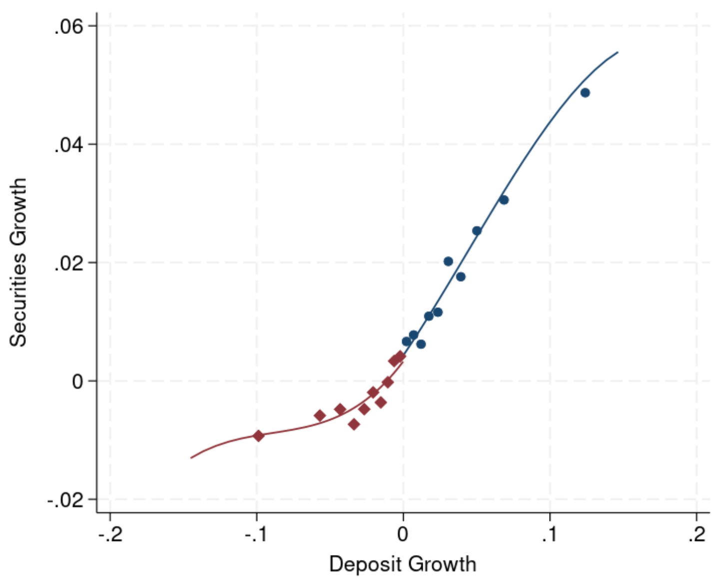
Notes: The table shows estimates of projected changes in economic value of equity (EVE) at the bank × year × rate-scenario level on bank balance-sheet characteristics and their interaction with year indicators. Omitted year is 2020. Standard errors are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: 10-K filings of 62 banks; Call Reports; Philipp Schnabl's website (deposit betas).

D Asymmetric responses to deposit flows

This section presents evidence from a larger sample of banking organizations that banks' reluctance to sell bonds outright (as we have documented in the main text) led to an asymmetric response of the securities portfolio to deposit inflows vs outflows. Specifically, we find that bank portfolios were less responsive to deposit outflows, suggesting that banks were constrained, at least in the short run, by their unwillingness to sell underwater bonds.

Since we measure deposit flows only at the bank level, we test for the presence of such asymmetric effects using quarterly Call Reports data on the universe of commercial banks. To begin, we generate a binned scatter plot showing the contemporaneous relationship in 2022-23 between securities growth — measured at amortized cost so that changes do not simply reflect fluctuations in market value — and deposit growth. Results are reported in Figure A.12 below. As we can see, there is a kink around zero: securities portfolios grow significantly when banks experience deposit outflows, but shrink relatively slowly in response to deposit outflows.

Figure A.12: 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*. Weighted by bank size. Sample period is 2022:Q1 to 2023:Q4. Source: Call Reports.

Next, to examine statistical significance and explore dynamics more carefully, we estimate regressions of the form:

$$\Delta ln(securities_{b,t}) = \sum_{i=0}^{3} \alpha_i \Delta ln(dep_{b,t-i})^{+} + \sum_{i=0}^{3} \beta_i \Delta ln(dep_{b,t-i})^{-} + \gamma_b + \kappa_t + \varepsilon_{b,t}, \quad (2)$$

where $securities_{b,t}$ is the total amortized cost of the investment securities portfolio for bank b in quarter t (because again, 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 A.15. 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 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.[12] 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. 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).

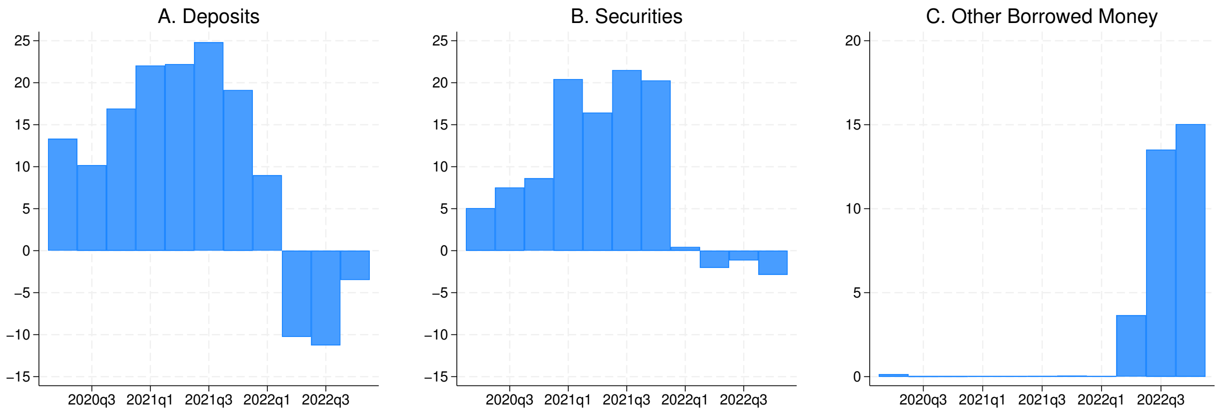
With the caveat that we do not isolate exogenous variation in bank deposit growth, our estimates are consistent with the presence of "downward rigidity" in the response of the securities portfolio to deposit outflows, particularly in 2022-23 when portfolios were typically underwater.[13] Silicon Valley Bank (SVB) itself is an interesting case study of such rigidity. As shown in Appendix Figure A.13, SVB rapidly acquired investment securities

[12] The difference between the two (i.e., $\hat{\alpha}_0 - \hat{\beta}_0$ in the notation of equation 2) 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.

[13] 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.

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 event that triggered the failure of the firm a few days later.[14]

Figure A.13: Silicon Valley Bank did not sell securities even as interest-rate risk increased and deposits flowed out



Notes: Figures show the change in deposits, securities amount, and other borrowed money for Silicon Valley Bank from 2020:Q2 to 2022:Q4. Securities in panel B include both the HTM and AFS portfolios, and are measured at amortized cost. Source: Call Reports.

We note 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., 2024a), 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.14.

[14] 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%."*

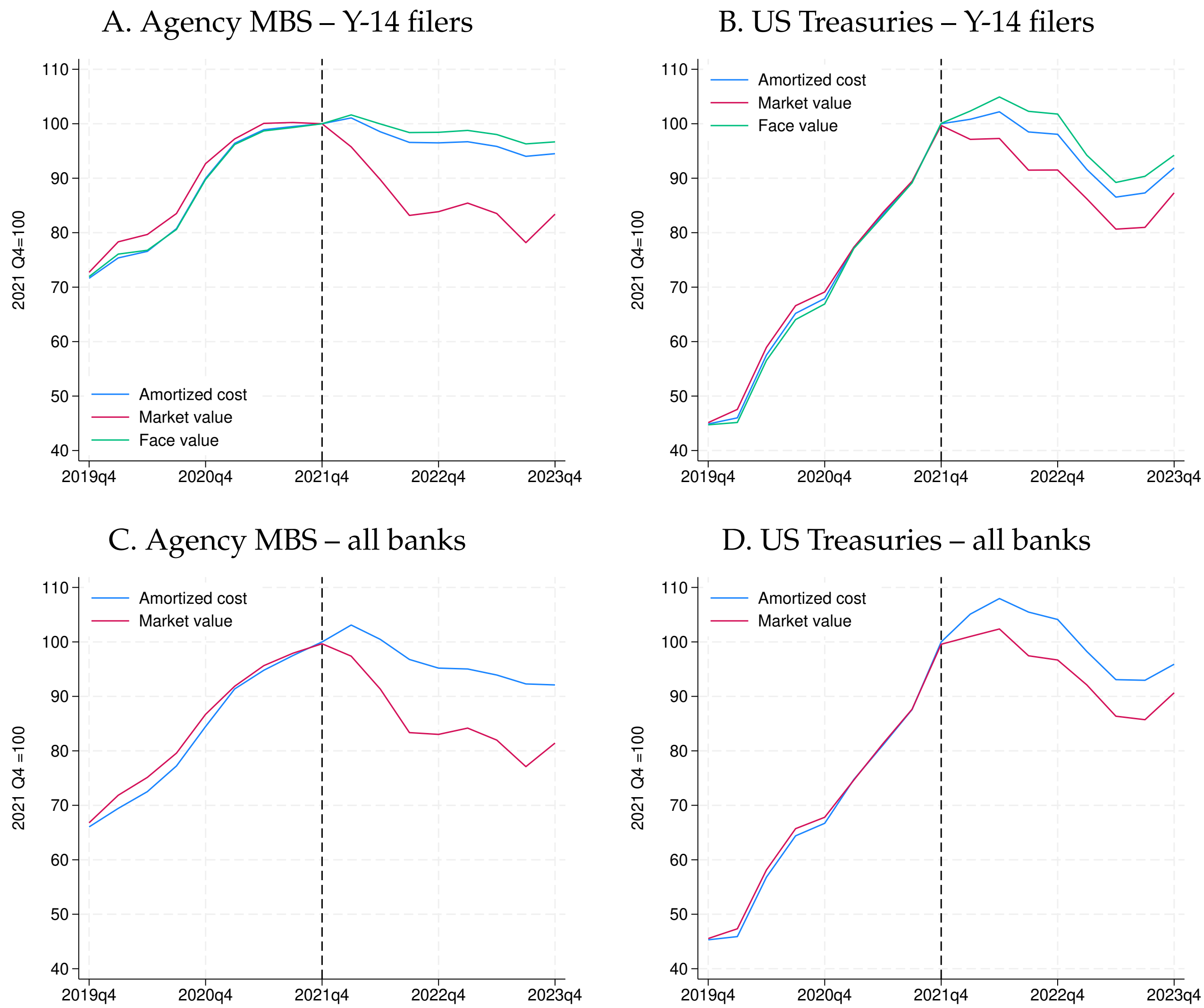
Table A.15: Securities portfolio response to positive vs. negative deposit growth

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.

Figure A.14: 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 2021:Q4 is used, and all series are indexed to equal 100 in 2021:Q4. The dashed line indicates 2022:Q1. Source: FR Y-14Q, Schedule B; Call Reports.

E The evolution of rate expectations

As we show in Figure 1 of the main text, US short- and longer-term interest rates increased rapidly over the course of 2022, and then remained relatively steady.[15] Two important questions that one may ask in this context are:

1. Did the increase in rates over 2022 come as a surprise? If not, banks would have had the opportunity to prepare for the rate increase, and the fact that (as we show) they did not do much of that reflects that they were not too concerned about the consequences of rate increases.

2. Once the rate increases had taken place (say, by Fall 2022), perhaps everybody simply expected that there was effectively no chance that rates would increase further, so a high interest-rate risk exposure was no longer problematic.

In what follows, we present evidence from professional forecasters and market prices that suggests that (1) the extent and speed of the rate increase did come as a surprise to many, and (2) that even after rates had increased, the possibility of further rate increases could not be ruled out.

We begin with the Philadelphia Fed's Survey of Professional Forecasters, which (among many other things) collects point forecasts from between 30 and 40 private sector economists on the evolution of the 10-year yield over the following quarters.

Panel A of Figure A.15 compares the evolution of the 10-year yield to what the SPF median forecast had predicted one year earlier. For instance, the data point for the third quarter of 2022 shows that the actual yield (measured as of September) was 3.52%, while the median SPF participant had forecasted one year earlier (in the third quarter of 2021) that the yield would be 1.85%. Comparing the red and blue lines thus reveals that, even though forecasters in 2021 had anticipated some increase in long yields over the coming year, they substantially underestimated the magnitude of that increase, by about 1.5 percentage points for the second half of 2022. Subsequently, the forecasts caught up with reality, and by end-2022 they forecasted rates to remain high (as indicated by the last data point in the chart).

Panel B provides a complementary perspective by showing the fraction of forecasters expecting any increase in the 10-year yield over the following year, and the fraction expecting an increase of at least 50 basis points. The first fraction (blue line) was between 0.8 and 1 for the entire period 2018-2021, meaning that forecasters systematically predicted long rates to increase; however, the red line indicates that only between 20 and 50% of forecasters predicted sizeable increases of at least 50 bp. Notably, this remained true at

[15] For instance, the 10-year yield reached 4% by mid-October 2022, an increase of 2.5 percentage point compared to one year earlier. Subsequently, the 10-year yield mostly hovered between 3.5% and 4.7% between October 2022 and April 2025, with a peak just below 5% in October 2023.

the end of 2021, before the rapid increase started; less than half of the forecasters predicted an increase of 50 bp or more.[16] Thus, this evidence suggests that forecasters were surprised by the speed and magnitude of the rate increase, even if directionally they did anticipate that rates might increase.

We can use the same chart to study the evolution of forecasts once the rate increase had taken place. Over the course of 2022/23, the share of forecasters expecting a further rate increase steadily fell, but even by mid-2023, still 30% of forecasters expected higher 10-year yields one year in the future. This suggests there was not a consensus that rates could not increase further at that point.

The analysis so far has focused on point forecasts, because survey-based measures of the full expected distribution of future rates are not broadly available. We therefore turn to market-based measures of the uncertainty about future interest rates.

Panel C of Figure A.15 shows the evolution of the ICE BofAML MOVE Index. The level of this index reflects the market-price-implied volatility of future Treasury yield volatility.[17] The figure indicates a clear jump in this volatility around January 2022, when the rate increase started. Until that point, market prices indicated an expectation of relatively muted changes in yields, why from February 2022 onward, implied volatility was much higher.

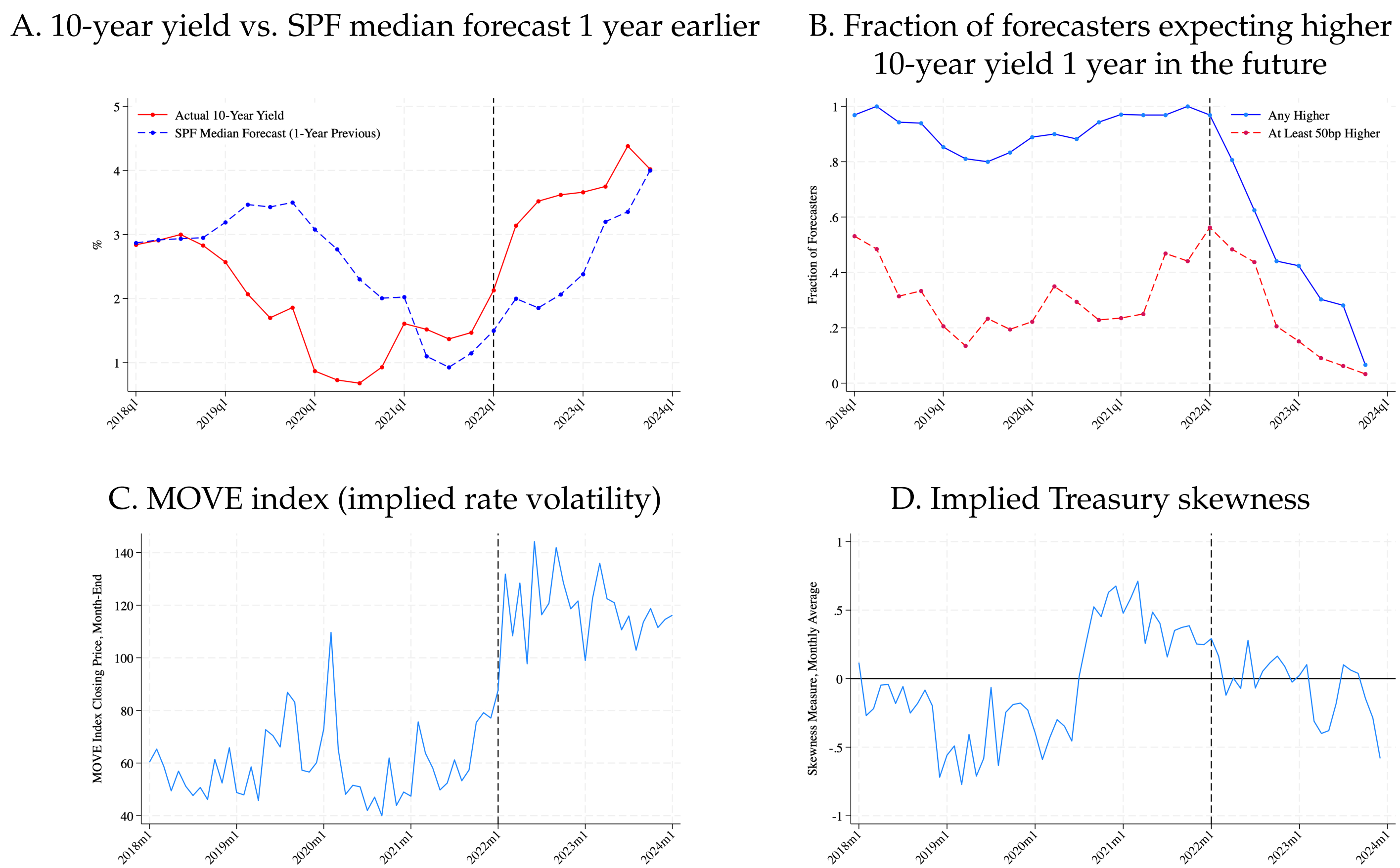
Of course, implied volatility could potentially be one-sided, with the market assigning a higher chance to rates decreasing than further increasing (or vice-versa). To shed light on this possibility, we rely on a measure of implied Treasury skewness based on the methodology of Bauer and Chernov (2024).[18] Implied skewness is calculated based on prices from 10-year Treasury note futures and options. These contracts expire some time between 1-3 months after the observed trading date. Positive (negative) skewness indicates that markets find an increase (decrease) in yields more probable than the opposite. Panel D of Figure A.15 indicates that over the course of 2021, the skewness was positive, although it decreased over the course of the year. Once the rate increase had started in 2022, skewness hovered around zero, meaning that the market found a further increase in yields equally plausible as a decrease. This remained the case through February 2023; skewness then became negative in March (dropping sharply after the failure of SVB). However, skewness became slightly positive again over July-September 2023, only dropping significantly toward the end of the year. Overall, these data thus indicate that over most of 2022 and 2023, after rates had already increased, the market thought it was plausible that long rates would increase further.

[16] Only two forecasters indicated a point forecast above 2.5%, the highest being 2.8%

[17] The index is calculated by taking a basket of at-the-money call and put options on US Treasuries (2-year, 5-year, 10-year, 30-year) with a one-month expiration, and backing out the implied volatility of each of these options given their prices. The index value is then a weighted average across these volatilities.

[18] The data are available at https://www.frbsf.org/research-and-insights/data-and-indicators/treasury-yield-skewness/.

Figure A.15: The evolution of rate expectations



Data sources: Panel A: Philadelphia Fed Survey of Professional Forecasters (SPF, https://www.philadelphiafed.org/surveys-and-data/tbond); FRED. Panel B: SPF. Panel C: Yahoo Finance. Panel D: Federal Reserve Bank of San Francisco (https://www.frbsf.org/research-and-insights/data-and-indicators/treasury-yield-skewness/).

F Strategic trading: longer sample period

The analysis in Section 4.1 of the main text 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 in the main text 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 A.16. 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 MV/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.[19] 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; Aland and Burks, 2023), 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.[20]

[19] This is shown graphically in Appendix Figure A.16, which is the equivalent of Figure 6, but using data for the 2015-21 period instead of 2022-23.

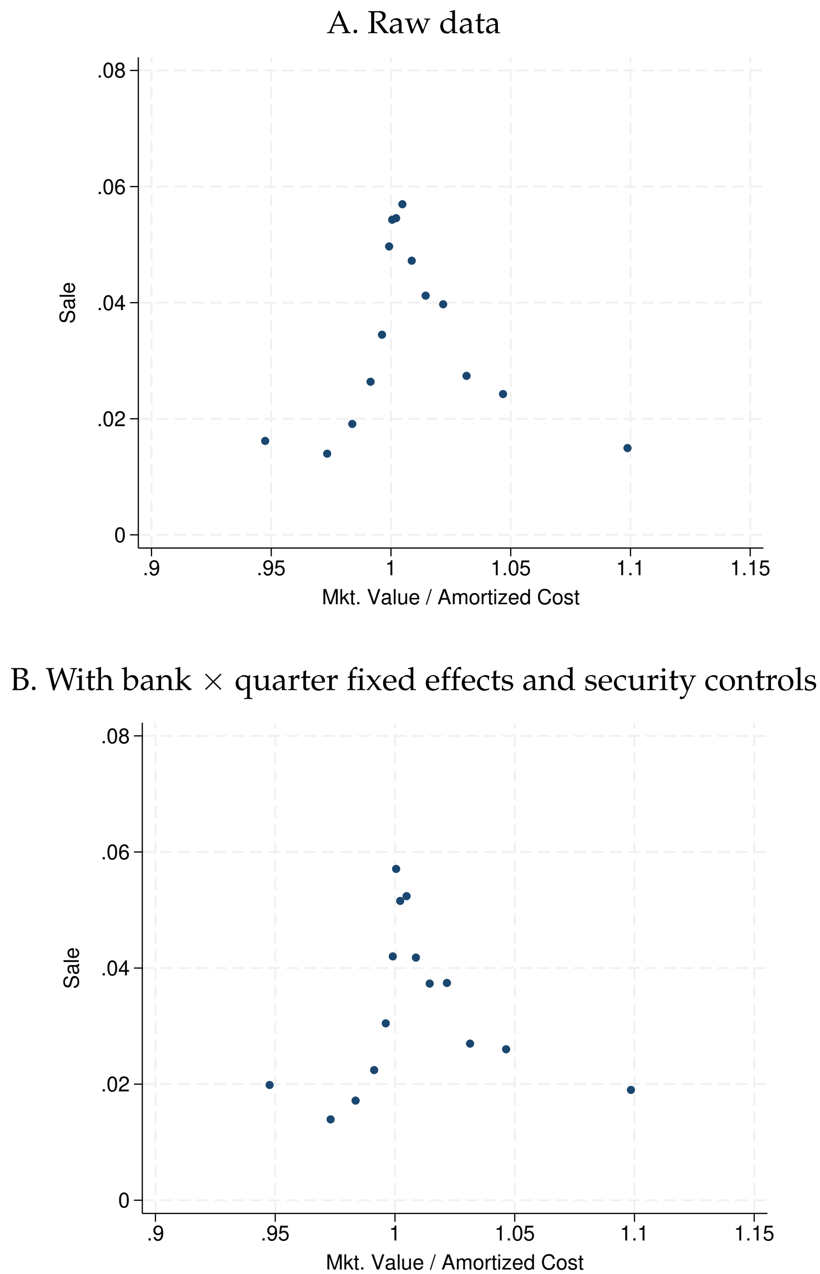
[20] Aland and Burks (2023) use data from banks' 10-K and 10-Q disclosures that separately report gross unrealized and realized gains and losses, rather than just the net values in regulatory reports (Y9-C/Call Reports) like earlier work. They find that banks use strategic selling to boost low earnings, 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.

Table A.16: Strategic trading: 2022-23 vs. earlier years

	(1)	(2)	(3)	(4)
MV/AC $\in$ [.99-1.01]	2.872***	2.634***	2.744***	2.572***
	[2.2,3.7]	[2.1,3.3]	[2.2,3.4]	[2.0,3.2]
MV/AC $>$ 1.01	1.866***	1.705***	1.639***	1.598***
	[1.4,2.4]	[1.3,2.2]	[1.3,2.1]	[1.2,2.1]
MV/AC $\in$ [.99-1.01] $\times$ Post-2022	1.197	1.421	1.387	1.410
	[0.7,2.1]	[0.8,2.5]	[0.8,2.5]	[0.8,2.5]
MV/AC $>$ 1.01 $\times$ Post-2022	5.291***	6.646***	6.047***	7.101***
	[2.9,9.8]	[3.5,12.6]	[3.0,12.0]	[3.4,14.7]
Obs.	2,666,632	2,665,660	2,664,174	2,655,447
Fixed effects	No	Time	Bank, Time	Bank, Time
Controls	No	No	No	Yes
Weights	Yes	Yes	Yes	Yes
P(sale) for MV/AC $<$ 0.99	.011	.011	.011	.011

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. MV: market value. AC: amortized cost. The independent variables are dummies for different bins of MV/AC; the omitted category is underwater securities (MV/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, time since purchase, duration, convexity, floating rate indicator, and remaining maturity (all from ICE/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; ICE; MSCI; Call Reports.

Figure A.16: Sales propensities in the cross section of securities in 2015-21



Notes: Binned scatter plot based on estimation using Y-14Q data. 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 amortized cost.

G Additional details on hedge accounting

The following quotes provide helpful perspective from practitioners about the complexities, costs and tradeoffs involved in applying hedge accounting in practice:

From J.P. Morgan Chase's 2024 10-K:

"To qualify for hedge accounting, a derivative must be highly effective at reducing the risk associated with the exposure being hedged. In addition, for a derivative to be designated as a hedge, the risk management objective and strategy must be documented. Hedge documentation must identify the derivative hedging instrument, the asset or liability or forecasted transaction and type of risk to be hedged, and how the effectiveness of the derivative is assessed prospectively and retrospectively. To assess effectiveness, the Firm uses statistical methods such as regression analysis, nonstatistical methods such as dollar-value comparisons of the change in the fair value of the derivative to the change in the fair value or cash flows of the hedged item, and qualitative comparisons of critical terms and the evaluation of any changes in those terms. The extent to which a derivative has been, and is expected to continue to be, highly effective at offsetting changes in the fair value or cash flows of the hedged item must be assessed and documented at least quarterly."

From the PricewaterhouseCoopers (2024) guide to hedging:

"The qualifying criteria for hedge accounting are rigorous and require a commitment of time and resources. To avoid the cost and the risk of misapplication of the rules, reporting entities may choose to not elect hedge accounting even though they have a risk management strategy that involves entering into derivatives."

"Economic hedging refers to the use of a derivative that mitigates risk without applying hedge accounting. An entity choosing to treat a transaction as an "economic" rather than an "accounting" hedge will bear the volatility of changes in the fair value of the derivative instrument in its income statement."