FEDERAL RESERVE BANK OF SAN FRANCISCO

WORKING PAPER SERIES

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July 2023

Working Paper 2023-18

https://www.frbsf.org/economic-research/publications/working-papers/2023/18/

Suggested citation:

Krainer, John, Pascal Paul. 2023 "Monetary Transmission through Bank Securities Portfolios," Federal Reserve Bank of San Francisco Working Paper 2023-18.
https://doi.org/10.24148/wp2023-18

Monetary Transmission through Bank Securities Portfolios

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Abstract

We study the transmission of monetary policy through bank securities portfolios for the United States using granular supervisory data on bank securities, hedging positions, and corporate credit. We find that banks that experienced larger market value losses on their securities during the monetary tightening cycle in 2022 extended relatively less credit to firms. Such a spillover effect was stronger for (i) available-for-sale securities, (ii) unhedged securities, (iii) low-capitalized banks, and (iv) banks that have to include unrealized gains and losses on their available-for-sale securities in their regulatory capital. Our findings provide evidence for a forceful transmission channel of monetary policy that is shaped by the regulatory framework of the banking system.

Keywords: Banks, Firms, Securities, Monetary Policy
JEL Codes: E32, E43, E44, E51 E52, E60, G21, G32

*We thank Monika Piazzesi and Mauricio Ulate for their comments, Jason Mills and Tian Assadian for many helpful discussions about the data, Sarah Chae for assistance with accounting rules, as well as seminar participants at Goethe University Frankfurt, SAFE Institute, Federal Reserve Bank of San Francisco, and Federal Reserve Board of Governors for their questions and insights. We also thank Zoe Arnaut-Hull for excellent research assistance. The views expressed herein are those of the authors and do not reflect the views of the Federal Reserve Bank of San Francisco, the Board of Governors of the Federal Reserve, or the Federal Reserve System. All errors are our own. This paper has been screened to ensure that no confidential data have been revealed. John Krainer: john.r.krainer@frb.gov. Pascal Paul: pascal.paul@sf.frb.org.

1 Introduction

In March 2023, the United States experienced one of the largest bank failures in decades. Depositors at Silicon Valley Bank (SVB) quickly withdrew their funds when concerns emerged that the bank would not be able to service all withdrawal requests. During a period of low interest rates in 2020 and 2021, SVB had experienced a large inflow of deposits and sharply increased its investment holdings of long-term securities. From a balance sheet accounting perspective, SVB mostly booked these purchases in the so-called held-to-maturity (HTM) portion of its investment portfolio, where such acquisitions are recorded at purchasing cost. However, in 2022, the Federal Reserve rapidly increased interest rates under inflationary pressures, resulting in large price declines of long-term securities. While these value losses were not recognized for HTM securities on SVB's balance sheet, uninsured depositors still worried that they would not be repaid in full if SVB was forced to sell its HTM securities at market prices, providing them with the incentive to withdraw their funds in the hope that they would be repaid before the bank exhausts its resources.

These events have put bank balance sheet accounting under the spotlight. However, disagreement and uncertainty about whether and how to reform bank accounting standards remain, illustrated in a recent survey conducted by the Kent Clark Center of Chicago Booth among leading academics.[1] One question asked experts to comment on the following statement: "For the purposes of capital regulation, banks should be required to mark their holdings of Treasury and Agency securities to market at all times (even though their loans are not marked to market)." The answers from the survey show that around half of the respondents agree with the statement, while around one-third are either uncertain or disagree.[2]

A potential benefit of marking securities to market at all times may be that sudden bank runs like the one experienced by SVB would become less likely since bank assets would more closely track their liquidation values. If such valuation changes of securities also affected regulatory capital—a requirement that currently only applies to the very largest U.S. banks and did not apply to SVB—then banks

[1] See `https://www.kentclarkcenter.org/surveys/banks-business-model/`.

[2] A similar debate on whether bank assets should be marked to market took place in response to the 2007-09 financial crisis, see, e.g., Allen and Carletti (2008), Heaton, Lucas and McDonald (2010), and Laux and Leuz (2010).

could further adjust their capital and investment positions in response to security price changes.[3] However, when security values decrease and those are immediately recognized on bank balance sheets, it may also put additional pressure on banks, as their liabilities are not marked to market and do not decrease at the same time. Specifically, when securities lose value, banks may react by cutting their credit supply to households and firms, thereby affecting real economic activity. Future regulatory changes to the accounting treatment of bank securities may therefore affect the strength of this monetary transmission channel.

In this paper, we study such a spillover effect from securities into loan portfolios during a period of monetary tightening. For the first time, we combine detailed supervisory data on security holdings, hedging positions, and corporate credit for large U.S. banks. These data are obtained from the Federal Reserve's Y-14Q data set, which is typically used for stress testing.

To begin, we document several stylized facts about banks' securities portfolios and their associated accounting hedges. First, U.S. Treasuries and agency mortgage-backed securities (MBS) account for almost 85 percent of bank securities holdings. Second, around 40 percent of securities are recorded as HTM, while the remaining 60 percent are available for sale (AFS) and marked to current market prices. Third, at the beginning of the monetary policy tightening cycle in 2021:Q4, around 19 percent of AFS securities were hedged, while banks are prohibited from using hedges that are associated with their HTM portfolios. Fourth, to hedge risk exposures, banks primarily use fair-value hedges against interest rate risk (interest rate swaps) which account for around 86 percent of all contracts. And fifth, around two-thirds of all hedges apply to Treasuries, with agency MBS accounting

[3] For example, such an argument is made in the Review of the Federal Reserve's Supervision and Regulation of Silicon Valley Bank (page 89): "Recognizing unrealized gains and losses on AFS securities in its CET1 capital would have reduced SVBFG's [SVB Financial Group] capital by $1.9 billion ... The decrease in its regulatory capital may have led SVBFG to operate differently. For example, SVBFG may have raised additional capital or may have made different business decisions." https://www.federalreserve.gov/publications/files/svb-review-20230428.pdf.
In a recent speech, Chairman of the FDIC Martin J. Gruenberg notes: "... although Silicon Valley Bank's (SVB) failure was caused by a liquidity run, the loss of market confidence that precipitated the run was prompted by the sale of assets at a substantial loss that raised questions about the capital adequacy of the bank. Had the unrealized losses on available for sale securities on the balance sheet of SVB, that were realized once sold, been required to be recognized in capital, as the Basel III framework would do, it might have averted the loss of market confidence and the liquidity run. That is because there would have been more capital held against these assets." https://www.fdic.gov/news/speeches/2023/spjun2223.html

for another 15 percent.

We continue by documenting differences in the regulatory treatment of the banks within our sample and their influence on bank investment decisions. The larger ones within our data, we label them AOCI-Capital (AC) banks as further explained below, must include unrealized gains and losses on their AFS securities in their regulatory capital. In contrast, for the relatively smaller, referred to as non-AOCI-Capital (NC) banks, fluctuations in the values of their AFS securities do not affect their regulatory capital positions. These regulations have evolved in recent years and the turmoil around SVB reignited a debate on whether to enlarge the set of banks that need to recognize such unrealized gains and losses in their regulatory capital.[4]

We use the differential regulatory capital treatment to characterize the different incentives banks have for their securities portfolio choice problem. During the period of low interest rates in 2020 and 2021, AC banks (i) show small increases in their security holdings relative to assets, (ii) sharply increased the fraction of their securities recorded as HTM, and (iii) strongly raised the portion of their AFS securities that is hedged. In contrast, the patterns for NC banks look strikingly different, reflecting the distinct pass-through of price changes of AFS securities to regulatory capital across the two sets of banks (see Fuster and Vickery, 2018, and Kim, Kim and Ryan, 2019, on related evidence for previous periods).

In our main set of empirical results, we investigate the spillover effect of price fluctuations of AFS securities through the bank-firm network. Specifically, for the monetary tightening episode of 2022, we study whether the large price declines of securities resulted in a crowding out of credit to nonfinancial firms. Using the fixed effects approach of Khwaja and Mian (2008) that allows us to control for firm

[4] For example, the Review of the Federal Reserve's Supervision and Regulation of Silicon Valley Bank notes that (page 3) "With respect to capital, we are going to evaluate how to improve our capital requirements in light of lessons learned from SVB. For instance, we should require a broader set of firms to take into account unrealized gains or losses on available-for-sale securities, so that a firm's capital requirements are better aligned with its financial positions and risk." https://www.federalreserve.gov/publications/files/svb-review-20230428.pdf.
As one of the reforms to bank capital requirements, Vice Chair for Supervision Michael Barr proposes to widen the set of banks that must recognize unrealized gains and losses on AFS securities in their regulatory capital: "Importantly, the proposed adjustments would require banks with assets of $100 billion or more to account for unrealized losses and gains in their available-for-sale (AFS) securities when calculating their regulatory capital. This change would improve the transparency of regulatory capital ratios, since it would better reflect banking organizations' actual loss-absorbing capacity." https://www.federalreserve.gov/newsevents/speech/barr20230710a.htm

credit demand, we find that banks that experienced larger value losses on their AFS portfolios extended relatively less credit. The effect is sizable with a $1 price decline leading to a relative credit contraction of around 20 cents. Interestingly, we find substantially smaller and insignificant results for value changes of HTM securities. These differences can be explained by the facts that banks generally do not intend to sell such securities before they mature and that value changes of HTM securities do not affect regulatory capital for all banks.

Motivated by the stylized facts that we document, we further explore the mechanisms that may explain our findings. First, we show that the spillover effect is substantially stronger for AC banks, despite their efforts to shield themselves from potential price declines of securities that we highlight. Second, the magnitude of the effect also depends on bank capital positions, with low-capitalized ones showing a larger spillover effect. Third, when differentiating AFS securities into hedged and unhedged ones, we find that our baseline results are driven by unhedged securities, whereas value changes of hedged securities show a smaller and insignificant crowding out effect of firm credit. Fourth, using unexpected yield changes of long-term securities as an instrument, we associate the price changes of AFS securities to banks' exposure to interest rate risk. And fifth, we directly control for simultaneous responses of bank deposits and cash flows to distinguish our channel working through value changes of securities from other prominent ones (Drechsler, Savov and Schnabl, 2017; Gomez et al., 2021).

Last, we test whether these spillover effects also translated into changes in total firm debt and investment, as firms may have obtained additional credit from other lenders or smoothed investment by adjusting other margins instead. We find that the crowding out effects influenced total firm debt almost one-for-one and sharply reduced investment.

Taken together, our findings provide evidence for a possibly powerful monetary transmission mechanism working through bank securities portfolios. Our results show that the strength of this channel depends on (i) bank balance sheet composition, (ii) the regulatory framework and accounting treatment of securities, (iii) bank capitalization, and (iv) the hedging of interest rate risk.

Our findings have implications for current policy debates. The regulatory treatment of securities and the pass-through of value changes into capital may not only affect the frequency of bank runs as intended but also the effects of monetary policy on the broader economy. If banks were required to mark all their securities to market or to pass unrealized gains and losses through to their regulatory capital, monetary policy could become more potent—both in speed and in magnitude—since the documented spillover channel working through fast-moving asset prices would strengthen.

Related Literature. Our paper relates to the literature on the "bank lending channel" of monetary policy, which focuses on the impact of monetary policy actions on the supply of loans by depository institutions (Bernanke and Gertler, 1995). We follow the approach of Kashyap and Stein (2000) and others of investigating cross-sectional differences in the lending behavior of banks. Using bank-level data, Kashyap and Stein (2000) find that banks with less liquid balance sheets, measured by the ratio of securities to assets, contract lending more after a monetary tightening. Jiménez et al. (2012) confirm this result using Spanish credit register data that can more clearly isolate the credit supply effect. In contrast, we find that banks with larger security holdings relative to assets adjust their lending more following changes in monetary policy since such banks experience larger value changes of securities relative to their assets. These alternative findings can be explained by (i) differences in bank regulation (our results are driven by AC banks), (ii) the sample (we consider a monetary tightening episode), and (iii) the identification approach (we directly measure security value changes based on micro data).

More recently, Drechsler, Savov and Schnabl (2017) and Gomez et al. (2021) investigate alternative transmission channels through bank balance sheets. Drechsler, Savov and Schnabl (2017) show that banks widen spreads between the federal funds rate and rates on liquid deposits after a monetary tightening, leading to deposit outflows and a contraction in credit supply. Gomez et al. (2021) find that banks with relatively more assets that reprice in the near term experience higher cash flows after a monetary tightening and contract their lending relatively less. We show that our findings are unaffected if we account for such alternative channels by directly controlling for deposit flows and cash flow effects. The sensitivity of credit supply along those various margins may in turn help banks achieve more stable net interest margins (Drechsler, Savov and Schnabl, 2021; Paul, 2022, 2023).

Abbassi et al. (2016), Peydró, Polo and Sette (2021), Carpinelli and Crosignani (2021), Peydró et al. (2023), and Abbassi et al. (2023) also use security- and loan-level data in combination. However, their focus is on the trade-off that banks face from investing in securities of different risk categories, and vis-á-vis loans. For example, Abbassi et al. (2016) find that German banks with more expertise in trading securities increased their security holdings during the 2007-09 financial crisis but lowered their credit supply to firms in turn. Peydró, Polo and Sette (2021) find similar effects for less-capitalized Italian banks during crisis times with softer monetary policy conditions. Carpinelli and Crosignani (2021) show that the long-term refinancing operations by the European Central Bank supported bank lending in Italy and banks used most of the additional liquidity to acquire domestic government securities.

Other studies have used loan-level data to establish a credit supply effect originating from banks' security exposures. Bottero, Lenzu and Mezzanotti (2020) show that banks with larger exposure to government securities extended relatively less credit around the 2010 Greek bailout. Popov and Van Horen (2015), Acharya et al. (2018), and De Marco (2019) show similar evidence using syndicated loan data. Rodnyansky and Darmouni (2017), Chakraborty, Goldstein and MacKinlay (2020), Luck and Zimmermann (2020), and Orame, Ramcharan and Robatto (2023) study the effects of quantitative easing on credit and real economic outcomes, differentiating banks by their ex-ante holdings of eligible securities. Similar to our findings, Orame, Ramcharan and Robatto (2023) show that these effects vary across periods with the accounting treatment of AFS securities.

Our paper differs from these studies in important ways. First, we combine micro data on bank security holdings, their associated hedging positions, and corporate loans. This newly created joint data set allows us to precisely estimate the effects of value changes of banks' pre-existing securities that we obtain by aggregating the individual positions. We can further differentiate between hedged and unhedged securities, and we show that our results depend on this distinction. Second, for identification, we exploit regulatory differences across banks within the same period. Thus, banks are subject to the same aggregate shocks, and the distinct regulatory rules that apply to them explain our findings as opposed to other observed differences in bank characteristics. And third, in contrast to other studies that focus on European institutions, we use detailed micro data for U.S. banks and study the effects of a unique monetary tightening episode.

We also provide new empirical evidence on the use and economic importance of derivative contracts for banks, which are particularly challenging to measure. Using bank-level data, Begenau, Piazzesi and Schneider (2015) and Jiang et al. (2023*a*) find little evidence that banks hedge their interest rate risk exposure. Banks may even use such contracts to amplify their exposures or reduce their use at times when hedging would be most needed. Hoffmann et al. (2019) collect transaction-level data on interest rate swaps for European banks and show that such contracts reduce the risk exposure of those institutions by around 25 percent. McPhail, Schnabl and Tuckman (2023) assemble regulatory data on interest rate swaps for U.S. banks and show that the interest rate risk of those positions for the average bank is close to zero. On the relation between hedging and credit supply, Purnanandam (2007) shows that banks that use derivatives cut their lending less if monetary policy tightens. We contribute to these existing studies by using new data on designated accounting hedges, which allow us to determine hedged positions security-by-security. Our findings show that the decision to hedge securities is influenced by banking regulation, is concentrated with AC banks, and varies with interest rate expectations. For hedged securities, we find negligible spillover effects from security price changes to banks' loan portfolios.

Finally, we connect with an evolving literature that was sparked by the banking turmoil around SVB. Jiang et al. (2023*b*) compute that the market value of U.S. bank assets was around $2.2 trillion lower than their book values following the monetary tightening cycle in 2022. The combination of such unrealized losses and uninsured depositors posed a run risk for a large set of banks. Drechsler et al. (2023) extend the work by Drechsler, Savov and Schnabl (2021) to show that the deposit franchise helps banks to stabilize their profit margins, but a run equilibrium can arise when interest rates rise. Granja (2023) shows that U.S. banks shifted AFS securities into the HTM portion of their investment portfolios in 2022 and that these movements were stronger for more fragile banks.

Road map. The rest of the paper is organized as follows. The next section lays out the institutional setting and U.S. regulatory framework for the banks in our data. Based on this setting, Section 3 illustrates balance sheet dynamics following security price changes and develops hypotheses that we aim to test empirically. Section 4 describes the data and Section 5 presents some stylized facts. Sections 6-8 summarize our main empirical findings. Section 9 concludes.

2 Institutional Setting

2.1 Accounting Classifications for Securities

Banks hold debt securities on their balance sheets under three possible accounting classifications. Securities can either be held in the trading book or in the banking book, where they can be marked as held-to-maturity or as available-for-sale. Each of these classification types is subject to a different treatment for the recognition of valuation changes and has distinct implications for bank capital. To provide some indication of magnitude, the median bank in our data has around 14 percent of its assets invested in AFS securities, close to 4 percent in HTM securities, and only around 0.7 percent in trading securities.[5]

Securities in the trading book. Securities held with the intention of trading in the near term are placed in the trading book. In this case, near-term can mean a holding period of less than one day. Securities in the trading book are held on the balance sheet at fair value. Unrealized gains or losses on trading book securities are recognized in trading profit and loss (P&L) and pass through net income to impact capital.[6] There are no limits on how long a bank holds a security in its trading portfolio. However, disincentives exist for booking in trading if the holding period is expected to be longer term. For example, banks subject to the market risk rule face higher regulatory scrutiny of their trading book positions and must include securities P&L in their Value at Risk disclosures.[7] If a bank intends to hold a security longer than is typical for a trading portfolio, it will book the security in the investment portfolio of the banking book. The investment portfolio is at the heart of the analysis in this paper.

Securities in the banking book: held-to-maturity. Banks report two valuation concepts for their debt securities in the investment portfolio. They report the fair value, or market value, which is meant to capture the value they would receive if they sold securities. Banks also record the amortized cost, or book value, which

[5]Banks hold securities in the trading book as both trading assets and trading liabilities. The median of 0.7 percent in trading securities is a net figure.

[6]Realized gains and losses from trading also flow through trading P&L.

[7]The market risk rule applies to banking organizations with aggregate trading assets and trading liabilities greater than $1 billion or 10% of total assets.

is the cost they incurred to buy the securities including any discounts or premia if the securities were not trading at par. Unrealized gains or losses are defined as the difference between these two valuation measures. Which of these two valuation concepts is used for capitalizing these assets on the balance sheet depends on the accounting designation chosen by a bank.

At one extreme, if a bank intends to hold a security until it matures, it uses the HTM classification. HTM securities are held on the balance sheet at amortized cost and are not marked to market as prices change. Unrealized gains or losses can be readily computed for HTM securities, but they do not impact balance sheet or income statement variables in any way. Banks can take charges on HTM securities if they anticipate expected credit losses on HTM securities due to issuer impairment.[8] However, as we show in Section 5, this source of revaluation is quantitatively small since the vast majority of the securities portfolio is invested in interest-rate sensitive securities with little credit risk.

The HTM designation is not necessarily permanent. A bank may sell a security out of HTM, but doing so risks "tainting" the entire remaining HTM portfolio and forcing a reclassification of *all* HTM securities into AFS. Under certain conditions a holder can sell HTM securities and avoid tainting. For example, such a reclassification is permitted if the security issuer's creditworthiness is downgraded or if there are regulatory rule changes that impact the security risk weightings (see Appendix C for other instances).[9]

Securities in the banking book: available-for-sale. AFS securities are considered a residual category. The holding period could be long term, but banks retain the option to sell these assets before maturity. AFS securities are held on the balance sheet at fair value. AFS securities are marked to market as prices change, but unlike securities in the trading book, unrealized gains or losses on AFS do not flow through to the income statement. Instead, unrealized gains and losses are recognized in the account "accumulated other comprehensive income" (AOCI) as part

[8]Prior to 2020, these charges were referred to as other than temporary impairment (OTTI) and are currently governed by the current expected credit loss framework (CECL) that applies not just to securities but also to bank loans.

[9]See ASC 320-10-25-6 for the FASB rules on portfolio tainting: https://asc.fasb.org/1943274/2147481736

of book equity.[10]

For a very simple example, consider a bank buying a security at $100 and booking this security in AFS. Assume that the market price falls by $10 to $90. The bank would mark down the security to $90. The unrealized loss is the new fair value minus the amortized cost. AOCI would decline by $10 (to balance the balance sheet). The $10 loss is considered unrealized and would not affect income.

As for HTM, the AFS designation is not necessarily permanent. While these events should be rare, banks can change their designation from AFS to HTM under certain conditions, though a similar tainting rule does not exist. It is important to note, however, that redesignating securities from AFS into HTM is not a way to avoid recognizing unrealized losses. If a security has incurred losses that are reflected in AOCI, a redesignation would result in setting the book value of the security at its market value and "lock in" any losses in the AOCI account that would then be amortized over the remaining life of the security.

2.2 AOCI and Regulatory Capital

AOCI is included in total capital for all banks. But importantly for this paper, a differential treatment of AOCI for *regulatory capital* across banks of different sizes exists, and this treatment has varied over time. Prior to 2013, U.S. bank regulators permitted a so-called AOCI filter, which removed AOCI from the calculation of regulatory capital (CET1). Starting in 2013 with the final rule for Basel III, the AOCI filter was removed for the largest U.S. banks using the advanced approaches capital framework, plus any banks that voluntarily chose to opt-in to the rule change and include AOCI in CET1.[11] This rule change was phased in at 20% per year until 2018 (see, e.g., Fuster and Vickery, 2018). Finally, with the Federal Reserve's tailoring rule in 2019, the filter was restored for all banks except the global systemically important banks (GSIBs) and non-GSIB banks with at least $700 billion in assets or $75 billion in cross-jurisdictional activity (see, e.g., Kim, Kim and Ryan,

[10]The main component of AOCI is unrealized gains or losses on securities, but the account also includes other items such as gains or losses on certain types of cash flow and foreign exchange hedges.

[11]Advanced approach banks are the ones with assets above $250 billion or foreign exposures above $10 billion.

2023).[12] Since 2019, these banks have been referred to as Category I and II banks, respectively. For clarity over the whole sample period, we refer to banks with the AOCI filter as non-AOCI-Capital (NC) banks and those banks that pass on AOCI to capital as AOCI-Capital (AC) banks.

2.3 Hedges and Hedge Accounting

Banks can manage their interest rate risk exposure and hedge price fluctuations in their securities portfolios. The simplest way to avoid balance sheet volatility in the securities portfolio is to book securities as HTM, for which changes in interest rates do not prompt revaluation of securities positions. However, banks have incentives to preserve a stock of AFS securities that can readily be sold, so they may instead choose to hedge their securities using interest rate derivatives. Additionally, booking a security as HTM does not change the fact that the economic value of a security fluctuates. Economic value may matter for other market participants. For example, counterparties in wholesale funding markets, depositors, rating agencies, or a bank's shareholders may look past accounting designations and focus on unrealized losses of securities when determining a bank's access to funding or new capital.[13]

One of the most common ways to hedge interest rate risk exposure with derivatives is via interest rate swaps. For example, if a bank has a long-dated fixed-rate security, it can hedge the interest rate risk with a plain-vanilla swap where the bank agrees to pay a fixed rate to the swap counterparty and receives a floating rate. If interest rates increase, the expected stream of floating-rate cash flows increases. The swap position for the bank would increase in value and would help offset the value losses on their security exposure. Such interest rate swaps against interest rate risk are therefore considered fair value hedges and are the most common hedges in our data, as shown in Section 5.

By hedging their securities with such interest rate swaps, banks effectively shorten the duration of their securities. Swap arrangements also help a bank mit-

[12] That is, advanced approaches banks with assets between $250 billion and $700 billion and foreign exposures below $75 billion were able to reinstate the AOCI filter if the banks chose to opt out of the inclusion of AOCI in regulatory capital.

[13] For example, the tangible common equity ratio used by many market participants as an underwriting guideline does not include the AOCI filter.

igate its balance sheet volatility. However, depending on whether such a hedge is declared as a designated accounting hedge or not, it can also generate income statement volatility. While AFS security price changes do not go through the income statement, swap valuation changes that are held in the derivative book do. The mismatch can be mitigated through hedge accounting. If a hedging instrument (e.g., an interest rate swap) is judged as “highly effective” in offsetting fluctuations in the value of the security, then the hedging arrangement may qualify for fair value hedge accounting treatment.[14] Under such hedge accounting, price fluctuations of AFS securities and their associated hedge instrument do not affect banks’ AOCI or their income statement. In practice, banks often prefer to use qualified accounting hedges since it allows them to avoid volatility in their income statement. In addition, qualified accounting hedges are recognized as offsetting value changes of securities in the stress tests of the Federal Reserve.[15]

To illustrate, consider again the simple example used above. Assume that an AFS exposure declines in value from $100 to $90, and that the bank has a qualified hedge that offsets $5 of this loss. The bank would mark down the security to $90, because that is what the position is now worth. It would record a $5 gain on the hedging instrument on its balance sheet. At the same time, the bank would also adjust the amortized cost of the security to $95 to reflect the impact of the hedge. AOCI would change by -$5 (fair value minus amortized cost). The income statement is not affected because the hedge accounting allows the bank to net out the value gain on the hedging instrument with the unrealized loss on the hedged portion of the security.

In our data, we observe qualified accounting hedges and can match those to their associated securities. These hedge positions help us form a precise picture of a bank’s exposure to price fluctuations of securities.

[14] The rules for hedge accounting are set forth in ASC 815: https://asc.fasb.org/815/tableOfContent.

[15] See, for example, https://www.federalreserve.gov/publications/files/2022-march-supervisory-stress-test-methodology.pdf

3 Balance Sheet Dynamics & Testable Hypotheses

Given this regulatory setting, we illustrate the impact of security price changes on bank balance sheets in this section and derive testable hypotheses for our empirical analysis.

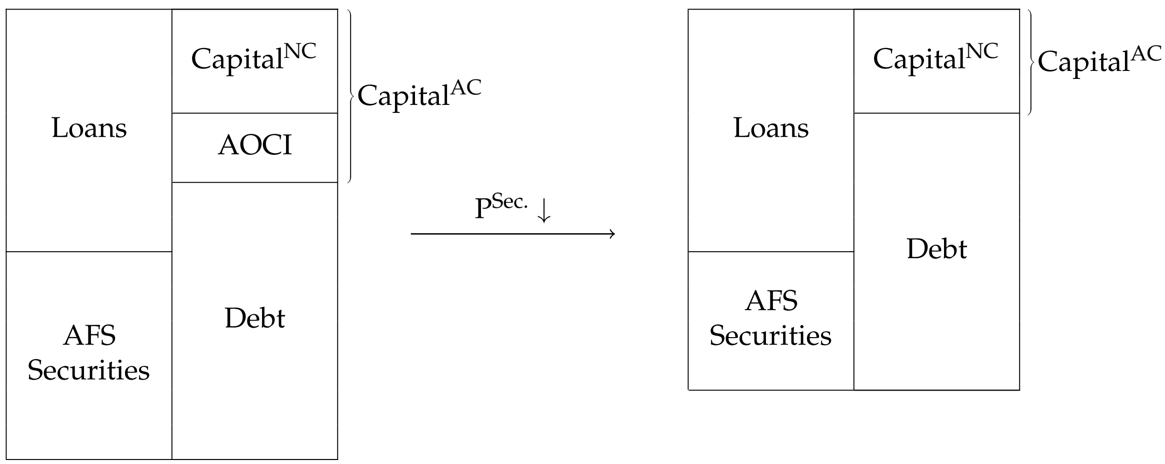
To begin with, the differential treatment of AOCI for the regulatory capital of AC and NC banks should affect their securities portfolio decisions. Since unhedged AFS value changes directly alter the capital positions of AC banks, such banks should try to avoid fluctuations of their regulatory capital (i) by holding a relatively larger fraction of their securities as HTM and (ii) by hedging more of their AFS securities. Moreover, such patterns should intensify in anticipation of higher rates. These predictions are summarized as Hypothesis I.

Hypothesis I. *AC banks (i) hold a relatively larger fraction of their securities as HTM and (ii) hedge more of their AFS securities. In anticipation of higher rates, these patterns strengthen.*

Value changes of securities may also spill over to other parts of a bank's balance sheet, in particular affecting its credit supply schedule. To illustrate how such mechanisms can work, Figures 3.1-3.3 consider hypothetical bank balance sheets distinguishing whether a security is recorded as an unhedged AFS, an HTM security, or a hedged AFS security. These distinctions matter for the responses of bank balance sheets to security price changes. Starting with the left-hand side of 3.1, consider a bank that holds loans and AFS securities. Assume that the bank has accumulated a positive AOCI account in the past, originating from unrealized value gains, for example. Note that we choose a positive AOCI account for illustration, but this balance sheet item could also be negative. For a NC bank, AOCI is not included in regulatory capital, and the bank's capital is given by Capital^{NC}. In contrast, AC banks include AOCI in their regulatory capital and their capital is therefore $\text{Capital}^{AC} = \text{Capital}^{NC} + \text{AOCI}$.

Next, holding all else constant, consider a fall in the price of securities. The immediate impact of this decline in the value of bank securities is illustrated with the change in the balance sheet when moving from the left-hand side to the right-hand side in Figure 3.1. The balance sheet shrinks because AFS securities are marked to

Figure 3.1: Accounting treatment for AFS Securities.



Notes: The chart shows changes in a hypothetical bank's balance sheet following a decline in security prices where securities are booked in AFS.

market. In this example, we assume for simplicity that the price decline wipes out the previous unrealized capital gains, so AOCI disappears. Again, this choice is just made for illustration, AOCI could reduce but remain positive or even turn negative. Following the price change, an AC bank suffers a regulatory capital decline, while capital remains unchanged for an NC bank.[16]

As an additional response, banks may alter their loan supply schedule because of the loss in the value of their AFS securities. Specifically, there are three distinct channels for such a spillover effect to occur. We label the first channel the "planned income channel." This channel operates through the expected value of future security transactions in the AFS portfolio. Banks hold securities in AFS because they expect to sell them at some future date. Unrealized losses today lower these expected or planned income streams in the future. In turn, this could lower the amount of lending a bank can support in the future or a bank may react by immediately reshuffling its portfolio away from loans to securities to rebuild its buffer stock of liquid securities.

The second channel is a collateral channel. Banks can pledge securities and

[16]In this example, AC banks are actually better capitalized for a given amount of risk-weighted assets to begin with. In practice, banks would adjust their capital positions to remain relatively close to the required levels of capital. Thus, if AC and NC banks start with the same level of capital, AC banks would end up with less capital after the price decline.

borrow against them (e.g., in repo markets). A decline in the market value of their securities reduces their own funding capacity and their ability to lend in the future.

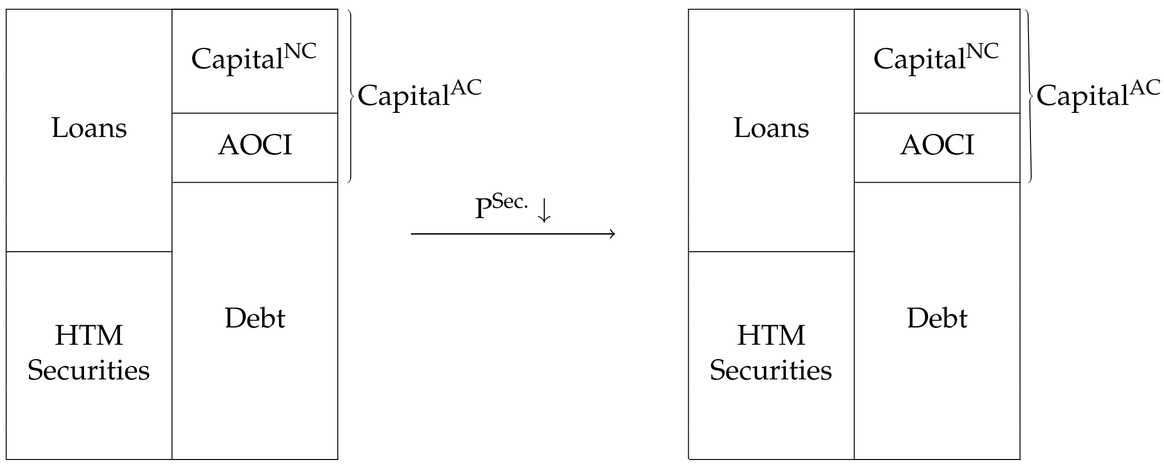
The third channel works through regulatory capital constraints with two predictions. First, the two mentioned channels should be stronger for low-capitalized banks since such banks should have a stronger incentive to reduce their loan supply to regain their capital position. Second, for the same fall in the value of AFS securities, AC banks should show a relatively stronger spillover effect, since a reduction in the value of AFS securities directly deteriorates their capital position via the AOCI account. These considerations are summarized as Hypothesis II.

Hypothesis II. *Banks with larger losses on their AFS securities extend relatively less credit to firms or households. Such spillover effects are more pronounced for less capitalized and AC banks.*

Figures 3.2 and 3.3 instead consider the cases when a bank books a security as HTM or fully hedges the security. For these two cases, a fall in the price of securities does not lead to a reduction of the bank's balance sheet or its AOCI, and thus also leaves bank capital unaffected. However, this is achieved in different ways. If a security is booked as HTM, a price change of the security simply does not affect its balance sheet valuation since it is recorded at purchasing cost (see Figure 3.2). For a fully hedged AFS security, a fall in the price of the security does lead to a reduction of its balance sheet value. However, the hedge also increases in value and perfectly offsets the value loss on the security (see Figure 3.3). As explained above, this leaves AOCI and regulatory capital unchanged if the hedge qualifies for hedge accounting.

Nonetheless, a spillover effect on the loan portfolio may still be present for these two cases due to a collateral channel. What matters for the pledgeability of HTM securities is their economic value, which decreases. Similarly, for a fully hedged security, this value falls, though the bank also gains since the value of the hedge increases. However, hedges are rarely used as collateral in financial markets and are therefore less pledgeable, reducing the value of the total collateral that the bank has available. These predictions are summarized as Hypothesis III.

Figure 3.2: Accounting treatment for HTM Securities.



Notes: The chart shows changes in a hypothetical bank's balance sheet following a decline in security prices where securities are booked in HTM.

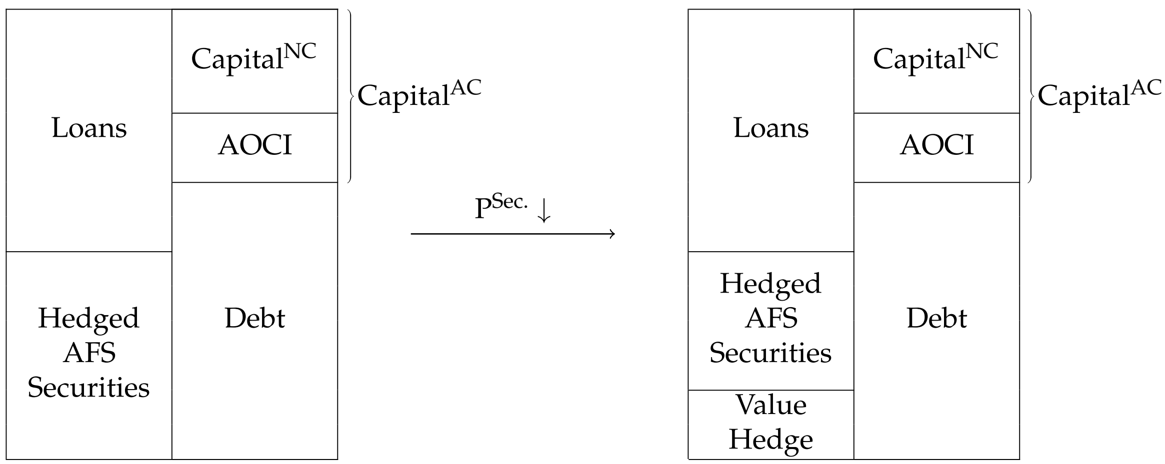
Hypothesis III. *Value losses on HTM securities or on fully hedged AFS securities lead to smaller or no crowding out of credit supply compared to value losses on unhedged AFS securities.*

Equipped with the institutional knowledge and the three testable hypotheses, we turn to the data and the empirical analysis next.

4 Data

We primarily base our analysis on the FR Y-14Q data (or Y14 for short), which are collected at the bank holding company (BHC) level for institutions subject to the Dodd-Frank stress tests and are available at quarterly frequency. The Federal Reserve requires U.S. BHCs, savings and loan companies, and depository institutions with assets exceeding certain thresholds, and also some foreign banking organizations, to comply with the stress test rules. The number of BHCs subject to the stress tests has varied over time as institutions have changed in size or regulations on the size thresholds have been adapted. For the early part of our sample period, the size threshold was set at $50 billion in assets. In 2019, the threshold was increased to $100 billion with the tailoring rules. For our main sample, there were

Figure 3.3: Accounting treatment for hedged AFS Securities.



Notes: The chart shows changes in a hypothetical bank's balance sheet following a decline in security prices where securities are booked in AFS and matched with a qualified fair value hedge.

29 BHCs reporting data in the corporate loan portfolio consecutively, 10 of which were required to include AOCI in their regulatory capital—the so-called AC banks in what follows.[17]

We combine data from three different Y14 schedules that have not been used for research purposes in this combination before. Of particular interest is the B.1 schedule, which includes data on the universe of security holdings at the issue level for the investment portfolio.[18] In this schedule, we observe the current market value of security holdings, the security price, the amortized cost, the accounting intent (AFS or HTM), and an asset class description (e.g., agency MBS).[19]

We match the security level data with their associated hedging relationships designated under Generally Accepted Accounting Principles (GAAP) from the B.2 schedule. From this schedule, we use information about the hedge type (fair value or cash flow hedge), the hedged risk, the hedge sidedness (offsets in one or multiple directions), and the hedge percentage. For our main empirical analysis, we

[17]Our regressions will not always be able to leverage data on all BHCs due to our requirements that the bank be a lender to a firm with multiple banking relationships and that we observe sufficient data on bank securities. In most of our specifications, we exploit information on 27 distinct BHCs.

[18]That is, this schedule excludes holdings of securities held in the trading account.

[19]Amortized cost is defined as the purchase price of a debt security adjusted for amortization of premium or accretion of discount if the debt security was purchased at other than par or face value.

select only two-sided fair value hedges, which account for around 94 percent of all hedges. The "hedge percentage" variable indicates how much of the securities holding is covered by the hedge. According to this variable, we consider a certain percentage of a security's price movement as hedged. Note that more than one hedge can be associated with a security, and we aggregate all the hedge percentages to the security level.

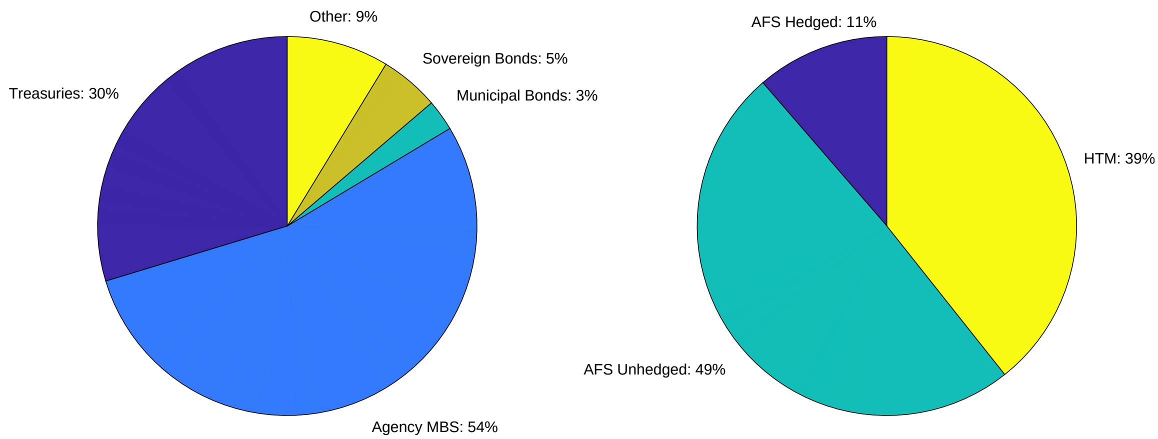
We obtain information on corporate credit relationships and firm financials from the Y14's H.1 schedule. This schedule consists of information on all commercial loan facilities with over $1 million committed.[20] We refine the information on firm balance sheets and income statements that the banks report in two ways. First, whenever a firm is publicly traded, we instead use these data from Standard & Poor's Compustat which is considered the most reliable source in this respect. Second, for private firms, we use the financial statement data reported in the Y14 but select the median value for some variable over all observed BHC loan facilities and all BHCs in some period. Since the firm financial data should be the same across loans and banks, this approach of taking the median observed value helps eliminate reporting errors and increases the number of dates for which we have observations on each firm's financial characteristics. Throughout, we exclude lending to financial and real estate firms.

Finally, we augment the data with BHC-level information from the FR Y-9C. Importantly, we use the variable BHCAP838 to identify BHCs required to include AOCI in their regulatory capital, or the ones that have opted to do so. Appendix Table A.1 lists the resulting classification of AC and NC banks in our data. Appendix Tables A.2-A.5 summarize all the variables that we use from the Y14's B.1, B.2, and H.1 schedules, Compustat, and FR Y-9C. Appendix B lists a number of sample restrictions and filtering steps that we apply to exclude observations with likely data entry errors.

For our main empirical analysis, we focus on the monetary tightening cycle of 2022 and include data up until the latest vintage that is available in 2023:Q1. To consider a pre-sample of similar length, we start our sample in 2021:Q1. A benefit of this starting point is that it excludes the particular COVID-19 episode in 2020

[20] A loan facility is a lending program between a bank and a borrower organized under a specific credit agreement. Facilities can include more than one distinct loan, and possibly contain more than one loan type (e.g., credit line or term loan). Banks classify the facility type according to the loan type with the majority of total committed amount.

Figure 5.1: Composition of Securities Portfolio.



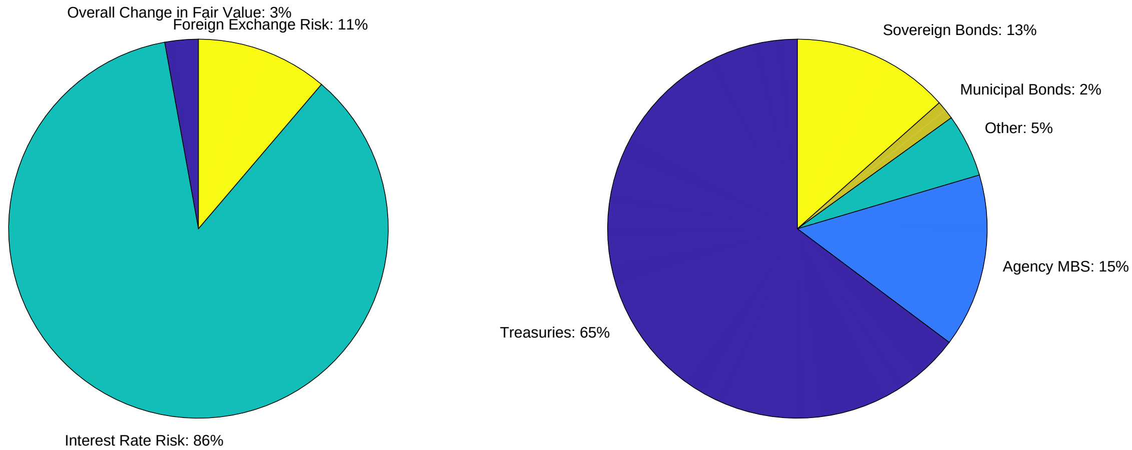
Notes: Data from FR Y-14Q sampled in 2021:Q4. The charts show the allocation shares of aggregate securities portfolio by asset class (left panel) and by accounting designation (right panel). Shares are computed as percent of total market value.

with its unusual behavior of bank-firm lending (see, e.g., Greenwald, Krainer and Paul, 2021). Thus, most regressions are conducted for the period 2021:Q1-2023:Q1 and we test the robustness of our findings on a longer sample that includes the COVID-19 episode below.

5 Stylized Facts

The investment securities portfolio is large, accounting for around 23 percent of aggregate bank assets in 2021:Q4. Figure 5.1 shows the composition of security holdings by asset class in the left panel. Most bank securities are comprised of agency MBS and Treasuries, which account for around 85 percent of the total portfolio at market value. The next largest asset classes are sovereign bonds with 5 percent and municipal bonds with around 3 percent. These asset classes carry both interest rate and credit risk components. However, during this period, bank holdings of these asset classes tended to be in high-rated issuers or were insured by government-sponsored enterprises, so the actual amount of credit risk was fairly small. The right panel of Figure 5.1 shows that around 60 percent of all bank securities was booked in AFS in 2021:Q4, and about 19 percent of the AFS portfolio

Figure 5.2: Composition of Accounting Hedges.



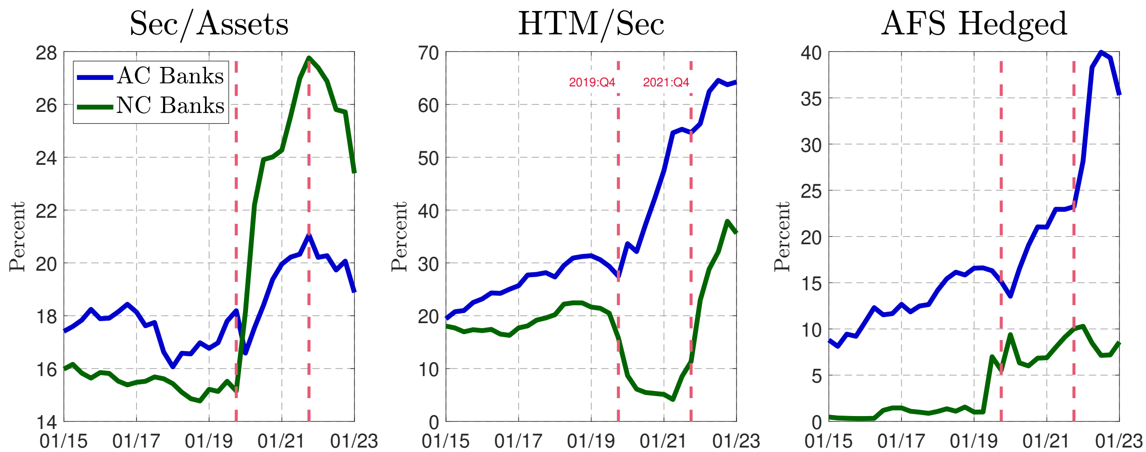
Notes: Data from FR Y-14Q sampled in 2021:Q4. The charts show the allocation shares of qualified accounting hedges by hedge type (left panel) and by hedged item or asset class (right panel). Shares are computed as percent of total market value hedged.

was hedged using some form of accounting hedge.

Figure 5.2 provides additional information on the type of risks that the hedges cover and the securities to which they apply. The left panel shows that banks primarily use hedges against interest rate risk (interest rate swaps), which account for around 86 percent of all contracts. The right panel shows that around two-thirds of all hedges apply to Treasuries. Agency MBS account for around 15 percent and sovereign bonds for 13 percent. Thus, banks mainly use fair-value hedges to cover their interest rate risk exposure inherent in long-term securities. These hedges effectively shorten the maturity of their securities since banks swap the fixed rate payments against floating-rate receipts that track short-term market rates. Banks are therefore isolated from valuation changes of their securities.

During the pandemic, BHCs experienced large inflows of deposits and chose to direct a sizable share of these funds to increase their securities portfolio, as can be seen in Figure 5.3 (left panel). This surge in securities holdings was particularly pronounced for the NC banks, including the smaller regional banks subject to the stress test. NC firms raised their securities holdings from approximately 15 percent of total assets to a peak of about 28 percent of assets before the monetary tightening led to a partial reversal. In contrast, AC banks raised their overall security holdings

Figure 5.3: Evolution of Securities Portfolio.



Notes: Data from FR Y-14Q Schedules B.1 and B.2. The graph shows the evolution of the securities portfolio by bank type (AC versus NC banks). The left panel depicts securities as a percentage of total assets. The middle panel shows HTM holdings as a percentage of total securities. The right panel shows the share of AFS securities that are hedged. Vertical dashed lines indicate 2019:Q4 and 2021:Q4.

by substantially less during the period of low interest rates.

The middle panel of Figure 5.3 shows that AC banks hold larger shares of their total securities book in HTM compared to NC banks throughout the sample period. This finding is also portrayed in Fuster and Vickery (2018) and Kim, Kim and Ryan (2019) who analyze the years prior to the COVID-19 pandemic. The differences between AC and NC banks become particularly stark during the low interest rate environment in 2020 and 2021, with AC banks booking additional securities in HTM while NC banks lowered their shares of HTM securities around this time. Appendix Figure C.1 further shows incidences of reclassifying existing securities between AFS and HTM for the two sets of banks.[21]

Finally, focusing on fair-value hedges against interest rate risk, the right panel of Figure 5.3 shows that AC banks hedge a larger share of their AFS securities compared with NC banks. This hedging gap grew during the period of low interest rates in 2020 and 2021 and accelerated even further when rates started to rise in 2022. These findings are consistent with Hypothesis I in Section 3: banks that are vulnerable to interest rate increases through their AOCI exposure take steps to

[21] Kim, Kim and Ryan (2023) focus on reclassifications of securities by the banks that reinstated the AOCI filter with the tailoring rules in 2019 and show that such banks reclassified more securities from HTM to AFS.

insulate themselves from this risk.

Appendix Figures D.1 and D.2 illustrate another margin of adjustment. AC banks hold relatively more Treasuries than agency MBS compared with NC banks, which is reflected in their hedge compositions. Since Treasuries held by banks have a shorter average duration than agency MBS, this compositional shift allows AC banks to reduce their duration risk.

6 Identifying Credit Supply Effects

In this section, we test for the presence of a spillover effect between fluctuations in asset valuations of bank security holdings and their credit supply to nonfinancial firms. To this end, we employ a fixed effect regression approach similar to the one in Khwaja and Mian (2008). This methodology can account, for example, for a potential sorting between firms with lower credit demand and banks that are expected to have lower changes of asset valuations in equilibrium. This is achieved by restricting the sample to firms that borrow from multiple lenders and by controlling for credit demand using fixed effects. For firm i and bank j, we estimate regressions of the form

$$\frac{L_{i,j,t+2} - L_{i,j,t}}{0.5 \cdot (L_{i,j,t+2} + L_{i,j,t})} = \alpha_{i,t} + \beta \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} + \tau_{AC_j,t} + \gamma X_{j,t} + \kappa_j + u_{i,j,t} \, , \qquad (6.1)$$

where $L_{i,j,t}$ is the aggregated amount of credit between a firm and a bank at time t and the dependent variable measures percentage changes in credit over two quarters. Specifically, we use the symmetric growth rate as an approximation of a percentage change, which allows for possible zero observations at time t and is bounded in the range $[-2, 2]$, reducing the potential influence of outliers.

The firm-time fixed effect $\alpha_{i,t}$ absorbs a firm's common demand across lenders. To further ensure that our results are not driven by demand effects, we exclude credit lines from the sample of loans since those tend to be strongly demand-driven (Greenwald, Krainer and Paul, 2021), but we show below that our findings are robust to lifting this restriction.

The main regressor of interest is the change in the value of a bank's AFS portfolio between t and $t+1$ relative to total bank assets, denoted by $\Delta Value^{AFS}_{j,t} \, / \, Assets_{j,t}$.

Since we observe the market value $MV^k_{j,t}$ and the price $P^k_{j,t}$ of some bank's security k, we compute a bank's aggregated AFS value change as $\Delta Value^{AFS}_{j,t} = \sum^k (\Delta P^k_{j,t} / P^k_{j,t}) \cdot MV^k_{j,t}$.[22] Importantly, constructing this regressor without the detailed security-level data would not be feasible. The data enable us to compute the total value change of a bank's *pre-existing* securities portfolio aggregated from all the individual value changes. In contrast, a regressor that is constructed from aggregated bank balance sheet data would confound pre-existing securities with new purchases and sales.

The associated coefficient β captures credit supply effects. A positive β would indicate that a bank that experiences a decrease in the value of its AFS portfolio relative to another bank extends less credit to the same firm. Based on the discussions in Sections 3 and 5, a potential concern may be that AC banks show a higher β but a lower $\Delta Value^{AFS}_{j,t} / Assets_{j,t}$ over our sample period.[23] This potential correlation between exposure and response may lead us to find a substantially smaller β. To account for this correlation, we further include an AC-banks-time fixed effect $\tau_{AC_j,t}$, where AC_j is an indicator that is equal to one if bank j is an AC bank and zero otherwise.[24] This allows us to consider the variation within the set of AC or NC banks at a particular time. Below, we remove this fixed effect and explore differences across the two sets of banks using interaction terms.

Finally, to account for a potential correlation of our regressor of interest with time-varying and time-invariant bank characteristics, we include a standard set of bank-specific controls $X_{j,t}$ and a bank fixed effect κ_j. Appendix Table E.1 shows summary statistics for the main regressors in (6.1).

The estimation results for regression (6.1) are reported in Table 6.1. Column (i) shows the ones for our baseline regression. We find that β is positive and strongly statistically significant at the 1 percent confidence level. That is, banks that experience more negative AFS value changes extend relatively less credit. This confirms part of Hypothesis II from Section 3.

To measure economic significance, we combine our results using a back-of-the-envelope calculation. Given the average ratio of term lending to bank assets that

[22] To account for potential outliers in security prices, we again use the symmetric growth rate for a percentage change in the price, that is $(\Delta P^k_{j,t} / P^k_{j,t}) \approx 2 \cdot (P^k_{j,t+1} - P^k_{j,t}) / (P^k_{j,t+1} + P^k_{j,t})$.

[23] Specifically, the average of $\Delta Value^{AFS}_{j,t} / Assets_{j,t}$ for AC banks is around -0.1% over our sample, whereas NC banks experienced a more negative average decline of -0.4%.

[24] Over our sample, banks do not switch between the sets of AC and NC banks.

Table 6.1: Credit Supply Effects.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	6.08***	7.31***	6.15***	7.37***
	(1.85)	(1.91)	(1.78)	(1.88)
Δ Value HTM			1.93	1.31
			(1.47)	(1.23)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.57	0.55	0.57	0.55
Observations	13,038	11,093	13,038	11,093
Number of Firms	1,289	1,105	1,289	1,105
Number of Banks	27	26	27	26

Notes: Estimation results for regression (6.1). All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

we observe, these estimates imply a lending cut of around 20 cents for a $1 decline in the value of bank AFS portfolios.[25] While these spillover effects are already substantial, we consider them a lower bound on the total crowding out effect, which likely extends to other forms of credit not present in our sample such as small business, consumer, and real estate credit.

These estimates are also sizeable from a different perspective. In regression (6.1), we consider all value changes of AFS securities. That is motivated by the stylized fact in Section 5 that the vast majority of securities are interest rate-sensitive but carry little credit risk, so that most price changes are due to ex-post movements in interest rates. Nonetheless, some value changes may be expected ex-ante. The fact that we still find a spillover effect into banks' loan portfolio shows that an im-

[25] This is computed by multiplying the typical ratio of term lending to bank assets across the Y14 banks over our sample (around 3 percent) with the mid-point of the estimates for β in Table 6.1.

portant fraction is unexpected, such that banks cannot perfectly shield themselves from value changes of securities and must adjust their credit supply schedule. Below, we show that the estimates are even larger when instrumenting the value changes with the interaction between unexpected movements in interest rates and banks' ex-ante securities portfolios.

Column (iii) in Table 6.1 includes value changes of HTM securities as a separate regressor, which are defined in the same way as our main regressor of interest. While the coefficient on AFS value changes remains largely unchanged, the one associated with HTM securities is substantially smaller and not statistically different from zero at standard confidence levels. This partly confirms Hypothesis III from Section 3.

Columns (ii) and (iv) extend the firm-time fixed effects by different loan purposes. These regressions are intended to address the possibility that banks specialize in certain types of lending and that firm demand differs across lending types which may be correlated with our regressors of interest (Paravisini, Rappoport and Schnabl, 2023).[26] The estimation results show that our baseline findings are robust to this extended fixed effect and even somewhat intensify.

Robustness and Extensions. Before exploring the mechanism further, we test the robustness of our baseline findings and consider several extensions. First, we extend the sample backwards as far as possible to include periods of monetary easings. Appendix Table E.2 shows the updated results for the period 2016:Q4-2023:Q1. While our key findings remain, the coefficients somewhat reduce in magnitude. This comparison indicates that the effects are larger following a sharp unexpected monetary tightening as it occurred in 2022.

Second, we explore the robustness of our findings to alternative fixed effects specifications. Appendix Table E.3 omits the firm-time fixed effects and replaces those by variations of location- and industry-time fixed effects, which extends the sample to include firms that borrow from a single lender. Again, our results remain intact but the coefficients somewhat reduce in magnitude. Third, loans differ by contract terms such as maturity, whether they are adjustable- or fixed-rate loans,

[26]Specifically, we consider the categories "Mergers and Acquisition," "Working Capital (permanent or short-term)," "Real estate investment or acquisition," and "All other purposes" as separate types (see also Appendix Table A.2).

and whether a loan is syndicated. To ensure that we compare loans with similar contract terms, we extend the firm-time fixed effects with such characteristics. Appendix Table E.4 shows the updated estimation results, which are again similar to our baseline estimates.

Fourth, we extend the sample to include bank-firm observations that also cover credit lines. Appendix Table E.5 shows that our results remain much the same for this extended sample. Fifth, we test for a pre-trend by running a placebo regression that uses $(L_{i,j,t} - L_{i,j,t-2})/(0.5 \cdot (L_{i,j,t} - L_{i,j,t-2}))$ as a dependent variable in (6.1). Appendix Table E.6 shows that our findings vanish for this alternative setup.

Sixth, a potential concern may be that firms reduce their credit demand at banks with larger value losses of securities, as opposed to banks restricting credit supply, since firms might be worried about overall bank health. We view such a concern to be less applicable to the set of relatively large banks in our data over most of the sample when the stability of the U.S. financial system was not being questioned. However, in 2023:Q1, financial stability concerns may have played a role with the turmoil around SVB. We therefore rerun our regressions on a sample that ends in 2022:Q4. The results are shown in Appendix Table E.7. The findings for value changes of AFS securities remain on this new sample. We also find positive and marginally significant results for value changes of HTM securities. These results can be explained by the collateral channel discussed in Section 3.

Seventh, in addition to the intensive margin responses, we further analyze extensive margin adjustments. That is, the dependent variable in our baseline regression (6.1) includes all bank-firm observations in t and $t+2$ that show an existing lending relationship for both periods and are non-zero in at least one of the periods. However, non-existing relationships in either t or $t+2$ are not part of the sample. We incorporate such new lending relationships or the end of old relationships by including zero-observations for $L_{i,j,t}$ or $L_{i,j,t+2}$ in such instances. The updated results are shown in Appendix Table E.8. The estimated coefficients β increase in magnitude and are even more precisely estimated, showing that such extensive margin adjustments further strengthen our findings.[27]

Eighth, we reestimate regression (6.1) for various horizons to portray the dy-

[27] However, we do not measure the exact strength of the spillover effect in dollar terms based on these estimates, since the symmetric growth rate that we use as a dependent variable in regression (6.1) approximates all new relationships or the ending of old relationships as either -2 or 2.

namic response of credit. Appendix Table E.9 shows the results. The crowding out effect is already sizable and significant within the same quarter during which securities change value. Hence, the transmission of monetary policy through bank securities portfolios operates at a high frequency since asset prices change instantly and lead to quick credit adjustments. The response builds up over time and becomes strongest at the three-quarter horizon.

And ninth, we test whether the identified supply effects not only apply to credit quantities but also to interest rates charged on loans. Appendix Table E.10 shows the results for regressions that use changes in interest rates as a dependent variable in (6.1), again portraying the dynamic response for various horizons. We find negative coefficients for β which indicate the identification of supply adjustments. At the three-quarter horizon, the responses are statistically different from zero at the 5 confidence level. However, compared with the credit responses, the statistical significance is weaker overall. Those findings suggest that the mechanism primarily works through bank balance sheet space, in line with the results in the next section that emphasize channels operating through bank capital.

7 Exploring the Mechanism

In this section, we investigate the channels that determine the strength of the spillover effects that we find.

AC Banks. To explore differences between AC and NC banks, we consider the regression

$$\frac{L_{i,j,t+2} - L_{i,j,t}}{0.5 \cdot (L_{i,j,t+2} + L_{i,j,t})} = \beta_1 \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} + \beta_2 \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} \cdot AC_j + \gamma X_{j,t} + \kappa_j + u_{i,j,t} \,. \quad (7.1)$$

In comparison with our baseline specification (6.1), we allow for the spillover effect to differ across the two sets of banks by including an interaction term between $\Delta Value^{AFS}_{j,t} / Assets_{j,t}$ and the indicator AC_j. Since we allow for such differential effects, we further exclude the AC-banks-time fixed effect $\tau_{AC_j,t}$.

The estimation results for regression (7.1) are reported in column (i) of Table 7.1. We obtain a positive coefficient for β_2 that is statistically different from zero at the 5 percent confidence level. That is, the spillover effect is stronger for AC banks for

Table 7.1: AC Banks.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	4.83**	5.65**	-2.08	-2.53
	(2.14)	(2.37)	(4.81)	(4.92)
Δ Value AFS × AC	7.55**	9.26***	12.95*	15.18**
	(3.50)	(3.14)	(6.94)	(6.39)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
Bank Controls × Δ Value AFS			✓	✓
R-squared	0.57	0.55	0.57	0.55
Observations	13,038	11,093	13,038	11,093
Number of Firms	1,289	1,105	1,289	1,105
Number of Banks	27	26	27	26

Notes: Estimation results for regression (7.1). All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. Columns (iii) and (iv) include interaction terms between the various demeaned bank controls and $\Delta Value^{AFS}_{j,t}/Assets_{j,t}$. All specifications include bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

which value changes of AFS portfolios directly feed into regulatory capital. This partly confirms Hypothesis II from Section 3.

Column (ii) of Table 7.1 shows that these results remain and somewhat intensify when the firm-time fixed effects are extended by the loan purpose. Columns (iii) and (iv) further include interaction terms between $\Delta Value^{AFS}_{j,t}/Assets_{j,t}$ and various other (demeaned) bank controls to ensure that the channel does not operate through other observed bank characteristics that are correlated with AC_j. If anything, the results intensify as β_2 increases in magnitude for those specifications relative to columns (i) and (ii). Thus, despite their efforts to shield themselves from potential price declines of securities that we document in Section 5, AC banks show a substantially stronger spillover effect.

Bank Capital. Next, we explore differences across banks depending on their capital positions. To this end, we consider the regression

$$\frac{L_{i,j,t+2} - L_{i,j,t}}{0.5 \cdot (L_{i,j,t+2} + L_{i,j,t})} = \beta_1 \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} + \beta_2 \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} \cdot Cap_{j,t} + \gamma X_{j,t} + \kappa_j + u_{i,j,t}\ , \quad (7.2)$$

where $\Delta Value^{AFS}_{j,t} \,/\, Assets_{j,t}$ is now interacted with a measure of bank capital $Cap_{j,t}$. For bank capital positions, we consider CET1, Tier 1, and total bank capital, and use the difference between the ratio and the requirement for each.

The estimation results for regressions (7.2) are reported in Table 7.2. Across the various capital measures, β_2 is negative and statistically different from zero at standard confidence levels. That is, banks that are less capitalized show stronger spillover effects. This partially confirms Hypothesis II from Section 3. For the reported estimation results, we control for interaction terms between $\Delta Value^{AFS}_{j,t} \,/\, Assets_{j,t}$ and various other bank controls, ensuring that we are not picking up an alternative channel based on correlations between bank observables.

Hedging. To further test Hypothesis III from Section 3, we reconsider our baseline regression (6.1) but distinguish between hedged and unhedged AFS securities. That is, in our data, banks report the fraction of a security that is hedged against a certain risk. The values of many securities can fluctuate due to a number of risk factors (e.g., interest rate risk, credit risk, prepayment risk, foreign exchange risk, etc.). We focus on fair-value hedges against interest rate risk, which account for around 85 percent of all hedges. Treasuries are the only securities within our data whose value fluctuates only because of interest rate risk. Thus, if a bank reports a treasury security as fully hedged against interest rate risk, we can safely consider any value change as completely offset by the hedge. To be conservative, we consider value changes of other securities as unhedged since we cannot safely associate those to being purely due to interest rate risk even if a bank reports that a security is fully hedged against that risk. We further add various information about bank derivatives from their trading and their derivative books as controls.[28]

Based on those distinctions, Table 7.3 reports the estimation results. We find

[28] Specifically, based on the Y-9C filings, we add derivatives with a positive or negative fair value from the trading book (BHCM3543, BHCK3547), as well as notional and fair values for interest rate contracts from the derivative book (BHCKA126, BHCK8733, BHCK8737), all scaled by total assets, see Appendix Table A.5 for details.

Table 7.2: Bank Capital Positions.

	(i)	(ii)	(iii)
Δ Value AFS	5.85	6.04	7.49
	(4.51)	(4.90)	(5.12)
Δ Value AFS × CET1	-1.07*		
	(0.58)		
Δ Value AFS × Tier1		-1.19*	
		(0.67)	
Δ Value AFS × Total			-1.52**
			(0.70)
Firm × Time FE; Bank FE	✓	✓	✓
Bank Controls	✓	✓	✓
Bank Controls × Δ Value AFS	✓	✓	✓
R-squared	0.57	0.57	0.57
Observations	13,038	13,038	13,038
Number of Firms	1,289	1,289	1,289
Number of Banks	27	27	27

Notes: Estimation results for regression (7.2). All specifications include firm-time and bank fixed effects. Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, the ratio of unused credit lines to assets, and each respective capital buffer. All specifications include interaction terms between the various demeaned bank controls and $\Delta Value^{AFS}_{j,t}/Assets_{j,t}$, apart from bank leverage which is highly correlated with the other capital measures. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

that value changes of unhedged AFS securities show an economically and statistically large spillover effect into firm credit supply. In contrast, we find a substantially smaller effect for hedged securities that is not statistically different from zero. Thus, these findings show that our baseline results were driven by unhedged securities, partially confirming Hypothesis III from Section 3.

Interest Rate Risk Channel. Last, we provide further evidence that our baseline findings are explained by banks' exposure to interest rate risk that leads to fluctuations in the value of their securities portfolios, as opposed to other simultaneous reactions to changes in interest rates. To this end, we consider three extensions

Table 7.3: Hedged and Unhedged Securities.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS Unhedged	7.08**	8.09***	7.35**	8.35***
	(2.93)	(2.71)	(2.81)	(2.70)
Δ Value AFS Hedged			4.75	4.16
			(5.58)	(5.33)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
Derivatives	✓	✓	✓	✓
R-squared	0.57	0.55	0.57	0.55
Observations	13,027	11,093	13,027	11,093
Number of Firms	1,288	1,105	1,288	1,105
Number of Banks	26	26	26	26

Notes: Estimation results for regression (6.1) that distinguishes between hedged and unhedged AFS value changes. All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects, as well as controls for derivative contracts from the trading and derivative book (see footnote 28 for details). Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

of regression (6.1) that are summarized in Table 7.4 where column (i) shows our baseline results.

First, Kashyap and Stein (2000) show that the effect of monetary policy on lending is stronger for banks with less liquid balance sheets, that is, with lower security holdings relative to assets. Intuitively, as monetary policy tightens, these banks have less liquid assets to sell and therefore need to contract lending. In contrast, we find that banks with larger value changes of securities relative to assets show a stronger lending response (which tend to be banks with more ex-ante securities relative to assets). To account for the channel by Kashyap and Stein (2000), we further control for banks' ex-ante AFS and HTM holdings, which we add to our set of standard bank controls, as well as their trading securities (distinguishing government, mortgage-backed, and other debt securities, as well as short positions for debt securities, see Appendix Table A.5 for details). The estimation results with these additional controls are shown in column (ii) of Table 7.4. If anything, our findings slightly strengthen magnitude and statistical significance.

Second, we employ an instrumental variable regression. As discussed above, value changes of a bank's AFS portfolio can be the result of a number of risk factors and we aim to isolate the channel working through unexpected changes in interest rates. As an instrument for $\Delta Value^{AFS}_{j,t} / Assets_{j,t}$, we therefore use the interaction between the yield change of the one-year treasury security from t to $t+1$, which captures changes in the stance of monetary policy, and a bank's AFS portfolio valued at market prices relative total assets at time t.

The first-stage regression yields a negative coefficient with respect to our instrument which is statistically different from zero at the 1 percent confidence level and yields an F-statistic of 45. Intuitively, an unexpected increase in interest rates leads to a more negative response of the value of a bank's AFS portfolio the larger the initial value of that portfolio. Table 7.4 reports the second-stage results in column (iii). The coefficient associated with $\Delta Value^{AFS}_{j,t} / Assets_{j,t}$ remains positive and statistically significant at the 5 percent confidence level for the instrumental variable regression, providing additional evidence for the interest rate risk channel. The estimated coefficient is also larger than our baseline estimate, indicating that unexpected value changes of securities may yield even stronger spillover effects.

Third, we directly control for other simultaneous responses to interest rates movements. Specifically, changes in interest rates affect the interest rate gap between deposit rates and short-term market rates, resulting in deposit fluctuations (Drechsler, Savov and Schnabl, 2017). In turn, banks may alter their credit supply schedule to firms. Moreover, changes in the stance of monetary policy can affect banks differently depending on the maturity structure of their balance sheets. For example, banks that hold more adjustable-rate loans may obtain relatively more interest income in the short-run when monetary policy tightens (Gomez et al., 2021).

While our baseline controls—in particular banks' deposit shares and their income gap—partly account for such simultaneous deposit flows and cash flow effects, we directly control for them by including changes in bank deposits and net income from t to $t+1$ (both relative to total assets at time t) as separate regressors

Table 7.4: Interest Rate Risk Channel.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	6.19***	7.71***	14.05**	6.81***
	(1.65)	(1.47)	(6.12)	(1.84)
Δ Net Income				0.37
				(2.84)
Δ Deposits				-0.05
				(0.19)
Δ Probability Default				42.33
				(44.99)
Δ Provision Losses				6.20
				(6.33)
Firm × Time FE	✓	✓	✓	✓
Bank FE; AC × Time FE	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
Trading Book Securities		✓		
Estimator	OLS	OLS	IV	OLS
First Stage F-Stat.			45	
R-squared	0.57	0.57	0.57	0.57
Observations	13,038	13,027	13,038	13,038
Number of Firms	1,289	1,288	1,289	1,289
Number of Banks	27	26	27	27

Notes: Estimation results for regression (6.1). All specifications include firm-time fixed effects, AC-banks time fixed effects, and bank fixed effects. Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, the ratio of unused credit lines to assets, and AFS securities at market value as well as HTM securities at book value, both relative to assets. Column (ii) includes banks' securities from the trading portfolio at time t: government, mortgage-backed, and other debt securities, as well as short positions on debt securities (all relative to assets). Column (iii) considers an instrumental variable regression using the interaction between the yield change of the one-year treasury security from t to $t+1$ and a bank's AFS portfolio valued at market prices relative total assets at time t as an instrument. Column (iv) includes changes in net income, deposits, probabilities of default of banks term loan portfolios (weighted by used credit amounts), and provision for loan losses from t to $t+1$ (all relative to assets). Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

into our baseline regression (6.1).[29]

[29]We use banks' net income change as opposed to changes in the net interest margin to account

Moreover, a potential alternative explanation for our results is that banks with larger value losses of securities also experienced a stronger decline in the expected profitability of their legacy loans, leading to a contraction in lending that is not caused by the value losses of securities but by the poor performance of the loan portfolio. To address this concern, we directly control for the change in the quality of a bank's existing term loan portfolio using banks' reported probabilities of default and provision for loan losses from banks' income statements from t to $t+1$.[30]

Column (iv) of Table 7.4 reports the new estimation results. While the coefficients on the added regressors are not statistically different from zero, the size and significance of the coefficient with respect to $\Delta Value^{AFS}_{j,t} / Assets_{j,t}$ remain largely unchanged, providing further evidence that our initial results are not driven by such simultaneous developments but by responses to security price changes.

8 Effects at the Firm Level

In a final exercise, we test whether the spillover effects also persist at the firm level, affecting total firm debt and investment. To this end, we aggregate a firm's borrowing exposures across its lenders, using the debt shares as weights (as in Khwaja and Mian, 2008, for example). For firm i, we estimate

$$\frac{y_{i,t+4} - y_{i,t}}{0.5 \cdot (y_{i,t+4} + y_{i,t})} = \alpha_i + \tau_{m,k,t} + \beta \cdot \widetilde{\Delta Value}^{AFS}_{i,t} + \gamma X_{i,t} + u_{i,t} \,, \tag{8.1}$$

where $y_{i,t}$ is either total debt or fixed assets, which serves as a measure of investment. We again use the symmetric growth rate for the dependent variable to approximate percentage changes, but this time consider a four-quarter-horizon since firm balance sheets are updated annually for the majority of private firms.

Our regressor of interest is $\widetilde{\Delta Value}^{AFS}_{i,t} = \sum^{j} (\Delta Value^{AFS}_{j,t} / Assets_{j,t}) \cdot (L_{i,j,t} / Debt_{i,t})$. These are exposures to fluctuations in bank security values aggregated to the firm

for other non-interest income changes. However, the results are unaffected by this choice. They equally hold when controlling for changes net interest margins instead.

[30] Specifically, we compute changes in banks' reported probabilities of default on their total term loan portfolio weighted by used credit amounts and omitting the observation associated with the dependent variable (leave-one-out). Provision for loan losses are measured using item BHCKJJ33 from the Y-9C filings (see Appendix Table A.5 for details).

Table 8.1: Firm Level Effects.

	Δ Total Debt			Investment		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Δ Value AFS	6.17**	7.59**	7.61**	5.31**	7.05**	5.46*
	(3.09)	(3.48)	(3.87)	(2.67)	(2.99)	(3.16)
Fixed Effects						
Firm	✓	✓	✓	✓	✓	✓
Time	✓			✓		
Time × State		✓			✓	
Time × State × Industry			✓			✓
Firm Controls	✓	✓	✓	✓	✓	✓
R-squared	0.73	0.73	0.75	0.72	0.72	0.74
Observations	69,934	54,159	53,288	82,472	63,962	63,133
Number of Firms	19,046	14,866	14,659	22,162	17,300	17,111
Number of Banks	29	29	29	29	29	29

Notes: Estimation results for regression (8.1) where $y_{i,t}$ is either total debt in columns (i)-(iii) or fixed assets in columns (iv)-(vi). All specifications include firm fixed effects and the firm controls: cash holdings, fixed assets, liabilities, debt, net income, sales (all scaled by total assets), firm size (natural logarithm of total assets), the ratio of observed debt to total debt, as well as all the set of bank controls used in all previous regressions and deposit and net income changes from column (iv) of Table 7.4 aggregated to the firm level using debt shares across lenders. Standard errors in parentheses are clustered by firm. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

level using firm debt shares across lenders.[31] We also include a firm fixed effect α_i and variations of industry-location-time fixed effects $\tau_{m,k,t}$. In the vector $X_{i,t}$, we further collect a standard set of firm controls as well as bank controls that are aggregated to the firm level based on the debt shares, including the contemporaneous deposit and net income changes used in Table 7.4 to account for alternative channels. We note that, unlike regression (6.1), we are unable to include firm-time fixed effects, as regression (8.1) covers only a single firm observation per period. As a result, the sample now also includes firms with only a single lender.

The estimation results are reported in Table 8.1. Across various fixed effect specifications, we find positive coefficients for β for total debt and investment that are statistically different from zero at either the 5 or the 10 percent confidence level.

[31] Consistent with the previous regressions, we restrict the sample to term loans only. Since we do not cover all firm debt positions, we control for the ratio of observed credit to total firm debt.

Interestingly, the magnitude of the coefficients for total debt are similar in Table 8.1 compared with our baseline estimates in Table 6.1. Thus, in response to a lending cut originating from a fall in the value of bank AFS securities, firms seem unable to substitute across banks or toward non-bank lenders, so that their total debt responds in a similar way. The pass-through to investment is similarly sizable, in the order of half of the total debt response since the median ratio of debt-to-fixed assets is around 1.5 in our data. Firms are therefore unable to use other margins like cash holdings or payouts to completely mitigate lending restrictions from affecting their investment schedule.

9 Conclusion

Bank regulation and monetary policy are often considered separately. In contrast, this paper provides evidence that the two are inherently related.

By changing interest rates, monetary policy affects market prices of various debt securities that account for close to a quarter of bank assets. We show that such value changes lead to adjustments of banks' credit supply to nonfinancial firms and translate to changes of real firm outcomes like investment.

The strength of this monetary transmission channel through bank balance sheets is determined by bank regulation. In the United States, larger banks must adapt their regulatory capital when the value of their securities that are marked to market changes. Our evidence shows that such banks extend relatively less credit to firms when monetary policy tightens and lowers security prices.

These findings have implications for current policy debates. If banks were required to mark all their securities to market or a larger set of banks would have to pass unrealized gains and losses through to their regulatory capital, monetary policy may become more potent—both in speed and in magnitude—since the documented spillover channel through fast-moving asset prices would strengthen.

Considering such policy counterfactuals is a salient target for future research. To this end, our cross-sectional regression evidence can serve as a useful calibration target within a general equilibrium model (see, e.g., Greenwald, Krainer and Paul, 2021). Such a model would allow for a quantitative assessment of the transmission through bank security portfolios at the aggregate level and to jointly consider monetary policy and various bank regulations.

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APPENDIX

A Data

Table A.1: AC and NC Banks.

AC BHCs	NC BHCs
JPMORGAN CHASE & CO	CHARLES SCHWAB CORP
BANK OF AMER CORP	M&T BK CORP
STATE STREET CORP	KEYCORP
WELLS FARGO & CO	HUNTINGTON BSHRS
NORTHERN TR CORP	PNC FNCL SVC GROUP
CITIGROUP	FIFTH THIRD BC
MORGAN STANLEY	TRUIST FC
GOLDMAN SACHS GROUP THE	U.S. BANCORP
DB USA CORP	CITIZENS FNCL GRP
BANK OF NY MELLON CORP	BMO FNCL CORP
	MUFG AMERS HOLDS CORP
	ALLY FNCL
	CAPITAL ONE FC
	HSBC N AMER HOLDS
	REGIONS FC
	TD GRP US HOLDS LLC
	SANTANDER HOLDS USA
	UBS AMERS HOLD LLC
	RBC US GRP HOLDS LLC

Notes: This table lists the AC and NC banks in our data for our main sample 2021:Q1-2023:Q1. Banks are identified to be one of the two categories according to the variable BHCAP838 from the Y-9C filings.

Table A.2: FR Y-14Q H.1 Variable Definitions.

Variable Name	**Description / Use in main analysis**	**Field No.**
Zip code	Zip code of headquarters	7
Industry	Derived 2-Digit NAICS Code	8
TIN	Taxpayer Identification Number	11
Internal Credit Facility ID	Used together with BHC and previous facility ID to construct loan histories	15
Previous Internal Credit Facility ID	Used together with BHC and facility ID to construct loan histories	16
Term Loan	Loan facility type reported as Term Loan, includes Term Loan A-C, Bridge Loans, Asset-Based, and Debtor in Possession.	20
Credit Line	Loan facility type reported as revolving or non-revolving line of credit, standby letter of credit, fronting exposure, or commitment to commit.	20
Purpose	Credit facility purpose	22
Committed Credit	Committed credit exposure	24
Used Credit	Utilized credit exposure	25
Line Reported on Y-9C	Line number reported in HC-C schedule of FR Y-9C	26
Participation Flag	Used to determine whether a loan is syndicated	34
Variable Rate	Interest rate variability reported as "Floating" or "Mixed"	37
Interest Rate	Current interest rate	38
Date Financials	Financial statement date used to match firm financials to Y-14 date	52
Net Sales Current	Firm sales over trailing 12-month period	54
Net Income	Current net income for trailing 12-months used to construct return on assets	59, 60
Cash	Cash & Marketable Securities	61
Fixed Assets	Fixed assets	69
Total Assets	Total assets, current year and prior year	70
Short Term Debt	Used in calculating total debt	74
Long Term Debt	Used in calculating total debt	78
Syndicated Loan	Syndicated loan flag	100

Notes: Nominal series are converted into real series using the consumer price index for all items taken from St. Louis Fed's FRED database. The corresponding "Field No." can be found in the data dictionary (Schedule H.1, pp. 162-217): https://www.federalreserve.gov/reportforms/forms/FR_Y-14Q20200331_i.pdf

Table A.3: FR Y-14Q B.1 & B.2 Variable Definitions.

Variable Name	**Description / Use**	**Schedule / Field No.**
Unique Identifier	ID, corresponds to a CUSIP, ISIN, or SEDOL identifier, if it exists	B.1
Security description	Reported asset class of security	B.1
Market value	Fair value of security holding in $USD	B.1
Price	Price of security in $USD.	B.1
Amortized cost	Purchase price of debt security in $USD adjusted for amortization/accretion of discounts/premia and adjusted for hedge gains and losses	B.1
Accounting intent	Available-for-sale, held-to-maturity.	B.1
Hedge type	Use only fair value hedges.	B.2/6
Hedged risk	Use only hedges linked to interest rate risk.	B.2/7
Hedge percentage	Portion of the asset holding being hedged, 0-100 percent.	B.2/9
Hedge sidedness	Use only two-sided hedges.	B.2/12

Notes: Variables and further descriptions for FR Y-14Q schedules B.1 and B.2 may be found in data dictionary: https://www.federalreserve.gov/reportforms/forms/FR_Y-14Q20200331_i.pdf

Table A.4: Compustat Variable Definitions.

Variable Name	**Description**	**Compustat Name**
Total Assets	Total firm assets	atq
Employer Identification Number	Used to match to TIN in Y14	ein
Total Liabilities	Total firm liabilities	ltq
Net Income	Firm net income (converted to 12-month trailing series)	niq
Total Debt	Debt in current liabilities + long-term debt	dlcq + dlttq
Sales	Total firm sales	saleq
Fixed Assets	Net property, plant, and equipment	ppentq
Cash	Cash & Marketable securities	cheq

Notes: All data obtained from the Wharton Research Data Services. Nominal series deflated using the consumer price index for all items taken from St. Louis Fed's FRED database.

Table A.5: Variables from Y-9C filings.

Variable Code	Variable Label
BHCK2170	Total Assets
BHCK2948	Total Liabilities
BHCK4340	Net Income
BHCK3197	Earning assets that reprice or mature within one year
BHCK3296	Interest-bearing deposit liabilities that reprice or mature within one year
BHCK3298	Long-term debt that reprices within one year
BHCK3408	Variable-rate preferred stock
BHCK3409	Long-term debt that matures within one year
BHDM6631	Domestic offices: noninterest-bearing deposits
BHDM6636	Domestic offices: interest-bearing deposits
BHFN6631	Foreign offices: noninterest-bearing deposits
BHFN6636	Foreign offices: interest-bearing deposits
BHCAP793	CET 1 Capital Ratio
BHCA7206	Tier 1 Capital Ratio
BHCA7205	Total Capital Ratio
BHCKB529	Loans and Leases held for investment
BHCK5369	Loans and Leases held for sale
BHCM3543	Trading Assets: Derivatives positive fair value
BHCK3547	Trading Liabilities: Derivatives with a negative fair value
BHCKA126	Derivatives, Interest Rate Contracts: Total gross notional amount of derivative contracts held for trading
BHCK8733	Derivatives, Interest Rate Contracts: Contracts held for trading: Gross positive fair value
BHCK8737	Derivatives, Interest Rate Contracts: Contracts held for trading: Gross negative fair value
BHCAP838	AOCI opt-out election
BHCM3531, BHCM3532, BHCM3533	Trading book: Government securities
BHCKG379, BHCKG380, BHCKG381, BHCKK197, BHCKK198	Trading book: Mortgage-backed securities
BHCKHT62, BHCKG386	Trading book: Other debt securities
BHCKG210	Trading book: Short position for debt securities
BHCKJJ33	Provision for loan and lease losses

Notes: The table lists variables that are collected from the Consolidated Financial Statements or FR Y-9C filings for Bank-Holding Companies from the Board of Governors' National Information Center database. The one-year income gap is defined as $(\text{BHCK}\,3197 - (\text{BHCK}\,3296 + \text{BHCK}\,3298 + \text{BHCK}\,3408 + \text{BHCK}\,3409))\,/\text{BHCK}\,2170$. Total deposits are given by $(\text{BHDM}\,6631 + \text{BHDM}\,6636 + \text{BHFN}\,6631 + \text{BHFN}\,6636)$. Nominal series are deflated using the consumer price index for all items taken from St. Louis Fed's FRED database.

B Sample Restrictions and Filtering Steps

We apply the following filtering steps to the H.1 schedule:

1. We constrain the sample to loan facilities with line reported on the HC-C schedule in the FR Y9-C filings as commercial and industrial loans, "other" loans, "other" leases, and owner-occupied commercial real estate (corresponding to Field No. 26 in the H.1 schedule of the Y14 to be equal to 4, 8, 9, or 10; see Table A.2). In addition, we drop all observations with NAICS codes 52 and 53 (loans to financial firms and real estate firms).

2. Observations with negative or zero values for committed exposure, negative values for utilized exposure, with committed exposure less than utilized exposure, and gaps in their loan histories are excluded.

3. When aggregating loans at the firm level, we exclude observations for which the firm identifier "TIN" is missing. To preserve some of these missing values, we fill in missing TINs from a history where the non-missing TIN observations are all the same over a unique facility ID.

4. When using information on firms' financials in the analysis, we apply a set of filters to ensure that the reported information is sensible. We exclude observations (i) if total assets, total liabilities, short-term debt, long-term debt, cash assets, tangible assets, or interest expenses are negative, (ii) if tangible assets, cash assets, or total liabilities are greater than total assets, and (iii) if total debt (short term + long term) is greater than total liabilities.

5. When using the interest rate on loans in our calculations, we exclude observations with interest rates below 0.5 or above 50 percent to minimize the influence of data entry errors.

We apply the following filtering steps to the B.1 and B.2 schedules:

1. We exclude hedges with hedge horizons past the observation date.

2. We exclude observations with negative market values, amortized costs, or prices.

3. If the pricing date differs from the observation date, we refill the price variable one year backwards or forward, so that pricing date and observation date align.

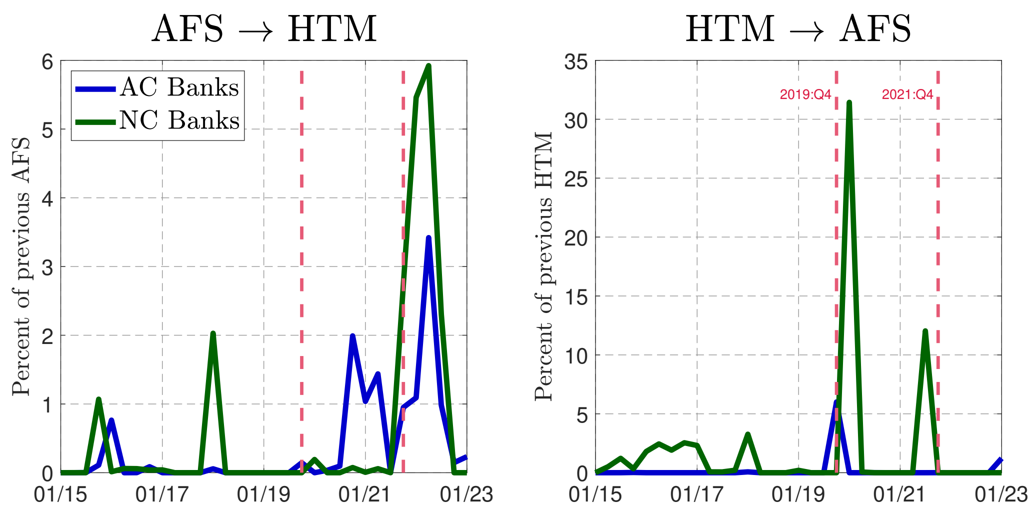
C Security Reclassifications

Accounting reclassifications are intended to be rare, but permissible under certain circumstances. Conditions under which a security holder can reclassify from HTM to AFS include (see ASC 320-10-25-6):

- Evidence of significant deterioration in security issuer's creditworthiness
- A change in tax law that eliminates or reduces the tax-exempt status of interest of the debt security
- A major business combination or major disposition that necessitates the sale or transfer of held-to-maturity securities to maintain the entity's interest rate risk position or credit risk policy
- A change in statutory or regulatory requirements significantly modifying either what constitutes a permissible investment or the maximum level of investments in certain kinds of securities, thereby causing an entity to dispose a held-to-maturity security
- A significant increase in the industry's capital requirements by the regulator that causes the entity to downsize by selling held-to-maturity securities
- A significant increase in the risk weights of debt securities used for regulatory risk-based capital purposes

Also relevant for security reclassifications is that holders are allowed a one-time election to sell and/or transfer debt securities classified as held-to-maturity that reference a rate expected to be discontinued (e.g., LIBOR), see ASC 848-10-35-1.

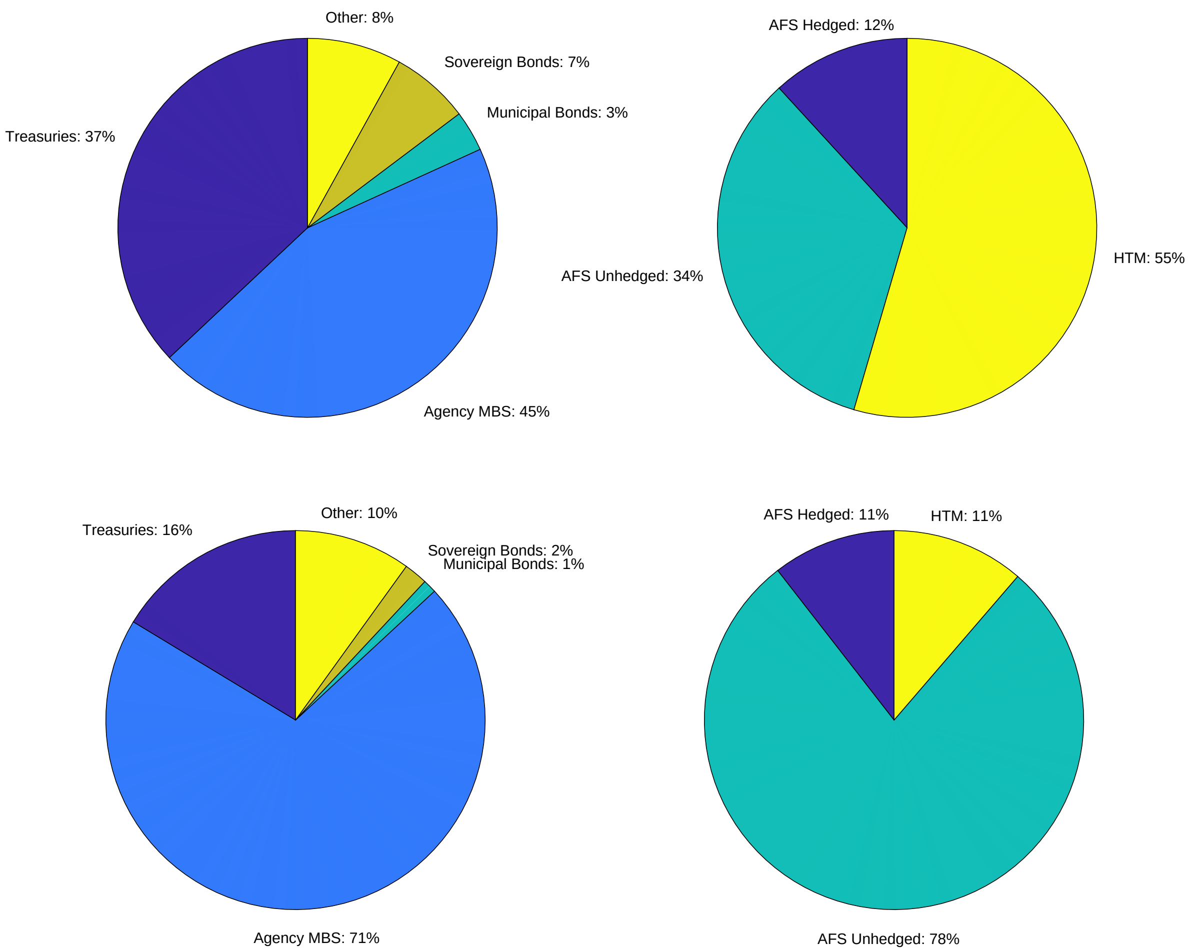
Figure C.1: Accounting designation changes



Notes: Data from FR Y-14 Schedule B.1. The chart shows the fraction of securities transferred between AFS and HTM accounting designations relative to total AFS or HTM securities in the previous quarter. Vertical dashed lines indicate 2019:Q4 and 2021:Q4.

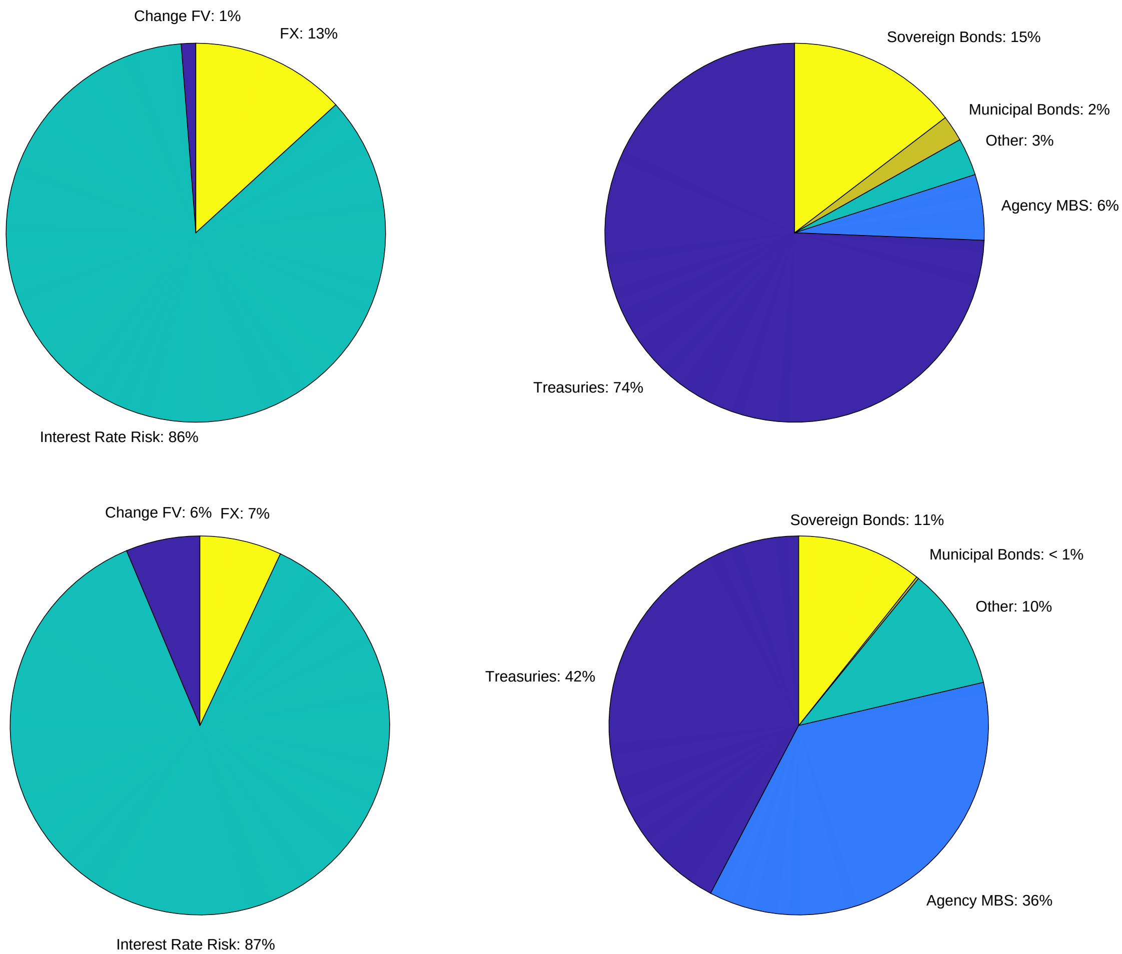
D Stylized Facts

Figure D.1: Securities Portfolios for AC banks (top) and NC Banks (bottom).



Notes: Data from FR Y-14Q sampled in 2021:Q4. The charts show the allocation shares of aggregate securities portfolio by asset class (left panels) and by accounting designation (right panels), separately for AC banks (top) and NC banks (bottom). Shares are computed as percent of total market value.

Figure D.2: Accounting Hedges for AC banks (top) and NC Banks (bottom).



Notes: Data from FR Y-14Q sampled in 2021:Q4. The charts show the allocation shares of qualified accounting hedges by hedge type (left panels) and by hedged item or asset class (right panels), separately for AC banks (top) and NC banks (bottom). Shares are computed as percent of total market value hedged.

E Credit Supply Effects

Table E.1: Summary Statistics.

Variable	Obs.	Mean	Std.	P10	Median	P90
Main Regressors						
Δ Value AFS/Assets	183	-.28	.39	-.91	-.11	.06
Δ Value HTM/Assets	183	-.16	.40	-.55	-.012	.02
Bank Controls						
ROA	183	.62	.42	.22	.55	1.11
Income Gap	183	37.30	11.74	28.50	38.85	49.23
Leverage	183	90.23	1.81	87.93	90.40	92.47
Ln(Total Assets)	183	19.67	1.01	18.73	19.22	21.39
Deposit Share	183	69.50	16.06	50.79	75.23	84.51
Loan Share	183	42.40	17.27	15.41	45.25	63.85
Unused Credit/Assets	183	8.13	5.37	2.23	6.63	16.98

Notes: Summary statistics for the regressors in regression (6.1) at the bank level. All variables are multiplied by 100, except for Ln(Total Assets). Sample: 2021:Q1 - 2023:Q1.

Table E.2: Extended Sample.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	3.17**	4.87***	3.23**	4.91***
	(1.49)	(1.77)	(1.53)	(1.79)
Δ Value HTM			1.24	0.60
			(0.94)	(0.91)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.56	0.55	0.56	0.55
Observations	41,541	33,269	41,541	33,269
Number of Firms	2,301	1,896	2,301	1,896
Number of Banks	34	34	34	34

Notes: Estimation results for regression (6.1). All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2016:Q4 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.3: Omitting Firm-Time Fixed Effects.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	2.16**	2.65***	1.75*	2.11**
	(0.99)	(0.96)	(0.92)	(0.83)
Δ Value HTM			-2.30*	-2.75**
			(1.27)	(1.28)
Fixed Effects				
Industry × Time	✓		✓	
Industry × Location × Time		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.02	0.15	0.02	0.15
Observations	158,406	116,098	158,406	116,098
Number of Firms	32,055	24,206	32,055	24,206
Number of Banks	29	29	29	29

Notes: Estimation results for regression (6.1). Columns (i) and (iii) include industry-time fixed effects using 2-digit NAICS codes and columns (ii) and (iv) include industry-location-time fixed effects using 2-digit NAICS and MSA codes. Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.4: Firm-Time Fixed Effects Extensions.

	(i)	(ii)	(iii)	(iv)	(v)
Δ Value AFS	6.08***	5.65***	5.49***	5.33***	5.63**
	(1.85)	(1.94)	(1.56)	(1.65)	(2.08)
Fixed Effects					
Firm × Time	✓				
Firm × Time × Syn.		✓			
Firm × Time × Mat.			✓		
Firm × Time × Float.				✓	
Firm × Time × All					✓
Bank & AC × Time	✓	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓	✓
R-squared	0.57	0.53	0.54	0.54	0.53
Observations	13,038	11,606	12,523	11,376	10,277
Number of Firms	1,289	1,165	1,242	1,142	1,035
Number of Banks	27	27	27	27	25

Notes: Estimation results for regression (6.1). Columns (i) and (iii) include industry-time fixed effects using 2-digit NAICS codes and columns (ii) and (iv) include industry-location-time fixed effects using 2-digit NAICS and MSA codes. Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.5: Credit Lines.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	6.68***	7.63***	6.68***	7.63***
	(1.97)	(2.30)	(1.98)	(2.29)
Δ Value HTM			0.36	0.29
			(0.95)	(1.00)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.62	0.62	0.62	0.62
Observations	35,884	29,988	35,884	29,988
Number of Firms	2,718	2,359	2,718	2,359
Number of Banks	28	28	28	28

Notes: Estimation results for regression (6.1) which extends the sample to include bank-firm observations that also cover credit lines. All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.6: Placebo Regression.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	-0.32	-0.07	-0.26	-0.06
	(1.98)	(1.84)	(1.97)	(1.84)
Δ Value HTM			0.44	0.08
			(0.57)	(0.72)
Fixed Effects				
Firm $\times$ Time	✓		✓	
Firm $\times$ Time $\times$ Pur.		✓		✓
Bank & AC $\times$ Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.58	0.56	0.58	0.56
Observations	16,570	14,082	16,570	14,082
Number of Firms	1,423	1,215	1,423	1,215
Number of Banks	29	28	29	28

Notes: Estimation results for regression (6.1) which uses $2 \cdot (L_{i,j,t} - L_{i,j,t-2})/(L_{i,j,t} + L_{i,j,t-2})$ as a dependent variable. All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.7: Excluding 2023:Q1.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	8.16***	9.95***	8.45***	10.26***
	(2.70)	(2.66)	(2.40)	(2.43)
Δ Value HTM			3.21*	2.52*
			(1.58)	(1.36)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.59	0.56	0.59	0.56
Observations	11,020	9,365	11,020	9,365
Number of Firms	1,243	1,065	1,243	1,065
Number of Banks	27	26	27	26

Notes: Estimation results for regression (6.1). All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2022:Q4. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.8: Extensive Margin.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	48.38***	43.47***	47.48***	43.70***
	(14.23)	(11.57)	(13.48)	(11.26)
Δ Value HTM			-7.61	1.89
			(11.82)	(9.14)
Fixed Effects				
Firm × Time	✓		✓	
Firm × Time × Pur.		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.69	0.71	0.69	0.71
Observations	23,200	19,744	23,200	19,744
Number of Firms	2,781	2,385	2,781	2,385
Number of Banks	30	28	30	28

Notes: Estimation results for regression (6.1) that incorporates new lending relationships and the ending of old relationships. All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii) and (iv). Bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.9: Dynamic Response.

	h=1	h=2	h=3	h=4	h=5
Δ Value AFS	6.82**	11.80***	12.56***	9.91*	6.03
	(3.18)	(3.80)	(4.11)	(5.17)	(4.04)
Fixed Effects					
Firm × Time	✓	✓	✓	✓	✓
Bank & AC × Time	✓	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓	✓
R-squared	0.59	0.57	0.57	0.57	0.58
Observations	5,087	5,087	5,087	5,087	5,087
Number of Firms	771	771	771	771	771
Number of Banks	27	27	27	27	27

Notes: Estimation results for regression (6.1) that uses $2 \cdot (L_{i,j,t+h} - L_{i,j,t})/(L_{i,j,t+h} + L_{i,j,t})$ as a dependent variable for $h = 1, 2, \ldots$. All specifications are estimated for a balanced sample, include firm-time fixed effects, as well as various bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table E.10: Interest Rates.

	h=1	h=2	h=3	h=4	h=5
Δ Value AFS	-0.02	-0.09	-0.16**	-0.13	-0.10
	(0.03)	(0.05)	(0.06)	(0.11)	(0.13)
Fixed Effects					
Firm × Time	✓	✓	✓	✓	✓
Bank & AC × Time	✓	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓	✓
R-squared	0.6	0.81	0.89	0.91	0.92
Observations	5,017	5,017	5,017	5,017	5,017
Number of Firms	765	765	765	765	765
Number of Banks	27	27	27	27	27

Notes: Estimation results for regression (6.1) that uses changes in interest rates $r_{i,j,t+h} - r_{i,j,t}$ as a dependent variable for $h = 1, 2, ...$. All specifications are estimated for a balanced sample, include firm-time fixed effects, as well as various bank controls: bank size (natural log of assets), return on assets (net income/assets), deposit share (total deposits/assets), loan share (loans/assets), leverage (liabilities/assets), banks' income gap, and the ratio of unused credit lines to assets. All specifications include AC-banks-time fixed effects and bank fixed effects. Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.