Monetary Transmission through Bank Securities Portfolios

Daniel L. Greenwald, John Krainer, Pascal Paul

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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, and (iii) banks that have to include unrealized gains and losses on their available-for-sale securities in their regulatory capital. A structural model, disciplined by our cross-sectional regression estimates, shows that policy rate transmission is more powerful if banks are required to adjust their regulatory capital for unrealized value changes of securities.

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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 incentives for depositors to withdraw their funds in the hope that they would be repaid before the bank exhausted 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. In particular, the risk of runs may decline if 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—as banks may react to market value losses on securities by making more prudential decisions like raising additional equity.[3] However, when securities lose value and

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[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).

[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

those decreases are immediately recognized on bank balance sheets, banks may also 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 accounting hedges that are associated with their HTM portfolios. Fourth, to hedge risk exposures, banks primarily use fair-value hedges against interest rate risk (e.g., 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 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, labeled 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 banks, 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

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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 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. During the period of low interest rates in 2020 and 2021, AC banks (i) showed 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 were 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 also Fuster and Vickery, 2018, and Kim, Kim and Ryan, 2019).

In our main set of empirical results, we investigate the spillover effect of price fluctuations of 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 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, which can be explained by the fact that HTM securities do not affect regulatory capital for all banks (see also Orame, Ramcharan and Robatto, 2023).

Motivated by the stylized facts we document, we further explore the mechanisms that may explain our findings. 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. Moreover, when differentiating AFS securities into hedged and unhedged, 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.

In a final empirical exercise, we test whether these spillover effects also translated

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[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`

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. However, we obtain these results only for smaller firms, whereas debt and investment of larger firms are not affected, pointing to heterogeneity in transmission across the firm distribution.

Inspired by these empirical findings, we develop a structural model to study how the transmission of monetary policy is shaped by the regulatory framework of the banking system in general equilibrium. Banks in our model hold long-term securities that are revalued when interest rates change. Motivated by our evidence on heterogeneity in transmission, our model features two types of firms that differ in their access to financing, building on Greenwald, Krainer and Paul (2023). Smaller "constrained" firms are completely bank-dependent and borrow using term loans at market rates. In contrast, larger "unconstrained" firms have access to the corporate bond market and obtain bank credit in the form of precommitted credit lines at predetermined spreads.

Within this framework, we consider the impact of a rise in interest rates under various policy scenarios for the valuation of securities on bank balance sheets. If banks are required to adjust their regulatory capital for unrealized value changes of securities, their capital positions deteriorate when monetary policy tightens and security prices fall. In response, banks cut lending to the nonfinancial corporate sector. Unconstrained firms are shielded from such credit supply reductions since they can either draw on their precommitted credit lines or obtain additional credit from the corporate bond market. In contrast, constrained firms are unable to find alternative sources of financing and need to sharply cut their investment when bank credit supply contracts.

We discipline the model by calibrating the parameters governing this spillover effect to match our cross-sectional regression evidence. In aggregate, we find that transmission of an increase in interest rates through measured regulatory capital leads to substantially lower firm debt, investment, and output compared to a counterfactual economy where regulatory capital ignores unrealized security losses.

In summary, our findings provide evidence for a powerful monetary transmission mechanism working through bank securities portfolios that is shaped by the regulatory framework of the banking system. 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 influence how monetary policy affects 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. Closest to our findings, Orame, Ramcharan and Robatto (2023) show that these effects vary across periods with the accounting treatment of AFS securities following introductions of the European Central Bank's quantitative easing programs.

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. 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. And fourth, our cross-sectional estimates further enable us to calibrate a macroeconomic model and show how the regulatory framework of the banking system shapes the transmission of monetary policy in general equilibrium.

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 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 presents the macroeconomic model and studies counterfactual policy scenarios. Section 10 concludes.

2 Institutional Setting

Security Classifications. 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 investment portfolio of the banking book, where they can be marked as HTM or as AFS. This section contains information on these classifications that are most relevant for our analysis, while more detailed descriptions are left to Appendix B.

To provide some indication of magnitude, the median bank in our data has around 14 percent of its assets invested in AFS securities and close to 4 percent in HTM securities. Only around 0.7 percent are marked as trading securities, since banks face various disincentives to hold a security in the trading book, such as the fact that unrealized gains and losses pass through net income to impact capital.[5] The remainder focuses on the investment portfolio of the banking book, which is at the heart of the analysis in this paper.

Classifying a security as HTM or AFS implies a different treatment for the recognition of valuation changes and has distinct implications for bank capital. HTM securities are held on the balance sheet at amortized costs, or book value, and are not updated as market prices change.[6] In contrast, AFS securities are held at fair value and marked to market. Unlike trading securities, unrealized gains and losses—the difference between amortized costs and fair values—do not flow to the income statement under both classifications. However, while balance sheets are not affected as market prices of HTM securities change, unrealized gains and losses of AFS securities affect book equity as part of the account "accumulated other comprehensive income" (AOCI).

AOCI and Regulatory Capital. 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 larger 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 (Fuster and Vickery, 2018).[7] 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 the largest non-GSIB banks (Kim, Kim and Ryan, 2023).[8] 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

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[5] Banks hold securities in the trading book as both trading assets and trading liabilities. Securities inventories associated with market making activity are typically booked in trading. The median of 0.7 percent in trading securities is a net figure.

[6] If a bank classifies a security as HTM, it should have the intention to hold the security until it matures. However, the HTM classification 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 (see Appendix C for such instances). A bank can also redesignate a security from AFS to HTM under certain conditions, though a similar tainting rule does not exist.

[7] Advanced approach banks have assets above $250 billion or foreign exposures above $10 billion. This rule change was phased in at 20% per year until 2018.

[8] That includes non-GSIB banks with at least $700 billion in assets or $75 billion in cross-jurisdictional activity, which implies that advanced approach banks with assets between $250 and $700 billion and foreign exposures below $75 billion were able to reinstate the AOCI filter.

capital as AOCI-Capital (AC) banks.

Hedging. To avoid balance sheet and AOCI volatility as interest rates change, banks can hedge their AFS securities. One of the most common ways to hedge interest rate risk exposure is via interest rate swaps. For example, if a bank has a long-dated fixed-rate security, it can agree to pay a fixed rate to the swap counterparty and receive 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 that closely track changes in security values can qualify as fair value accounting hedges and are the most common hedges in our data, as shown in Section 5. Specifically, we observe qualified accounting hedges that are directly associated with certain securities positions. The benefit of such links between hedges and securities is that price fluctuations of AFS securities and their associated hedging instrument offset each other: banks' AOCI and their income statement are not affected if a security is completely hedged against a certain risk.[9] These hedge positions therefore help us form a precise picture of a banks' exposure to price fluctuations of securities.

3 Balance Sheet Dynamics

Given this regulatory setting, we illustrate the impact of security price changes on bank balance sheets in this section, and argue that they 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, Figure 3.1 considers a hypothetical balance sheet. Starting with the left-hand side, consider a bank that holds loans and AFS securities. Assume that the bank has accumulated a positive AOCI account, 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 an NC bank, AOCI is not included in regulatory capital, and the bank's regulatory capital is given by Capital^{NC}. In contrast, AC banks include AOCI in their regulatory capital which is therefore Capital^{AC} = Capital^{NC} + AOCI.

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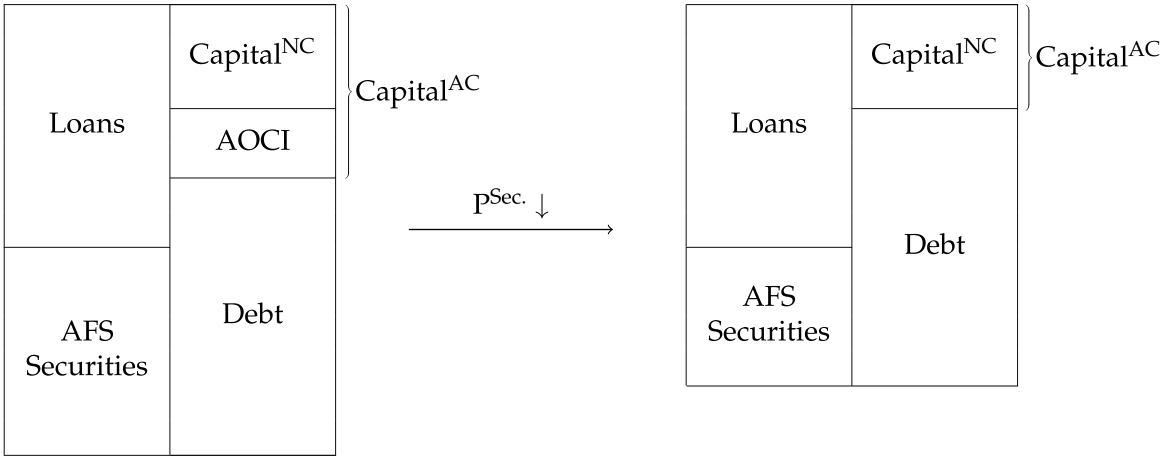
[9] In practice, banks often prefer to use such qualified accounting hedges since valuation changes do not pass through the income statement, in contrast to hedges held in the derivatives book. A hedging arrangement may qualify for fair value hedge accounting treatment if the hedging instrument is judged as "highly effective" in offsetting fluctuations in the value of the security. The rules for hedge accounting are set forth in ASC 815: `https://asc.fasb.org/815/tableOfContent`.

Figure 3.1: Accounting treatment for AFS Securities.



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

Next, holding all else constant, consider a fall in the price of securities. The immediate impact of this decline 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 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.[10]

As a reaction, banks may alter their loan supply schedule. 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, possibly supporting some short-term liquidity needs. 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. Similarly, 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 borrow

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[10] 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.

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. To summarize, a prediction for our empirical analysis is that banks with larger losses on their AFS securities should extend relatively less credit to firms or households. Moreover, such spillover effects should be more pronounced for less capitalized and AC banks.

Appendix Figures B.1 and B.2 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. Nonetheless, a spillover effect on the loan portfolio may still be present 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 that falls in value, the bank also gains since the value of the hedge increases. Thus, another prediction for our empirical analysis is that value losses on HTM securities or on fully hedged AFS securities should lead to smaller or no crowding out of credit supply compared with value losses on unhedged AFS securities.

Equipped with the institutional knowledge and these predictions, 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 a quarterly frequency. 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 in the investment portfolio. 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).[11] To obtain a

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[11] 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.

measure of effective duration, we further add security-level data from the Intercontinental Exchange (ICE) Fixed Income & Data Services.

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 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. Accordingly, we consider a certain percentage of a security's price movement as hedged.[12]

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.[13] 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 D.1 lists the resulting classification of AC and NC banks in our data. For our main sample, there were 29 BHCs reporting data in the corporate loan portfolio consecutively, 10 of which are considered AC banks. Appendix Tables D.2-D.5 summarize all the variables we use from the Y14's B.1, B.2, and H.1 schedules, Compustat, and FR Y-9C. Appendix E lists a number of sample restrictions and filtering steps that we apply to exclude observations with likely data entry errors.

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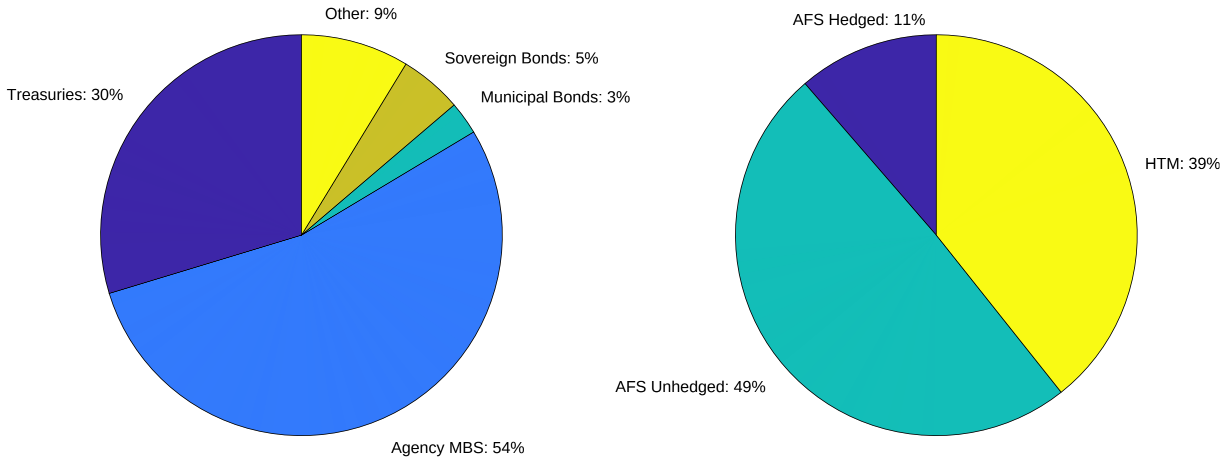
[12] Note that more than one hedge can be associated with a security, and we aggregate all the hedge percentages to the security level.

[13] 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.



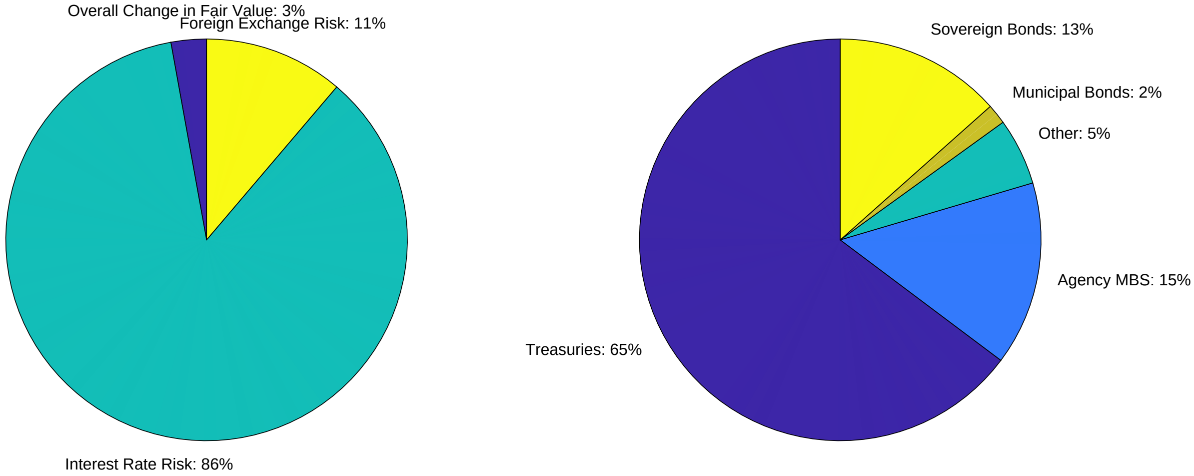
Notes: Data from FR Y-14Q sampled in 2021:Q4. The charts show the allocation shares of aggregate securities portfolio by asset class (left panel) and by accounting designation (right panel). Shares are computed as percent of total market value.

For our main empirical analysis, we focus on the monetary tightening cycle of 2022 and include data until the latest vintage that is available in 2023:Q1. To consider a presample 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 with its unusual behavior of bank-firm lending (see, e.g., Greenwald, Krainer and Paul, 2023). 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. The left panel of Figure 5.1 shows the composition of security holdings by asset class. Most bank securities are composed 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

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.

AFS portfolio 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.[14] Banks are therefore isolated from valuation changes of their hedged 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 banks 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,

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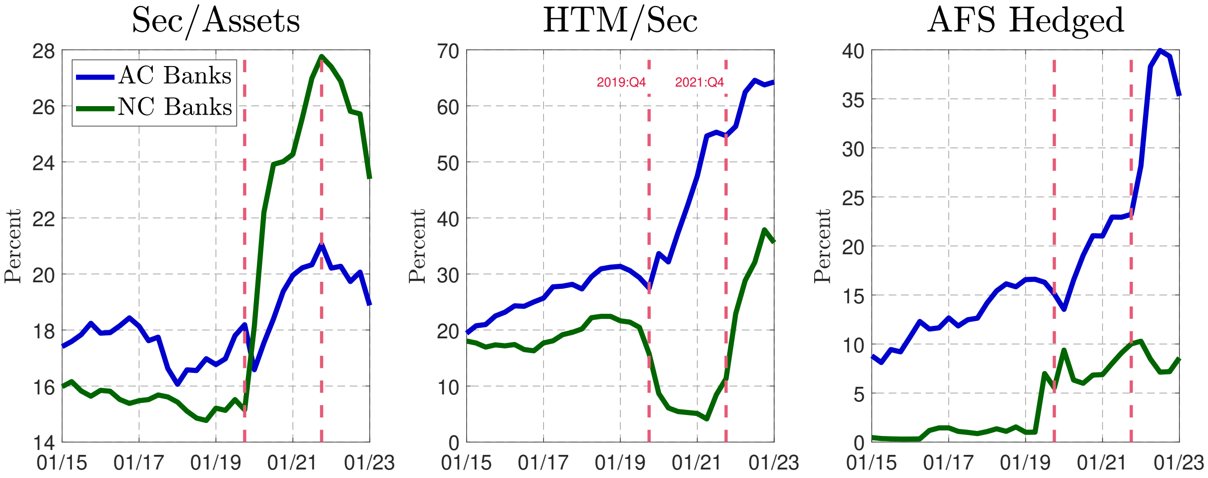
[14] We illustrate the maturity reduction due to hedging in Appendix Figure F.1. While AC and NC banks have similar effective duration of AFS and HTM securities portfolios, AC banks hold AFS securities with substantially lower effective duration when taking into account hedges.

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.

AC banks raised their overall security holdings 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 with 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 the same time. Appendix Figure C.1 further shows incidences of reclassifying existing securities between AFS and HTM for the two sets of banks.[15]

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 show that banks that are vulnerable to interest rate increases through their AOCI exposure take steps to insulate themselves from this risk.[16]

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[15] Kim, Kim and Ryan (2023) focus on reclassifications 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.

[16] Appendix Figures F.3 and F.4 decompose these patterns by AC and NC banks, showing that AC banks hold relatively more Treasuries than agency MBS compared with NC banks, which is also reflected in their

Despite their prudential behavior, AC banks experienced a sharp reduction of their AOCI positions over the monetary tightening episode in 2022 as shown in Appendix Figure F.2. Relative to risk-weighted assets, their AOCI fell around 1 percentage point due to unrealized losses on AFS securities, directly reducing their regulatory capital positions by the same amount. In comparison, NC banks experienced an even sharper decline of around 3 percentage points because of their larger unhedged AFS portfolios. However, regulatory capital was not directly affected for these banks.

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

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

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, 2023), 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

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hedge compositions.

a bank's aggregated AFS value change as $\Delta Value^{AFS}_{j,t} = \sum^k (\Delta P^k_{j,t} / P^k_{j,t}) \cdot MV^k_{j,t}$.[17] 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.[18] 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.[19] 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 G.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 our baseline regression results. 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, confirming the prediction from Section 3.

To measure economic significance, we conduct a back-of-the-envelope calculation. Given the average ratio of term lending to bank assets that we observe, these estimates imply a lending cut of around 20 cents for a \$1 decline in the value of bank AFS portfolios.[20] 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.

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

[18] Specifically, the quarterly 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%.

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

[20] 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 midpoint of the estimates for β in Table 6.1.

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 × Purpose		✓		✓
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. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

These estimates are also sizable 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 portfolios shows that an important 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 ex-post 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, again confirming a prediction 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).[21] The estimation results show that our baseline findings are robust to this extended fixed effect and even intensify somewhat.

Robustness and Extensions. In Appendix G, we explore extensions and test the robustness of our empirical findings along the following dimensions. First, we consider alternative regression specifications that (i) replace the firm-time fixed effects by variations of location-, size-, and industry-time fixed effects, (ii) extend the firm-time fixed effects by other contract terms, (iii) include credit lines into the analysis, and (iv) exclude the episode of financial turmoil in 2023:Q1. By and large, our results remain much the same across the various robustness tests. Second, we extend the sample backwards to include episodes of monetary easings and explore the possibility of asymmetric effects by separating positive and negative AFS value changes. Both extensions yield consistent findings: we obtain smaller effects for positive AFS value changes and samples that cover periods of falling interest rates. Third, we investigate alternative setups for the dependent variable in regression (6.1) by considering the creation and termination of credit relationships, various impulse response horizons as well as interest rate changes, and by testing for a pretrend based on a placebo regression. We find that our results strengthen when accounting for extensive margin adjustments and that the credit supply effects already show up within the same quarter as security prices change and build up over time. The effects for interest rates are consistent but weaker compared with the results for credit quantities, and we obtain no evidence for a pretrend.

7 Exploring the Mechanism

Building on the robustness of our baseline findings, we next investigate the channels that determine the strength of the spillover effects we find.

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[21] 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 D.2).

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 × Purpose		✓		✓
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. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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

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

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 which value changes of AFS portfolios directly feed into regulatory capital, confirming a prediction 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.

Hedging. To further test a prediction 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 assume those are purely resulting from 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.[22]

Based on those distinctions, Table 7.2 reports the estimation results. We find 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.

Further Evidence. In Appendix H, we further explore the mechanisms explaining our baseline results and contrast them with alternative channels. First, we explore differences across banks depending on their capital positions. We find that less-capitalized banks show stronger spillover effects, as predicted in Section 3. Second, we provide further evidence that our baseline findings are explained by banks' exposure to interest rate risk

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[22] 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 D.5 for details.

Table 7.2: 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 × Purpose		✓		✓
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 22 for details). Standard errors in parentheses are clustered by bank. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

that leads to fluctuations in the value of their securities portfolios. To this end, we employ an instrumental variable regression, using the interaction between the yield change of the one-year Treasury security and a bank's preexisting AFS portfolio as an instrument for our main regressor. If anything, our results strengthen in magnitude for this alternative specification. And third, we directly control for deposit flows, net income changes, liquid asset holdings, and changes in the quality of loan portfolios to distinguish our channel from the ones by Drechsler, Savov and Schnabl (2017), Gomez et al. (2021), Kashyap and Stein (2000), or simultaneous reactions to the performance of the loan portfolio. Again, the estimate for our regressor of interest remains nearly unchanged and even strengthens somewhat in magnitude.

Table 8.1: Firm Level Effects.

	Δ Total Debt		Investment		Δ Cash	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Δ Value AFS	6.17**		5.31**		10.46**	
	(3.09)		(2.67)		(4.48)	
Δ Value AFS × Small		6.27**		5.36**		10.48**
		(3.10)		(2.67)		(4.49)
Δ Value AFS × Large		-11.37		-4.32		7.65
		(13.12)		(9.31)		(18.39)
Fixed Effects						
Firm	✓	✓	✓	✓	✓	✓
Time	✓	✓	✓	✓	✓	✓
Firm Controls	✓	✓	✓	✓	✓	✓
R-squared	0.73	0.73	0.72	0.72	0.66	0.66
Observations	69,934	69,934	82,472	82,472	81,900	81,900
Number of Firms	19,046	19,046	22,162	22,162	22,116	22,116
Number of Banks	29	29	30	30	30	30

Notes: Estimation results for regression (8.1) where $y_{i,t}$ is either total debt in columns (i) and (ii), fixed assets in columns (iii) and (iv), or cash holdings in columns (v) and (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 the set of all bank controls used in previous regressions and deposit and net income changes from column (iv) of Table H.2 aggregated to the firm level using debt shares across lenders. Standard errors in parentheses are clustered by firm. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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

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

where $y_{i,t}$ is either total debt, fixed assets (a proxy for investment), or cash and marketable securities. 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 financials are updated annually for the majority of private firms.

Our regressor of interest is $\Delta \widetilde{Value}^{AFS}_{i,t} = \sum^{j} (\Delta Value^{AFS}_{j,t} / Assets_{j,t}) \cdot (L_{i,j,t} / Debt_{i,t})$. These are exposures to fluctuations in bank security values aggregated to the firm level using firm debt shares across lenders.[23] We also include firm fixed effects α_i and time fixed effects κ_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 H.2 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.[24]

The estimation results are reported in columns (i), (iii), and (v) of Table 8.1. We find positive coefficients for β for changes in total debt, fixed assets, and cash holdings that are statistically different from zero at the 5 percent confidence level. 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 nonbank 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. Thus, even though firms adjust their cash holdings to mitigate the lending cuts as shown in column (v), they seem to be unable to use this margin or other ones to diminish the impact of lending restrictions on their investment schedule.

To explore heterogeneity in transmission, we distinguish firms by their size, with the hypothesis that larger firms should be less affected by a lending cut since they are not as bank-dependent and have access to other sources of financing. Columns (ii), (iv), and (vi) repeat the previous estimations but include interactions between our regressor of interest and firm size indicators.[25] We find that our previous estimates are driven by smaller firms. The estimated coefficients for large firms are insignificant for the various dependent variables. These results motivate our model setup which accounts for this heterogeneity in transmission by considering two types of firms that differ in their access to financing.[26]

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[23] 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.

[24] We explored various combinations of time, industry, and location fixed effects and found that our results are much the same across those specifications.

[25] As a conservative approximation, we define a large firm as one that is in the top decile of the size distribution based on firm total assets. The share of capital held by the 10 percent of largest firms is around 86 percent in the Y14 data, and we calibrate our model to match this moment.

[26] Consistent with our model setup, where large firms have access to credit lines, Appendix Table I.1

9 Model

To study the effects of changes in security value and their regulatory treatment on interest rate transmission in general equilibrium, we present a structural model, adapted from Greenwald, Krainer and Paul (2023). We briefly summarize the key ingredients of the model, present the detailed structure, calibrate the model, and describe our findings.

9.1 Model Overview

Our model is designed to capture transmission from shocks to banking sector conditions into changes in bank-firm lending, and ultimately firm allocations and real activity.

The main innovation of our model is a capital requirement that incorporates gains and losses on securities. As in Greenwald, Krainer and Paul (2023), banks in our model must hold capital against their loan portfolio. To extend this basic structure, we introduce securities, which are held by the bank and accrue quantitatively realistic gains and losses as interest rates vary. Depending on the regulatory regime, these gains and losses may or may not count toward the capital banks must hold against their loan portfolio. Under a mark-to-market (AC) regime, where gains and losses are included in regulatory capital, an increase in securities prices allows banks to lend more without raising capital, expanding credit supply, while a decline in securities prices has the opposite effect.

As shown in Table 8.1, the degree to which gains and losses from bank securities affect firms depends crucially on firm size. As shown by Greenwald, Krainer and Paul (2023), this can largely be attributed to the difference in financial instruments to which the firms have access. In particular, credit lines are dominated by large firms, and have the potential to largely insulate them from rising bank spreads. To address this, our model features two types of firms: larger, unconstrained firms that have access to credit lines and corporate bonds, and smaller, constrained firms that are dependent on bank term loans.

We embed this structure into a general equilibrium framework featuring a rich set of margins with quantitatively realistic adjustment frictions. We expose this model to a large increase in interest rates inspired by the corresponding rise in the data from 2021 to 2023. This rise in rates causes securities prices to fall. If banks are required to include gains and losses on securities into their regulatory capital, this tightens capital requirements, contracting credit supply. To discipline the strength of the credit supply shift caused by this fall in securities prices, we directly calibrate the curvature on our bank capital holding

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shows that the results remain if we separate firms according to whether they have any unused credit line capacity in our data. Firms without credit line capacity show a similar pass-through as small firms.

cost function to match our regression results in Table 8.1 on the pass-through of securities gains to firm credit.

9.2 Model Structure

Demographics and Preferences. Our model features three types of household: constrained entrepreneurs (denoted C), unconstrained entrepreneurs (denoted U), and savers (denoted S). Each type of household is able to trade a complete set of contracts with other households of the same type, but not across types, leading to aggregation to a representative household for each type.

An entrepreneur of type j has exponential utility (constant absolute risk aversion) preferences over consumption $C_{j,t}$ defined by

$$U_{j,t} = E_t \sum_{k=0}^{\infty} \beta_j^k \frac{\left(1 - \exp(-\zeta_D C_{j,t})\right)}{\zeta_D}. \tag{9.1}$$

Each entrepreneur owns a firm of the same type and consumes its dividends. As a result, using a concave utility function increases marginal utility when dividends are low, providing incentives for firms to smooth dividends. The benefit of using a separate entrepreneur type for each firm is this incentive will drive each type of firm to smooth its own dividends, rather than trying to smooth aggregate dividends, generating a more realistic firm-level friction. We choose exponential utility in place of the more standard power utility (constant relative risk aversion) preferences, as it accommodates zero or negative dividends (corresponding to equity issuance), which can occur in practice.

For the saver type, we assume risk-neutral preferences over consumption $C_{S,t}$:

$$U_{S,t} = E_t \sum_{k=0}^{\infty} \left(\prod_{k=1}^{t} \beta_{S,k} \right) C_{S,t}. \tag{9.2}$$

This assumption of risk-neutral preferences adds simplicity to our analysis, since it implies an exogenous risk-free rate that depends only on the discount factor and expected inflation. The $\beta_{S,k}$ terms represent time-varying discount factors for the saver, following the stochastic process

$$\log \beta_{S,t} = (1 - \rho_\beta) \log \bar{\beta}_S + \rho \log \beta_{S,t-1} + \varepsilon_{\beta,t} \tag{9.3}$$

where $\varepsilon_{\beta,t}$ is a stochastic innovation we will use in Section 9.6 to shock real interest rates. Savers inelastically supply $\bar{N}$ units of labor each period.

Productive Technology and Labor Demand. The production function of a firm of type j is

$$Y_{j,t} = Z_t K_{j,t-1}^{\alpha} \bar{N}_j^{1-\alpha}$$

where Z_t is exogenous aggregate productivity, $K_{j,t-1}$ is capital, and $\bar{N}_j$ is labor, which firms use in a fixed quantity at a fixed wage w. The assumptions that labor demand and wages are fixed capture unmodeled frictions in the labor market that may prevent wage or hour adjustments at the relatively short time horizons we consider. Assuming that labor is as a fixed factor also serves as a simple way to pin down the relative scales of the two types of firms without requiring us to take a stand on the elasticity of substitution between goods produced by the two types.

Firm Types. We assume two types of firms — constrained firms (denoted C) and unconstrained firms (denoted U) — each owned by an entrepreneur of the corresponding type. These firms differ primarily in their ability to use financial instruments. While unconstrained firms can borrow using corporate bonds or credit lines from banks, constrained firms can only borrow using term loans from banks.

Firm Debt Contracts. We model all forms of firm debt (corporate bonds, credit lines, and term loans) as floating rate with a fixed spread, meaning that for each dollar of loan balance at time t, a firm must make an interest payment of $r_t + s$ dollars in the following period, where r_t is the current risk-free rate, and s is the loan spread, which is fixed at origination and does not vary over time. In addition to interest, a fraction ν of debt matures and must be repaid each period, while fraction $1 - \nu$ of debt is carried into the following period. This structure nests short-term (one-period) debt for $\nu = 1$.

Given these assumptions, we can track debt and required payments for a firm of type j over all debt instruments using two state variables: the total principal balance ($B_{j,t}$), and the total amount of spread payments (in dollars) a firm has promised in the following period ($S_{j,t}$). These evolve according to

$$\begin{aligned} B_{j,t} &= \underbrace{B_{j,t}^{*}}_{\text{new debt}} + \underbrace{(1-\nu)\pi_t^{-1} B_{j,t-1}}_{\text{existing debt}} \\ S_{j,t} &= \underbrace{s_{j,t} B_{j,t}^{*}}_{\text{new spread payments}} + \underbrace{(1-\nu)\pi_t^{-1} S_{j,t-1}}_{\text{existing spread payments}} \end{aligned}$$

where $B^*_{j,t}$ is newly issued debt, $s_{j,t}$ is the average spread per dollar of debt issued, and inflation (π_t) translates the debt balance from nominal to real terms.

The term $s_{j,t}$, reflecting the average spread on new debt for a firm of type j, depends on that firm's funding structure. We denote the spreads on corporate bonds, credit lines, and term loans using s^{bond}_t, $\bar{s}^{line}$, and s^{loan}_t, respectively, where the lack of a time subscript on $\bar{s}^{line}$ reflects that credit line spreads are prenegotiated and assumed to be fixed for our experiment. Since constrained firms are limited to borrowing in term loans, we have $s_{C,t} = s^{loan}_t$.

Unconstrained firms, however, endogenously choose between corporate bonds and credit lines. For simplicity, we assume that unconstrained firms do not use term loans, inspired by our evidence in Greenwald, Krainer and Paul (2023) that unconstrained (large) firms dominate the distribution of undrawn credit lines, and that firms typically use credit lines when available in response to shocks. As a result, the spread faced by unconstrained firms depends on the spreads on both bonds and credit lines, as well as its endogenous allocation of new debt between the two products.

To determine these shares, we next model the unconstrained firm's decision over bonds and credit lines. In the absence of additional frictions, unconstrained firms would simply choose whichever product had a lower spread, which would counterfactually predict that unconstrained firms obtain 100 percent of their new credit in a given period from one product, and 0 percent from the other. To obtain a more realistic split, we assume that for each dollar of debt a firm needs to raise in a given period, it draws a cost $q \sim N(\mu_q, \sigma^2_q)$, i.i.d. across firms and time, that must be paid each period until maturity if that debt is issued as a bond. Due to this cost, the optimal strategy is to select a threshold $q^*_{U,t}$ such that debt with $q < q^*_{U,t}$ is issued as a bond, while debt with $q \geq q^*_{U,t}$ is borrowed as a term loan.

Under these assumptions, the average spread faced by unconstrained firms is

$$s_{U,t} = \int^{q^*_{U,t}} (s^{bond}_t + q)\, d\Gamma_q(q) + \int_{q^*_{U,t}} \bar{s}^{line}\, d\Gamma_q(q) - s^{rebate}_t \tag{9.4}$$

where Γ_q is the CDF of the q distribution. The term s^{rebate}_t is taken as fixed by the firm but returns the total bond cost $\int^{q^*_{U,t}} q\, d\Gamma_q(q)$ to the firm at equilibrium so that this friction imposes no actual resource cost. The optimal policy that minimizes (9.4) for the firm is to set $q^*_{U,t} = \bar{s}^{line} - s^{bond}_t$.

Under these assumptions, the shares of unconstrained firm bond and credit line debt are in turn given by

$$F^{bond}_{U,t} = \Gamma_q(q^*_{U,t}), \qquad F^{loan}_{U,t} = 1 - \Gamma_q(q^*_{U,t})$$

the laws of motion for bond and loan balances are

$$B^{bond}_{U,t} = F^{bond}_{U,t} B^*_{U,t} + (1-\nu)\pi_t^{-1} B^{bond}_{U,t-1}, \qquad B^{loan}_{U,t} = F^{loan}_{U,t} B^*_{U,t} + (1-\nu)\pi_t^{-1} B^{loan}_{U,t-1}$$

and the average spread on new debt to unconstrained firms can be written

$$s_{U,t} = F^{bond}_{U,t} s^{bond}_t + F^{loan}_{U,t} s^{loan}_{U,t}. \tag{9.5}$$

Firm Debt Covenants. Firm debt contracts contain debt-to-EBITDA covenants that require firms to pay a penalty if their total debt is greater than a certain multiple of smoothed EBITDA ($X_{j,t}$), defined by

$$X_{j,t} = (1-\rho_X) \underbrace{(Y_{j,t} - w\bar{N}_j)}_{\text{current EBITDA}} + \rho_X \pi_t^{-1} X_{j,t-1} \tag{9.6}$$

where EBITDA represents output net of the wage bill, and the term π_t^{-1} accounts for the fact that smoothed EBITDA is measured in nominal terms.

In reality, firms face uncertainty about their future EBITDA that leads them to leave a precautionary buffer in their covenant ratios away from the violation threshold. To match this in our framework, we assume that a firm violates its covenant if

$$\pi_t^{-1} B_{j,t-1} > \omega_{i,t} \theta X_{j,t} \tag{9.7}$$

where $\omega_{i,t}$ are i.i.d. shocks. These shocks induce uncertainty similar to that described above, leading to similar precautionary behavior. Because firms in our model are not right at the covenant violation threshold, they are not literally constrained, and can obtain an additional dollar of debt if they choose to. Instead, the increased probability of covenant violation from maintaining a smaller buffer, combined with the cost of credit, balances against the marginal benefit of debt to create an interior solution.

Rearranging (9.7), a firm of type j violates its covenant if and only if $\omega_{i,t} < \bar{\omega}_{j,t}$, for

$$\bar{\omega}_{j,t} = \frac{\pi_t^{-1} B_{j,t-1}}{\theta X_{j,t}}. \tag{9.8}$$

As a result, the probability of violation is $\Gamma_{\omega,j}(\bar{\omega}_{j,t})$, which is increasing in the firm's expected ratio of debt to smoothed EBITDA. We assume that firms that violate must pay a penalty equal to fraction κ of their start-of-period principal balance $\pi_t^{-1}B_{j,t-1}$.

Firm's Problem. The representative firm owned by entrepreneurs of type j chooses dividends $D_{j,t}$, cash holdings $A_{j,t}$, new debt issuance $B^*_{j,t}$, and new capital $K_{j,t}$ to maximize

$$V_{j,t} = D_{j,t} + \eta_{A,j}\frac{A_{j,t}^{1-\zeta_A}}{1-\zeta_A} + E_t\Big[\Lambda_{j,t+1}V_{j,t+1}\Big]. \tag{9.9}$$

The term $\Lambda_{j,t+1}$ above is the stochastic discount factor of the type j entrepreneur

$$\Lambda_{j,t+1} = \beta_j \exp\Big(-\zeta_D(C_{j,t+1} - C_{j,t})\Big). \tag{9.10}$$

Due to our assumption of concave utility for entrepreneurs, this term will incentivize firms to smooth dividends and hence consumption for entrepreneurs of their type at equilibrium.

Equation (9.9) includes a utility term for holding cash. This stands in for the precautionary motives that typically lead firms to hold a reserve of cash in reality, allowing our model to reproduce this behavior in a deterministic setting. We allow the utility weight $\eta_{A,j}$ to vary by firm type j to match the different amounts of cash that large and small firms hold.

The budget constraint for a firm of type j is

$$\begin{aligned} D_{j,t} = {} & \underbrace{(1-\tau)\left(Y_{j,t} - wN_j\right)}_{\text{after-tax profit}} + \underbrace{\Big(1-(1-\tau)\delta\Big)\bar{Q}_{j,t}K_{j,t-1}}_{\text{old capital}} + \underbrace{\pi_t^{-1}A_{j,t-1}}_{\text{old cash}} \\ & \underbrace{-\,\pi_t^{-1}\Big[\Big((1-\tau)r_{t-1} + \nu + \kappa_j\Gamma_{\omega,j}(\bar{\omega}_{j,t})\Big)B_{j,t-1} + (1-\tau)S_{j,t-1}\Big]}_{\text{payments on existing debt}} \\ & - \underbrace{Q_{j,t}K_{j,t}}_{\text{new capital}} - \underbrace{A_{j,t}}_{\text{new cash}} + \underbrace{B^*_{j,t}}_{\text{new debt}} \end{aligned} \tag{9.11}$$

where $D_{j,t}$ is dividends paid to the type j entrepreneur, $Q_{j,t}$ is the price of new capital, $\bar{Q}_{j,t}$ is the resale price of old capital, $B^*_{j,t}$ is new debt issued by firm j, r_{t-1} is the risk-free interest rate, τ is the corporate tax rate, and δ is the depreciation rate. This constraint also captures that both depreciation and interest payments on debt are tax-deductible by the firm. Unpacking the "payments on existing debt" term, we see that it consists of base risk-free rate payments net of the tax shield $(1-\tau)r_{t-1}$, principal payments ν, and average violation costs $\kappa_j \Gamma_{\omega,j}(\bar{\omega}_{j,t})$, all per unit of principal balance, in addition to spread payments net of the tax shield $(1-\tau)S_{j,t-1}$.

Government Sector. The monetary authority has a time-varying inflation target π_t that it achieves perfectly. The stochastic process for this target (and hence for inflation) is

$$\log \pi_t = (1-\rho)\log \bar{\pi} + \rho \log \pi_{t-1} + \varepsilon_{\pi,t} \tag{9.12}$$

where $\varepsilon_{\pi,t}$ represents a shock to inflation. On the fiscal side, the government spends corporate tax revenues with no effect on household utility. The government provides risk-free one period bonds in zero net supply, and long-term securities in positive supply, with fixed quantity b^{LT}. These long-term securities are held by banks at equilibrium and financed by lump-sum taxes on the saver. A fraction ν^{LT} of these long-term securities mature each period, implying the cash flow structure ν^{LT}, $(1-\nu^{LT})\nu^{LT}$, $(1-\nu^{LT})^2\nu^{LT}$, etc.

Entrepeneurs' Problems. The unconstrained and constrained entrepreneurs choose consumption $C_{j,t}$ to maximize (9.1) subject to the budget constraint $C_{j,t} \leq D_{j,t}$.

Bank's Problem. The representative bank provides term loans to constrained firms, and credit lines to unconstrained firms. Since banks are owned by the saver and directly pass through profits, we abstract from separately modeling a deposit structure, because in the absence of additional frictions the balance sheets of the bank and saver household are effectively combined.

Each bank is required to hold χ^B dollars of capital for each dollar of used credit, and χ^L dollars of capital for each dollar of committed but undrawn credit on credit lines. We assume that the representative bank has total credit line commitments of size $\bar{L}$. Since unconstrained firms borrow in the form of credit lines, while constrained firms borrow in the form of term loans, the capital requirement can be expressed as

$$k_t + AOCI_t \geq \chi^B \underbrace{\left(B^{loan}_{C,t} + B^{loan}_{U,t}\right)}_{\text{used credit}} + \chi^L \underbrace{\left(\bar{L} - B^{loan}_{U,t}\right)}_{\text{undrawn lines}} \tag{9.13}$$

The main innovation of our model relative to Greenwald, Krainer and Paul (2023) is to incorporate $AOCI_t$ into this capital requirement, which represents gains and losses on firm securities in the form of AOCI. This term takes the form

$$AOCI_t = (P_t - \bar{P}) \times b^{LT} \tag{9.14}$$

where P_t is the price of the long-term bond held by the bank, $\bar{P}$ is its steady state value, and b^{LT} is the number of long-term bonds held by the bank, assumed to be fixed and exogenous. For a bank that begins in steady state $AOCI_t$ represents the total gains and losses on its portfolio as of any initial period before the arrival of the interest rate shock.

The representative bank chooses dividends d_t, bank capital k_t, and new debt to constrained firms $B^*_{C,t}$ (but not drawdowns $B^*_{U,t}$, which the bank cannot control) to maximize

$$v_t = \underbrace{d_t}_{\text{dividends}} - \underbrace{\left(\frac{\eta_k}{\bar{k}^{\zeta_L}}\right)\frac{k_t^{1+\zeta_L}}{1+\zeta_L}}_{\text{capital holding costs}} + E_t\left[\Lambda_{S,t+1} v_{t+1}\right]. \tag{9.15}$$

In reality, capital requirements matter for bank allocations because banks prefer to hold as little capital as possible. To reproduce this, we include capital holding costs in bank utility, which has the same effect in our model, causing the capital requirement (9.13) to bind at equilibrium. As a result, changes in risk-weighted assets or AOCI will influence bank behavior via the capital requirement. The capital holding cost has curvature ζ_L, which controls the strength of the mechanism and represents the key parameter in our calibration, below. It also has a level parameter η_k that we scale by $\bar{k}^{\zeta_L}$, where $\bar{k}$ is steady state bank capital to ensure numerical stability when ζ_L is large.

The bank maximizes (9.15) subject to (9.13) and the budget constraint

$$\begin{aligned} d_t \leq \sum_{j \in \{C,U\}} \Bigg\{ & \underbrace{\bar{\pi}^{-1}\left[(r_{t-1} + \nu) B^{loan}_{j,t-1} + S^{loan}_{j,t-1}\right]}_{\text{payments on existing loans}} - \underbrace{F^{loan}_{j,t} B^*_{j,t}}_{\text{new loans}} \Bigg\} \\ & + \underbrace{\nu^{LT} \bar{\pi}^{-1} (1 - P_t) b^{LT}}_{\text{LT securities}} \end{aligned} \tag{9.16}$$

which states that bank dividends equal total loan income net of newly issued debt plus net cash flows from long-term securities. The $1 - P_t$ term in the long-term securities cash flows reflects that the bank receives \$1 for each security that matures, but replaces it with a new security at cost P_t to keep its face value of debt fixed at b^{LT}.

Saver's Problem. The saver chooses consumption $C_{S,t}$, new corporate bond issuance $B_t^{bond,*}$, and new government bonds B_t^G to maximize (9.2) subject to the budget constraint

$$C_{S,t} \leq \underbrace{wN}_{\text{labor income}} + \underbrace{d_t}_{\text{bank dividends}} \underbrace{+\,\bar{\pi}^{-1}\Big[(r_{t-1}+\nu)\,B_{t-1}^{bond} + S_{t-1}^{bond}\Big]}_{\text{existing corp. bonds}} - \underbrace{B_t^{bond,*}}_{\text{new corp. bonds}}$$
$$+ \underbrace{(1+r_{t-1})\bar{\pi}^{-1}B_{t-1}^G - B_t^G}_{\text{government bonds}} + \underbrace{T_{S,t}}_{\text{transfers}}$$

where at equilibrium we must have $B_t^G = 0$ (zero net supply) and $B_t^{bond,*} = F_{U,t}^{bond} B_{U,t}^*$. Corporate bond principal balance and spread payments evolve according to

$$B_t^{bond} = B_t^{bond,*} + (1-\nu)\bar{\pi}^{-1}B_t^{bond} \tag{9.17}$$
$$S_t^{bond} = (s_t^{bond} - q_t^{bond})B_t^{bond,*} + (1-\nu)\bar{\pi}^{-1}S_t^{bond} \tag{9.18}$$

where q_t^{bond} is an exogenous bond holding cost that potentially drives variation in bond spreads. Last, $T_{S,t}$ is a lump sum tax or rebate that finances the government's cash flows on the long-term securities and returns the cost associated with q_t^{bond} to the saver, so that these have no effect on total resources.

Capital Producers. Capital is created for firm type j using technology

$$K_{j,t} = \Phi(i_{j,t})K_{j,t-1} + (1-\delta)K_{j,t-1}$$

where $i_{j,t} = I_{j,t}/K_{j,t-1}$ is the share of investment expenditures to existing capital in sector j. Competitive capital producers buy existing capital at price $\bar{Q}_{j,t}$ and sell new capital at price $Q_{j,t}$, choosing the investment rate $i_{j,t}$ to maximize the static objective

$$Q_{j,t}\Big[\Phi(i_{j,t})K_{j,t-1} + (1-\delta)K_{j,t-1}\Big] - i_{j,t}K_{j,t-1} - \bar{Q}_{j,t}(1-\delta)K_{j,t-1}.$$

9.3 Equilibrium

Competitive equilibrium is the allocation that solves the optimization problems of the firms, entrepreneurs, saver, bank, and capital producer, and that clears the markets for output, capital goods, bank loans, corporate bonds, and government bonds. For the complete set of equilibrium conditions characterizing the model solution, see Appendix A.1.

9.4 Replicating Our Empirical Regressions

To calibrate our model to match the empirical estimates in Table 8.1, we need to compute the coefficients from an equivalent regression in the model. We target a coefficient of growth in total debt on the scaled change in securities value (column (ii) of Table 8.1), mapping small firms in the data to constrained firms in the model.

We first define four-quarter debt growth, the left-hand side of (8.1), as

$$\Delta \text{ Total Debt}_{C,t} = \frac{B^{loan}_{C,t} - B^{loan}_{C,t-4}}{0.5(B^{loan}_{C,t} + B^{loan}_{C,t-4})}. \tag{9.19}$$

We next define the bank's scaled gain on securities Δ Value AFS, the right-hand side of the regression, as

$$\Delta \text{ Value AFS}_t = \frac{(P_{t-3} - P_{t-4})b^{LT}}{B^{loan}_{t-4}/0.093} \tag{9.20}$$

where B^{loan}_{t-4} is total bank credit lagged four quarters.[27] The numerator of (9.14) is similar to $AOCI_t$ but is relative to the price four quarters ago, rather than the original price in steady state. For the denominator (bank assets) we need an adjustment to capture that C&I loans are only a fraction of total bank assets, equal to 9.3 percent in a 2012:Q3 - 2019:Q4 preshock sample. We correspondingly map total bank assets in the data to $\bar{B}^{loan}_t/0.093$ in the model. Last, we use the difference between times $t-3$ and $t-4$ to reproduce the timing used in regression (8.1), where a 1Q change on the right-hand side (here from $t-4$ to $t-3$) drives a subsequent 4Q change on the left-hand side (here $t-4$ to t).

To compute regression coefficients, we need variation in securities gains or losses across the banks that firms borrow from. To do this, we create new types of constrained firms and banks, which can be thought of as hypothetical or as actually existing in the economy with infinitesimal size. In particular, we assume that firms of type $C(-)$ borrow from banks of type $(-)$ who hold a slightly lower amount of securities $a-\epsilon$, while firms of type $C(+)$ borrow from banks of type $(+)$, who hold a slightly higher amount of securities $a+\epsilon$. This implies the AOCI values

$$AOCI_t(-) = (P_t - \bar{P})(a - \epsilon)$$
$$AOCI_t(+) = (P_t - \bar{P})(a + \epsilon)$$

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[27] In practice, the time $t-4$ variables can be evaluated in steady state.

where we use $\epsilon = 10^{-4}$ in our calculations. When P_t varies from its steady state value, this will lead to differing gains and losses across these types of banks, leading to differing credit supply and loan spreads at these banks, and providing variation we can use for our regression. Our regression coefficient is computed as:

$$\beta_{debt} = \frac{\Delta \text{ Total Debt}_{C,t}(+) - \Delta \text{ Total Debt}_{C,t}(-)}{\Delta \text{ Value AFS}_t(+) - \Delta \text{ Value AFS}_t(-)}$$

which corresponds to the coefficient for small firms in column (ii) of Table 8.1.[28]

9.5 Calibration

Our quarterly calibration is displayed in Table 9.1. For consistency with our empirical findings in Table 8.1, we match unconstrained firms to data on firms in the top 10 percent of the size distribution and constrained firms to data on firms in the bottom 90 percent of the size distribution. Unless otherwise mentioned, our calibration is designed to match steady-state values to corresponding values in the data from the period 2012:Q3 to 2019:Q4, the most recent extended "normal" period for which we have Y14 data.

Adjustment Frictions. The core parameters of our model, denoted ζ with various subscripts, govern the frictions on bank and firm adjustment.

On the bank side, the curvature of the capital holding cost (ζ_B) determines how much a change in credit line drawdowns will pass through into spreads, thereby inducing crowding out. We set the capital holding cost curvature parameter $\zeta_B = 0.706$ so that β_{debt} in our model, measured four quarters after a shock to interest rates, is exactly equal to our estimate for small firms in column (ii) of Table 8.1. This represents the core of our calibration step, as it ensures that our model exactly reproduces the empirical spillover from securities gains or losses to bank lending. As a result, changing other parameters will generally have little effect on the strength of our mechanism so long as we recalibrate the model to match this moment.

On the firm side, the relative frictions on adjusting dividends, cash, and investment determine how heavily these three margins are used following a negative shock. We import these parameters from our previous work Greenwald, Krainer and Paul (2023), which used a standard value of 0.25 for ζ_K, and used the COVID-19 pandemic to carefully calibrate the remaining frictions via ζ_A and ζ_D.

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[28] To verify that these formulas indeed estimate the relevant regressions, it is straightforward to check that the residuals are zero for this two-observation regression.

Table 9.1: Parameter Values: Baseline Calibration (Quarterly)

Parameter	Name	Value	Internal	Target/Source
Adjustment Frictions				
Cash Utility (Curvature)	ζ_A	7.002	N	Greenwald, Krainer and Paul (2023)
Bank Capital Cost (Curvature)	ζ_B	0.706	Y	β_{debt}
Entrepreneur ARA	ζ_D	0.431	Y	Greenwald, Krainer and Paul (2023)
Capital Adjustment (Curvature)	ζ_K	0.250	N	Standard
Preferences				
Saver Discount Factor	β_S	0.995	N	Standard
Entrepreneur Discount Factor (U)	β_U	0.990	N	Standard
Entrepreneur Discount Factor (C)	β_C	0.990	N	Standard
Long-Term Securities				
Frac. LT Bonds Maturing	ν^{LT}	0.012	N	4Y Duration
Face Value of Securities	b^{LT}	1.789	Y	Securities-loans ratio
Debt Contracts				
Frac. Debt Maturing	ν	1.000	N	1Q Maturity
Credit Line Spread	$\bar{s}^{line}$	0.625%	N	250bp Spread (Ann.)
Bond Spread	$\bar{s}^{bond}$	0.625%	N	250bp Spread (Ann.)
Debt-to-EBITDA Limit	θ	15.000	N	Dealscan
Covenant Smoothing	ρ_X	0.750	N	4Q smoothing
Covenant Violation Fee (U)	κ_U	0.00362	N	Leverage, violation rate
Covenant Violation Fee (C)	κ_C	0.00396	N	Leverage, violation rate
Idio. EBITDA Vol. (U)	$\sigma_{\omega,U}$	0.715	N	Leverage, violation rate
Idio. EBITDA Vol. (C)	$\sigma_{\omega,C}$	0.794	N	Leverage, violation rate
Financial				
Cash Utility (Level, C)	$\eta_{A,C}$	0.00461	Y	$\bar{A}/\bar{K} = 7.4\%$
Cash Utility (Level, U)	$\eta_{A,U}$	0.00076	Y	$\bar{A}/\bar{K} = 9.6\%$
Bond Transaction Cost (Mean)	μ_q	-0.00524	Y	Bank debt shares
Bond Transaction Cost (Disp.)	σ_q	0.00399	Y	Bank credit growth
Bank Capital Cost (Level)	η_B	0.00619	Y	250bp Spread (Ann.)
Credit Line Commitments	$\bar{L}$	0.791	Y	Committed-to-used credit
Loan Risk Weight	χ^B	0.080	N	Basel risk weight
Loan Risk Weight	χ^B	0.040	N	Basel risk weight
Technology and Government				
Capital Share	α	0.330	N	Standard
Unconstrained Labor Demand	N_U	0.860	N	Asset shares
Productivity	$\log \bar{Z}$	-0.719	Y	$Y = 1$
Corporate Tax Rate	τ	0.210	N	Standard
Inflation Rate	$\bar{\pi}$	1.005	N	2% inflation

Preferences. For the saver, we set β_S to 0.995 to target a steady state real annualized interest rate of 2 percent. For the entrepreneurs, we choose a standard value of $\beta_C = \beta_U = 0.990$, which delivers a reasonable value for the capital-output ratio of 2.2.

Long-Term Securities. For the long-term bonds (securities) held by banks, we set $\nu^{LT} = 0.012$ so that these securities have a cash flow duration of four years. Given the security's perpetuity structure, this requires choosing ν^{LT} to satisfy

$$\frac{1+r}{r+\nu^{LT}} = 4.$$

where the left-hand side is the cash flow duration of the perpetuity. For the face value of long-term securities issued by the government and held by banks b^{LT}, we choose this parameter so that the steady state value of securities, $\bar{P} \times b^{LT}$, is equal to twice the steady state face value of bank debt $\bar{B}_C^{loan} + \bar{B}_U^{loan}$. This reproduces the fact that securities form a share of bank assets roughly twice as large as loans to firms in our Y14 data.

Debt Contracts. For firm debt, we assume a one-period maturity, corresponding to $\nu = 1$. We make this choice for simplicity, as Greenwald, Krainer and Paul (2023) show that transmission through the banking sector is, if anything, stronger for long-term debt when calibrating to match cross-sectional regressions as we do here.

We set the fixed spread on credit lines to $\bar{s}^{line} = 0.625$ percent and the steady state spread on corporate bonds to $\bar{s}^{bond} = 0.625$ percent, so that all debt has the same spread in steady state.

For the debt covenants, we choose a debt-to-EBITDA limit of 3.75 for annualized EBITDA (15 for quarterly EBITDA), in line with the evidence in Greenwald (2019). We set the smoothing parameter ρ_L to 0.750, consistent with covenants averaging EBITDA over four quarters. We parameterize the $\omega_{i,t}$ distribution as lognormal, so that

$$\log \omega_{j,t} \sim N\left(-\frac{1}{2}\sigma_{\omega,j}^2, \sigma_{\omega,j}^2\right).$$

We calibrate the violation costs κ_U, κ_C, and the idiosyncratic volatilities $\sigma_{\omega,U}, \sigma_{\omega,C}$ to match four targets: the ratio of debt to capital (leverage) for $j \in \{C, U\}$, equal to 28 percent and 32 percent respectively, and the rate at which firms exceed the model debt-to-EBITDA threshold for $j \in \{C, U\}$, equal to 32 percent and 34 percent, respectively.

Financial. For the scale of cash utility at each firm, we set $\eta_{A,C}$ and $\eta_{A,U}$ to target a cash-to-assets ratio of 9.6 percent for constrained firms and 7.4 percent for unconstrained firms, matching the corresponding ratios in the Y14 data for small and large firms.

For the distribution of q, the transaction costs that determine unconstrained firms' split between bank loans and corporate bonds, we assume a normal distribution $N(\mu_q, \sigma_q^2)$. Following Greenwald, Krainer and Paul (2023), we calibrate these parameters as $\mu_q = -0.00524$ and $\sigma_q = 0.00399$.

For the bank capital constraint, we set the risk weight on used credit to $\chi^B = 0.080$ and the risk weight on committed but unused credit to $\chi^L = 0.040$, to match typical risk weights under the Basel regulatory framework.[29] We set the capital holding cost scale to $\eta_k = 0.00619$ to ensure a steady state annual term loan spread of 250bp, matching corporate bonds and credit lines. We set the quantity of committed credit lines to $\bar{L} = 0.791$ to match a steady state ratio of committed to used credit of 1.371, as observed in the Y14 data.

Technology and Government. We set the capital share to a standard value of $\alpha = 0.330$, and $\log \bar{Z} = -0.719$ to target $\bar{Y} = 1$. We parameterize the investment adjustment cost as

$$\Phi(i_{j,t}) = \phi_0 + \phi_1 \frac{i_{j,t}^{1-\zeta_K}}{1-\zeta_K}.$$

We set ζ_K as discussed above, and set ϕ_0 and ϕ_1 to ensure that $\Phi(i) = i$ and $\Phi'(i) = 1$ in steady state. For the labor allocations, we normalize $\bar{N} = 1$, then set $\bar{N}_U = 0.860$ and $\bar{N}_C = \bar{N} - \bar{N}_U$ so that the share of capital held by unconstrained firms in steady state is 0.860, equal to the share of assets held by the top 10 percent of firms by size in the Y14 data. For the government sector we set τ to 0.210, matching the US corporate tax rate, and the inflation rate to 1.005, implying an annual inflation rate of 2 percent.

Stochastic Processes. For our stochastic processes for β_t and π_t, we set $\rho_\beta = 0.990$ and $\rho_\pi = 0.814$ so that our model's interest rate shocks are persistent enough to affect the pricing of the long-term securities held by banks in a quantitatively realistic way.

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[29] Undrawn credit on revokable or very short maturity credit lines have even lower risk weights. Since spillovers are larger when risk weights rise by more as lines are drawn, this is a conservative calibration.

9.6 Results: Shock to Interest Rates

Inflation rose strongly from 2020:Q4 to a peak in 2022:Q2, with CPI inflation increasing by 6.4pp over this period. At the same time, long-term interest rates also displayed a sharp increase. Five-year Treasury yields rose by 2.57pp, while real 5-year TIPS yields rose by 1.19pp, implying an increase in 5-year breakeven inflation of 1.39pp.

To implement this event in our model, we assume that all of these increases unexpectedly occur in a single quarter. To do this, we simultaneously apply shocks to inflation (ε_π) and to real discount rates (ε_β), to which households apply zero probability prior to the arrival of the shock. Following the shocks, we trace out the nonlinear perfect foresight path back to steady state. For the inflation shock, we set $\varepsilon_{\pi,1} = 6.44/400$ to match the initial increase in inflation, and set $\phi_\pi = 0.814$ to match the observed increase in five-year breakeven inflation on impact. Similarly, we set ϕ_β to a persistent value of 0.990, then choose $\varepsilon_{\beta,1} = -1.317/400$ to exactly match the observed increase in 5-year real yields.

To emphasize the impact of bank regulatory policy, we compare a "Mark-to-Market" economy, corresponding to our baseline economy described above, against an alternative "Book Value" economy, in which bank regulatory capital is computed using accounting (book) value so that $AOCI_t = 0$ in the bank regulatory capital equation (9.13).

The impact of this shock on the aggregate economy is displayed in Figure 9.1. To build intuition, we first briefly describe the impact of this shock in the Book Value economy — a world where banks do not mark their securities to market when computing regulatory capital. However, we note that our main results relate to the *comparison* between the two economies, rather than the baseline effect of this combination of shocks in this relatively simple framework. In the Book Value economy, a rise in both inflation and real rates raises the nominal risk-free rate and decreases the value of long-term bonds (securities) held by banks. However, under this regulatory assumption, similar to that for NC banks in the data, these losses have no impact on required regulatory capital k_t. In the absence of such changes, the spreads charged by banks remain effectively constant.

Turning to the bottom row, we see that the volume of bank lending changes little in the Book Value economy, reflecting the stability of loan spreads. For other financial variables, we observe a decrease in cash, which is more costly to hold under high inflation, and a shift of resources away from investment and toward payouts as their investors become effectively more impatient.

From this Book Value economy baseline, we move to our Mark-to-Market economy, in which gains and losses on securities appear in AOCI and regulatory capital. Differences between the two should therefore isolate the impact of mark-to-market regulatory accounting on interest rate transmission, and form our main results. Returning to the top

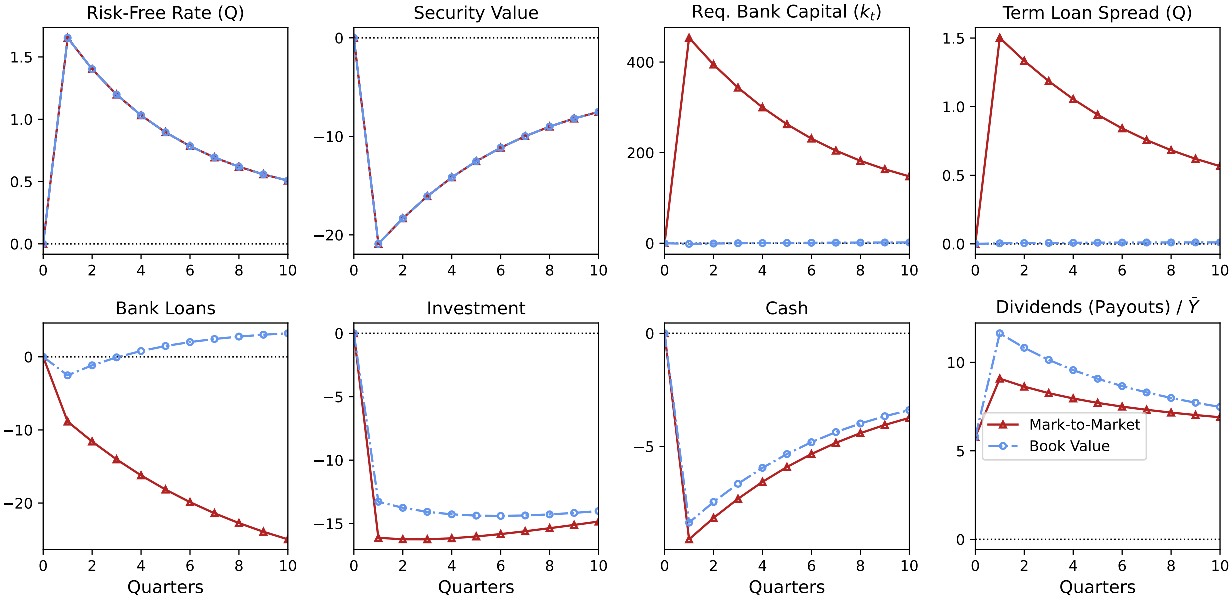

Figure 9.1: Aggregate Responses, Mark-to-Market vs. Book Value Economies

Notes: This figure plots the economy's response to an inflation shock of 300bp annualized ($\varepsilon_{\pi,1} = 0.03/4$). Variable definitions are as follows: Risk-Free Rate (R_t, the one-period risk-free rate), Security Value (P_t), Required Bank Capital (k_t), Output (Y_t), Bank Loans (B_t^{loan}), Investment (I_t), Cash (A_t), Dividends (Payouts) / $\bar{Y}$ ($D_t/\bar{Y}$). Aggregate variables (firm variables without a type subscript) are computed as sums over constrained and unconstrained firms. All variables are displayed in percent changes from steady state with the exception of Dividends / $\bar{Y}$, which displays levels in percent.

row, we observe the exact same changes in risk-free rates and security (bond) prices in the Mark-to-Market economy. However, unlike the Book Value economy, in the Mark-to-Market economy this large decrease in security values decreases $AOCI_t$ in the regulatory capital equation (9.13), requiring banks to raise capital (k_t).[30]

Due to this contraction in credit supply and corresponding increase in spreads, bank lending is much lower in the Mark-to-Market economy compared with the Book Value economy. In fact, bank lending now falls by 16.2pp at the 4Q horizon, compared to rising by 0.8pp in the Book Value economy. Lacking resources that would have been provided by bank credit, firms reduce investment, cash holdings, and dividends. Investment falls 16.1pp on impact in the Mark-to-Market economy compared with 13.3pp in the Book Value economy — a difference of 2.8pp.

Having analyzed the aggregate responses, we now turn to the responses by firm type.

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[30] Because banks in our model only hold capital against lending to firms, the proportional increase is too large relative to the real world, with required capital k_t increasing by more than 400%. However, we note that our calibration approach will adjust ζ_B accordingly so that we obtain the correct pass through from security values to firm lending. As a result our simplifying assumption that banks lend only to firms should not prevent our accurate calibration of the strength of this transmission mechanism.

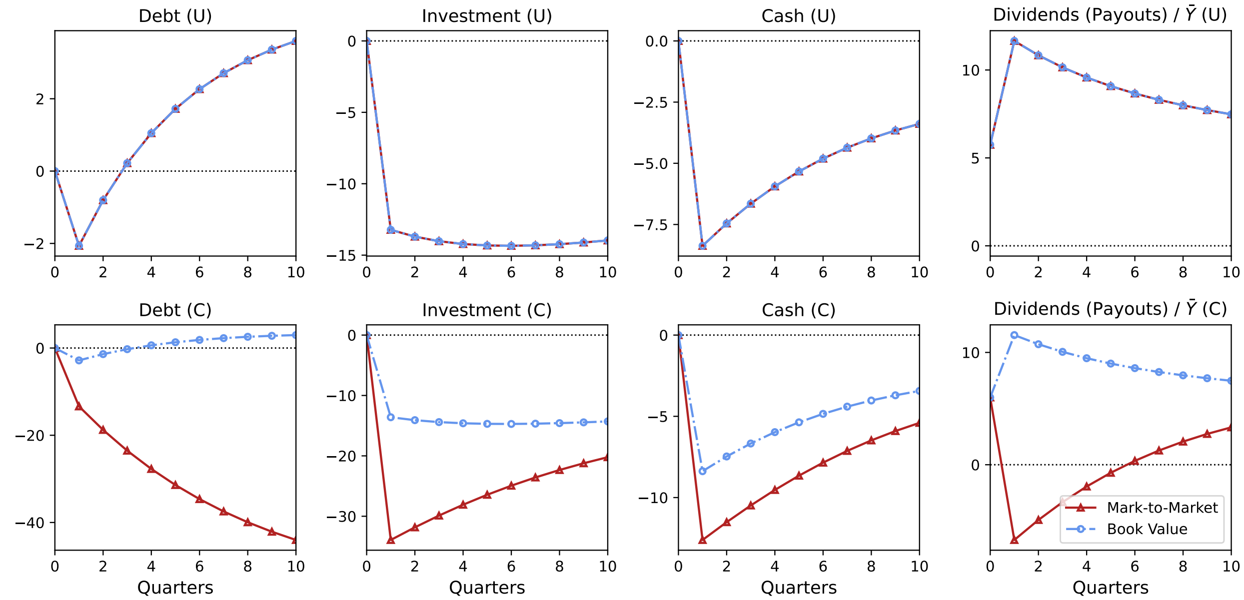

Figure 9.2: Responses by Type, Mark-to-Market vs. Book Value Economies

Notes: This figure plots the economy's response to an inflation shock of 300bp annualized ($\varepsilon_{\pi,1} = 0.03/4$). Variable definitions are as follows: Bank Loans ($B^{loan}_{j,t}$), Corporate Bonds ($B^{bond}_{j,t}$), Avg. Quarterly Spread ($s_{j,t}$), Debt ($B_{j,t}$), Investment ($I_{j,t}$), Cash ($A_{j,t}$), Dividends (Payouts) / $\bar{Y}$ ($D_{j,t}/\bar{Y}_j$). Variables followed by (U) refer to the unconstrained firm, while variables followed by (C) refer to the constrained firm. All variables are displayed in percent changes from steady state with the exceptions of Avg. Quarterly Spread, which is displayed percentage point changes from steady state, and Dividends (Payouts) / $\bar{Y}$, which is displayed in percent.

Figure 9.2 displays responses for unconstrained firms in the top row and constrained firms in the bottom row. Beginning with the top row, we see that unconstrained firms are completely unaffected by the difference in regulatory policy, with identical allocations in both economies. Unconstrained firms in this experiment borrow using corporate bonds, which are obtained outside the banking sector, and credit lines, which have fixed, prenegotiated spreads. As a result, the contraction in bank credit supply and resulting increase in spreads does not affect unconstrained firm borrowing at all. With firm financial conditions unchanged across the two economies, the optimal allocations of investment, cash, and dividends are similarly identical, producing the responses we observe.

The situation of constrained firms is quite different. These firms are completely dependent on term lending from banks when borrowing. As a result, the contraction in credit supply and increase in bank spreads in the Mark-to-Market economy has a very large depressing effect on constrained firm debt, with a gap in 4Q constrained firm credit growth of over 27pp between the two economies. This contraction of debt causes constrained firms to adjust their remaining margins, reducing investment, cash, and dividends heavily. Investment in particular shows persistent differences of more than 10pp across the two economies throughout the first year under higher interest rates.

Our aggregate results in Figure 9.1 are thus a composition of a complete non-response by large, unconstrained firms, combined with a very large response by smaller, constrained firms. Because smaller firms account for a minority of output and investment, this composition dampens the impact of the shock on the aggregate economy, which displays substantial but more modest differences. At the same time, Figure 9.2 shows that these aggregate results mask extremely large effects at constrained firms, which in our calibration map to 90 percent of the firms in the economy. To the extent that the real world contains nonlinearities due to distress, layoffs, or bankruptcies, these disproportionate impacts at small firms could have even larger distributional and aggregate implications.

In summary, our model shows that transmission from securities prices into measured bank regulatory capital via AOCI is an important channel by which interest rates influence firm borrowing and real activity.

10 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 empirical evidence shows that such banks extend relatively less credit to firms when monetary policy tightens and lowers security prices.

We study the quantitative importance of this transmission channel within a general equilibrium model that is tightly calibrated to our cross-sectional regression evidence. Based on counterfactual policy scenarios, we find that, if all banks were required to mark their securities to market and pass unrealized gains and losses through to their regulatory capital, monetary policy would become more potent—both in speed and in magnitude—since the spillover channel through fast-moving securities prices strengthens.

To close, we provide a caveat to our findings. Our results are measured in a particular economic environment. During the COVID-19 pandemic, deposits flowed into the banking system and banks largely used the additional funds to acquire securities. This period therefore made the system more vulnerable to the mechanism that we explore since the pandemic was quickly followed by an inflation surge and a sharp tightening of monetary policy. We leave to future work the task of determining how the strength of our mechanism varies with macroeconomic and banking sector conditions.

References

Abbassi, Puriya, Rajkamal Iyer, José-Luis Peydró and Francesc R. Tous. 2016. "Securities trading by banks and credit supply: Micro-evidence from the crisis." *Journal of Financial Economics* 121(3):569–594.

Abbassi, Puriya, Rajkamal Iyer, José-Luis Peydró and Paul Soto. 2023. "Stressed banks? Evidence from the largest-ever supervisory exercise." *Working paper* .

Acharya, Viral V, Tim Eisert, Christian Eufinger and Christian Hirsch. 2018. "Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans." *The Review of Financial Studies* 31(8):2855–2896.

Allen, Franklin and Elena Carletti. 2008. "Should financial institutions mark to market?" *Financial Stability Review* 12:1–6.

Begenau, Juliane, Monika Piazzesi and Martin Schneider. 2015. "Banks' Risk Exposures." *NBER Working Paper* (21334).

Bernanke, Ben S. and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of Economic Perspectives* 9(4):27–48.

Bottero, Margherita, Simone Lenzu and Filippo Mezzanotti. 2020. "Sovereign debt exposure and the bank lending channel: Impact on credit supply and the real economy." *Journal of International Economics* 126:1–26.

Carpinelli, Luisa and Matteo Crosignani. 2021. "The design and transmission of central bank liquidity provisions." *Journal of Financial Economics* 141(1):27–47.

Chakraborty, Indraneel, Itay Goldstein and Andrew MacKinlay. 2020. "Monetary stimulus and bank lending." *Journal of Financial Economics* 136(1):189–218.

De Marco, Filippo. 2019. "Bank Lending and the European Sovereign Debt Crisis." *Journal of Financial and Quantitative Analysis* 54(1):155–182.

Drechsler, Itamar, Alexi Savov and Philipp Schnabl. 2017. "The Deposits Channel of Monetary Policy." *The Quarterly Journal of Economics* 132(4):1819–1876.

Drechsler, Itamar, Alexi Savov and Philipp Schnabl. 2021. "Banking on Deposits, Maturity Transformation without Interest Rate Risk." *Journal of Finance* 76(3):1091–1143.

Drechsler, Itamar, Alexi Savov, Philipp Schnabl and Olivier Wang. 2023. "Banking on Uninsured Deposits." *Working paper* pp. 1–51.

Fuster, Andreas and James Vickery. 2018. "Regulation and risk shuffling in bank securities portfolios." *Federal Reserve Bank of New York Staff Report* (851).

Gomez, Matthieu, Augustin Landier, David Sraer and David Thesmar. 2021. "Banks Exposure to Interest Rate Risk and the Transmission of Monetary Policy." *Journal of Monetary Economics* 117:543–570.

Granja, Joao. 2023. "Bank Fragility and Reclassification of Securities into HTM." *Working paper* pp. 1–25.

Greenwald, Daniel. 2019. "Firm Debt Covenants and the Macroeconomy: The Interest Coverage Channel." *Unpublished Manuscript, MIT* .

Greenwald, Daniel, John Krainer and Pascal Paul. 2023. "The Credit Line Channel." *Journal of Finance, forthcoming* .

Heaton, John C., Deborah Lucas and Robert L. McDonald. 2010. "Is mark-to-market accounting destabilizing? Analysis and implications for policy." *Journal of Monetary Economics* 57(1):64–75.

Hoffmann, Peter, Sam Langfield, Federico Pierobon and Guillaume Vuillemey. 2019. "Who bears interest rate risk?" *Review of Financial Studies* 32(8):2921–2954.

Jiang, Erica, Gregor Matvos, Tomasz Piskorski and Amit Seru. 2023*a*. "Limited Hedging and Gambling for Resurrection by U.S. Banks During the 2022 Monetary Tightening?" *Working paper* pp. 1–30.

Jiang, Erica, Gregor Matvos, Tomasz Piskorski and Amit Seru. 2023*b*. "Monetary Tightening and U.S. Bank Fragility in 2023: Mark-to-Market Losses and Uninsured Depositor Runs?" *Working paper* pp. 1–31.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró and Jesús Saurina. 2012. "Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications." *American Economic Review* 102(5):2301–26.

Kashyap, Anil K. and Jeremy C. Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review* 90(3):407–428.

Khwaja, Asim Ijaz and Atif Mian. 2008. "Tracing the impact of bank liquidity shocks: Evidence from an emerging market." *American Economic Review* 98(4):1413–42.

Kim, Sehwa, Seil Kim and Stephen Ryan. 2019. "Economic Consequences of the AOCI Filter Removal for Advanced Approaches Banks." *The Accounting Review* 94(6):309–335.

Kim, Sehwa, Seil Kim and Stephen Ryan. 2023. "Banks' motivations for designating securities as held to maturity." *SSRN working paper* .

Laux, Christian and Christian Leuz. 2010. "Did Fair-Value Accounting Contribute to the Financial Crisis?" *Journal of Economic Perspectives* 24(1):93–118.

Luck, Stephan and Tom Zimmermann. 2020. "Employment effects of unconventional monetary policy: Evidence from QE." *Journal of Financial Economics* 135(3):678–703.

McPhail, Lihong, Philipp Schnabl and Bruce Tuckman. 2023. "Do Banks Hedge Using Interest Rate Swaps?" *Working Paper* pp. 1–22.

Orame, Andrea, Rodney Ramcharan and Roberto Robatto. 2023. "Macroprudential Regulation, Quantitative Easing, and Bank Lending." *Working Paper* .

Paravisini, Daniel, Veronica Rappoport and Philipp Schnabl. 2023. "Specialization in Bank Lending: Evidence from Exporting Firms." *Journal of Finance* 78(4):1–37.

Paul, Pascal. 2022. "When the Fed Raises Rates, Are Banks Less Profitable?" *Federal Reserve Bank of San Francisco Economic Letter* (35):1–6.

Paul, Pascal. 2023. "Banks, Maturity Transformation, and Monetary Policy." *Journal of Financial Intermediation* (53):1–14.

Peydró, José-Luis, Andrea Polo and Enrico Sette. 2021. "Monetary policy at work: Security and credit application registers evidence." *Journal of Financial Economics* 140(3):789–814.

Peydró, José-Luis, Andrea Polo, Enrico Sette and Victoria Vanasco. 2023. "Risk Mitigating versus Risk Shifting: Evidence from Banks Security Trading in Crises." *Working paper* .

Popov, Alexander and Neeltje Van Horen. 2015. "Exporting Sovereign Stress: Evidence from Syndicated Bank Lending during the Euro Area Sovereign Debt Crisis." *Review of Finance* 19(5):1825–1866.

Purnanandam, Amiyatosh. 2007. "Interest rate derivatives at commercial banks: An empirical investigation." *Journal of Monetary Economics* 54(6):1769–1808.

Rodnyansky, Alexander and Olivier M. Darmouni. 2017. "The Effects of Quantitative Easing on Bank Lending Behavior." *The Review of Financial Studies* 30(11):3858–3887.

Stiglitz, Joseph E and Andrew Weiss. 1981. "Credit Rationing in Markets With Imperfect Information." *The American Economic Review* 71(3):393–410.

APPENDIX

A Model Appendix

A.1 Model Optimality Conditions

This section derives the optimality conditions that must hold at equilibrium.

Firms. Define expected violation costs per dollar of debt to be

$$\xi_{j,t} = \kappa_j \Gamma_{\omega,j}(\bar{\omega}_{j,t})$$

which is equal to the product of the cost and probability of violation. The optimality condition for capital for a firm of type *j* is

$$Q_{j,t} = E_t \Bigg\{ \Lambda_{j,t+1} \Bigg[(1-\tau) \underbrace{\frac{\partial Y_{j,t+1}}{\partial K_{j,t}}}_{\text{MPK}} + \underbrace{\Big(1-(1-\tau)\delta\Big)\bar{Q}_{j,t+1}}_{\text{remaining capital}} + \underbrace{\Psi_{j,t}\frac{\partial X^*_{j,t+1}}{\partial K_{j,t}}}_{\text{violation costs}} \Bigg] \Bigg\}$$

which equates the cost of a new unit of capital to the discounted value of the marginal income it will provide next period, the marginal sale value of the remaining capital next period, and the effect of that capital on expected violation costs. To this end, the term $\Psi_{j,t}$ represents the marginal benefit of reducing the firm's violation costs by increasing smoothed EBITDA, both today and in the future, and is equal to

$$\Psi_{j,t} = -\bar{\pi}^{-1} \frac{\partial \xi_{j,t}}{\partial X_{j,t}} B_{j,t-1} + E_t \left\{ \Lambda_{j,t+1} \Psi_{j,t+1} \frac{\partial X^*_{j,t+1}}{\partial X_{j,t}} \right\}.$$

The optimality condition for debt is

$$1 = \Omega^B_{j,t} + \Omega^S_{j,t} s_{j,t}$$

which sets the benefit of debt ($1 today) against the marginal cost of carrying an additional $1 of debt into the next period and promising an additional $s_{j,t}$ in spread payments.

The marginal continuation costs of principal balances $\Omega^B_{j,t}$ and spread payments $\Omega^S_{j,t}$ are

$$\Omega^B_{j,t} = E_t\bigg\{\Lambda_{j,t+1}\bar{\pi}^{-1}\bigg[\Big((1-\tau)r_t + \nu + \xi_{j,t+1}\Big) + \frac{\partial \xi_{j,t+1}}{\partial B_t} + (1-\nu)\Omega^B_{j,t+1}\bigg]\bigg\}$$

$$\Omega^S_{j,t} = E_t\bigg\{\Lambda_{j,t+1}\bar{\pi}^{-1}\bigg[(1-\tau) + (1-\nu)\Omega^S_{j,t+1}\bigg]\bigg\}$$

The optimality condition for cash is

$$1 = \exp(\tilde{a}_t)\eta_{A,j}A_{j,t}^{-\zeta_A} + \bar{\pi}^{-1}E_t\Big[\Lambda_{j,t+1}\Big]$$

which sets the cost of acquiring \$1 of cash equal to the utility benefit to the firm from the liquidity services as well as the continuation value of \$1 of cash next period, net of discounting and inflation. Last, the derivative terms used above can be evaluated as

$$\frac{\partial Y_{j,t+1}}{\partial K_{j,t}} = \alpha\frac{Y_{j,t+1}}{K_{j,t}} \qquad \frac{\partial X^*_{j,t+1}}{\partial K_{j,t}} = (1-\rho_X)\frac{\partial Y_{j,t+1}}{\partial K_{j,t}} \qquad \frac{\partial X^*_{j,t+1}}{\partial X_{j,t}} = \rho_X\bar{\pi}^{-1}$$

$$\frac{\partial \xi_{j,t}}{\partial X_{j,t}} = -\kappa_j f_{\omega,j}(\bar{\omega}_{j,t})\frac{\bar{\omega}_{j,t}}{X_{j,t}} \qquad \frac{\partial \xi_{j,t+1}}{\partial B_{j,t}} = \kappa_j f_{\omega,j}(\bar{\omega}_{j,t+1})\frac{\bar{\omega}_{j,t+1}}{B_{j,t}}.$$

Saver. The saver's optimality condition for risk-free government debt is

$$1 = (1+r_t)\bar{\pi}^{-1}E_t\Big[\Lambda_{S,t+1}\Big].$$

Under the baseline assumption that the saver is risk-neutral we have $\Lambda_{S,t+1} = \beta$ and so

$$1 + r_t = \bar{\pi}\beta_S^{-1}.$$

The saver's optimality condition for corporate bonds is

$$1 = \Omega^B_{S,t} + \Omega^S_{S,t}(s^{bond}_t - q^{bond}_t) \tag{A.1}$$

which sets the cost of buying \$1 of corporate bonds today equal to the marginal benefit of \$1 of corporate bond balances and the marginal benefit of an extra s^{bond}_t of corporate bond spread payments going forward, net of the holding cost q^{bond}_t. These marginal continuation values are equal to

$$\Omega^B_{S,t} = E_t \left\{ \Lambda_{S,t+1} \bar{\pi}^{-1} \Big[r_t + \nu + (1-\nu)\Omega^B_{S,t+1} \Big] \right\} \tag{A.2}$$

$$\Omega^S_{S,t} = E_t \left\{ \Lambda_{S,t+1} \bar{\pi}^{-1} \Big[1 + (1-\nu)\Omega^S_{S,t+1} \Big] \right\}. \tag{A.3}$$

Under our benchmark assumption that savers have risk-neutral preferences, so that $\Lambda_{S,t+1} = \beta_S$ and $1 + r_t = \bar{\pi}\beta_S^{-1}$, we can guess and verify that these quantities are both equal to constants:

$$\Omega^B_{S,t} = 1 \qquad\qquad \Omega^S_{S,t} = \frac{1}{r+\nu}.$$

Substituting into the optimality condition, we obtain

$$s^{bond}_t = q^{bond}_t$$

so that the corporate bond spread is effectively exogenous.

Bank. The optimality conditions for the representative bank with respect to capital is

$$\mu_t = \eta_k k_t^{\zeta_B} \tag{A.4}$$

where μ_t is the multiplier on the capital requirement. The optimality condition for constrained debt issuance $B^*_{C,t}$ is

$$0 = -1 - \Xi_t + \Omega_{B,t} + s^{loan}_{C,t}\Omega_{S,t}$$

where $\Omega_{B,t}$ and $\Omega_{S,t}$ are defined as in (A.2) and (A.3), and Ξ_t represents the present and future cost of tightening the capital requirement. Intuitively, the $\Omega_{B,t}$ and $\Omega_{S,t}$ expressions are re-used because the saver's marginal value of an additional dollar of principal balance or additional dollar of promised spread payments is the same across both products, although the amount of spread payments promised per dollar of bank loan and corporate bond may differ.

The marginal holding cost term Ξ, after applying (A.4) above, is equal to

$$\Xi_t = \chi^B \eta_k k_t^{\zeta_B} + E_t \Big[\Lambda_{S,t+1} \bar{\pi}^{-1} (1-\nu) \Xi_{t+1} \Big].$$

Substituting for this term and applying (A.2) and (A.3) now yields

$$s_{C,t}^{loan} = \Omega_{S,t}^{-1}\left(1 + \Xi_t - \Omega_{B,t}\right) = (r + \nu)\Xi_t.$$

In the case $\nu = 1$ (short-term debt), this becomes

$$s_{C,t}^{loan} = (1 + r)\chi^B \eta_k k_t^{\zeta_B}.$$

Capital Producer. The optimality condition for a capital producer of type j is

$$\begin{aligned} Q_{j,t} &= \Phi'(i_{j,t})^{-1} \\ \bar{Q}_{j,t} &= Q_{j,t} + \frac{Q_{j,t}\Phi(i_{j,t}) - i_{j,t}}{1 - \delta} \end{aligned}$$

where $i_{j,t} \equiv I_{j,t}/K_{j,t-1}$. The difference between $Q_{j,t}$ and $\bar{Q}_{j,t}$ is second order and would disappear in a linearized solution.

B Institutional Setting

B.1 Accounting Classifications for Securities

This section provides additional information on the account classifications of bank securities.

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. Realized and 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. 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.[31] 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.

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

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 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.[32] 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).[33]

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 of book equity.[34]

For a very simple example, consider a bank buying a security at $100 and booking this

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[32] 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.

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

[34] 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.

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.

B.2 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.[35]

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

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

duration of their securities. Swaps also help a bank mitigate its balance sheet volatility. However, depending on whether such a hedge is declared as a designated accounting hedge or not, it can also mitigate 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. 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.[36]

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.

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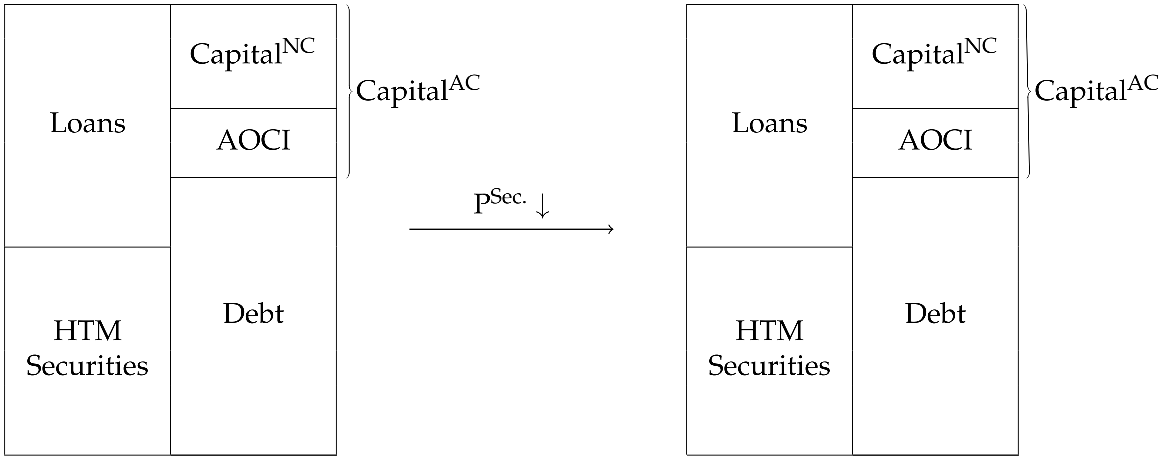
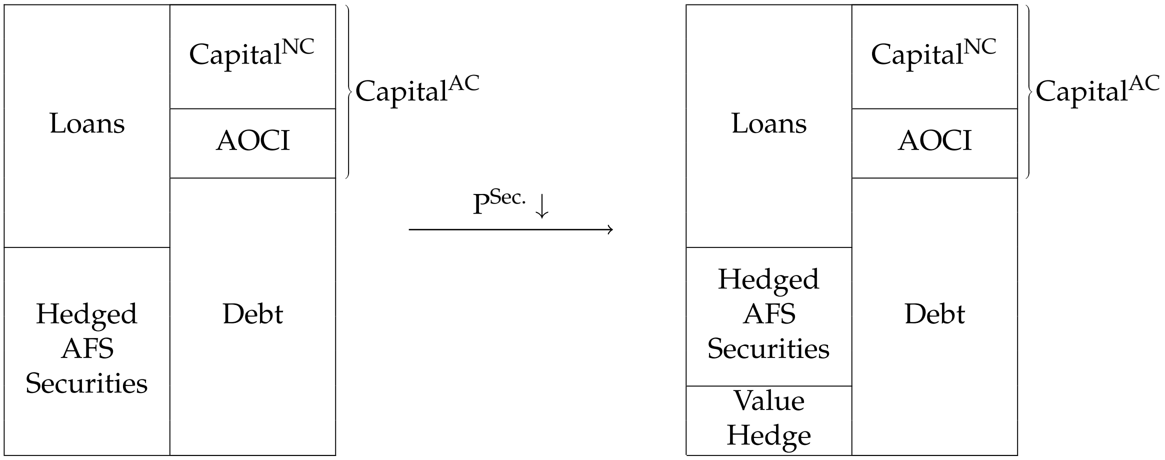
[36] See, for example, `https://www.federalreserve.gov/publications/files/2022-march-supervisory-stress-test-methodology.pdf`

Figure B.1: Accounting treatment for HTM Securities.



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

Figure B.2: Accounting treatment for hedged AFS Securities.



Notes: The figure 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.

C Security Reclassifications

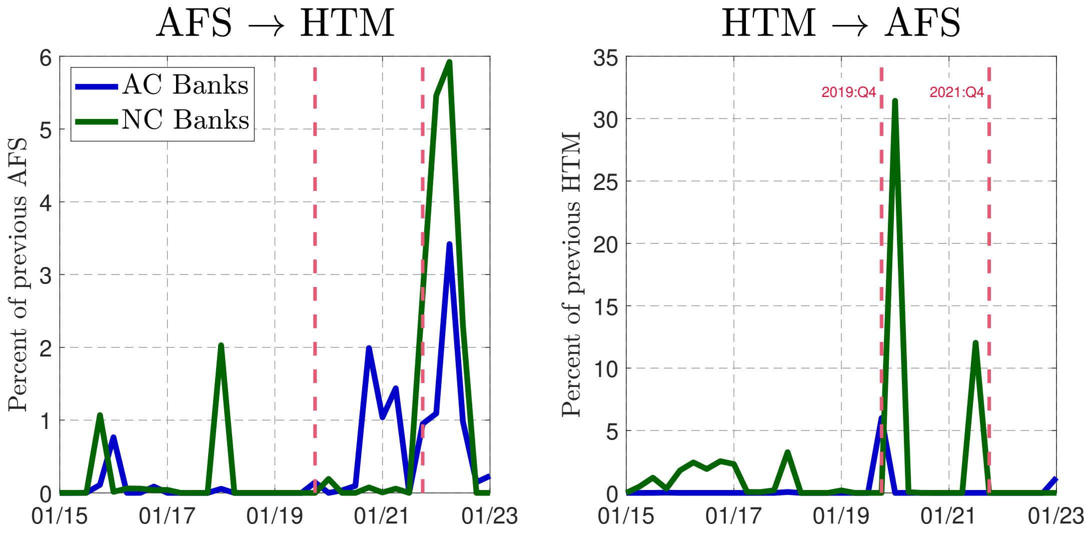
Accounting reclassifications are intended to be rare, but permissible under certain circumstances. Conditions under which a security holder can reclassify from HTM to AFS include (see ASC 320-10-25-6):

- 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 Data

Table D.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 D.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 D.3: FR Y-14Q B.1 & B.2 and Vendor Data Variable Definitions.

Variable Name	Description / Use	Schedule / Field No.
Unique Identifier	Unique ID used by BHC to identify each record over time	B.1/B.2
Identifier Value	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
Security duration	Effective rate duration at security level.	ICE

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 D.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 D.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
BHCAB530	AOCI
BHCAA223	Risk-weighted Assets

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.

E Sample Restrictions and Filtering Steps

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

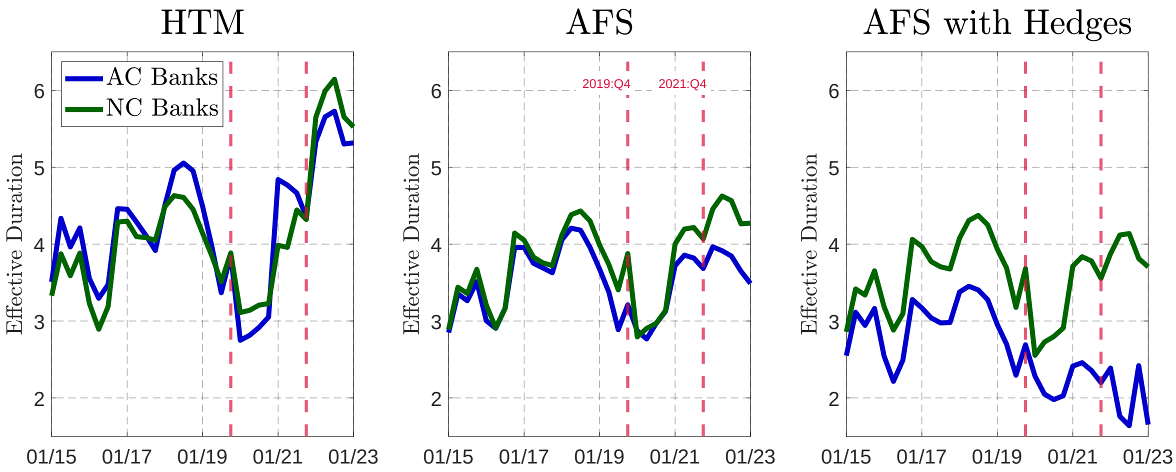
1. We constrain the sample to loan facilities with line reported on the HC-C schedule in the FR Y9-C filings as commercial and industrial loans, "other" loans, "other" leases, and owner-occupied commercial real estate (corresponding to Field No. 26 in the H.1 schedule of the Y14 to be equal to 4, 8, 9, or 10; see Table D.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.

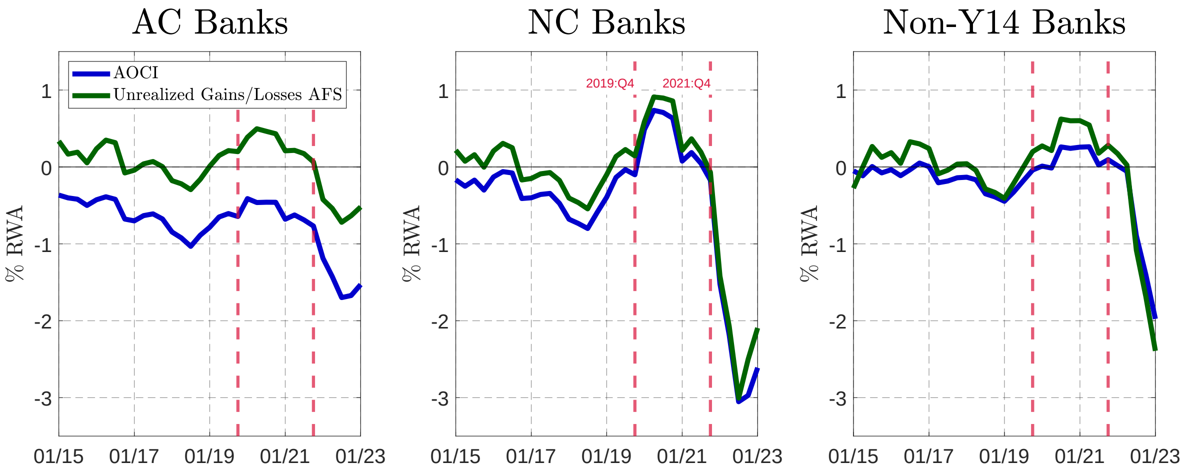
F Stylized Facts

Figure F.1: Duration of Securities Portfolios.



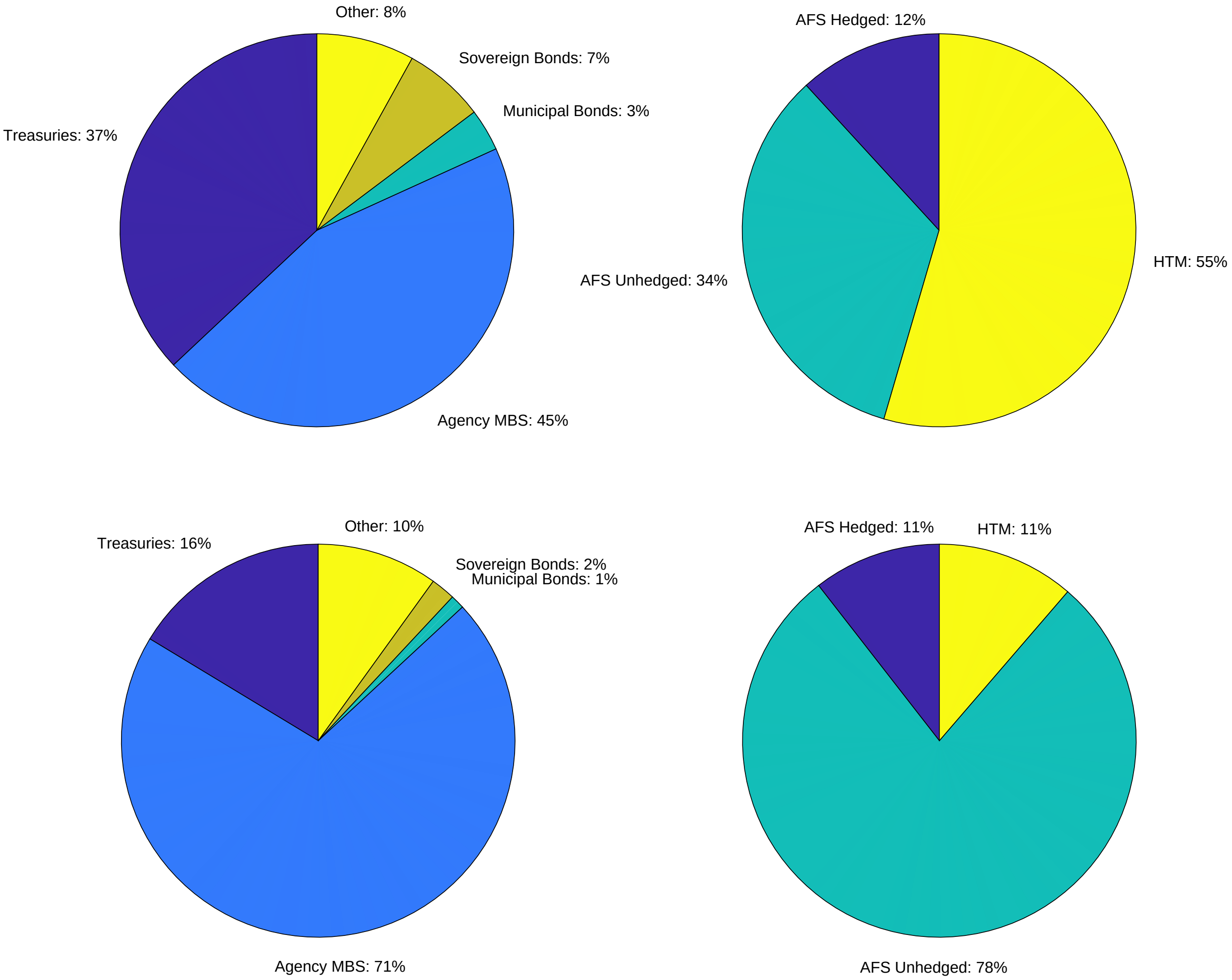
Notes: The graph shows the evolution of the effective duration of banks' HTM and AFS securities portfolios weighted by the market value of securities. The right panel takes into account that hedges shorten the maturity of AFS securities (i.e. a security that is fully hedged has a zero maturity).

Figure F.2: AOCI and Unrealized Gains/Losses AFS.



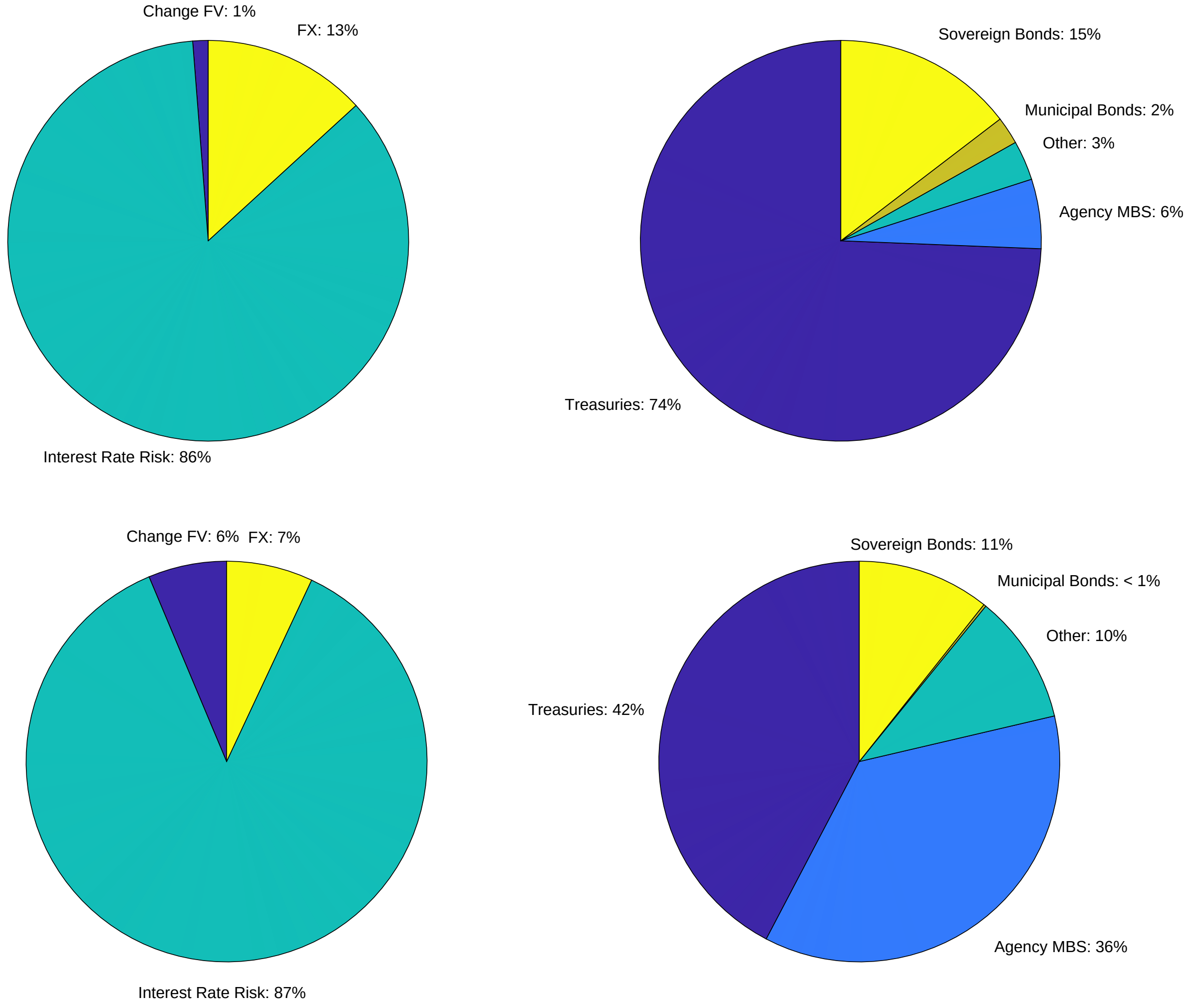
Notes: The graph shows the evolution of AOCI and unrealized gains/losses on AFS securities (both relative to risk-weighted assets) for AC banks (left panel), NC banks (middle), and non-Y14 banks (right). Source: Y-9C data.

Figure F.3: 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 F.4: 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.

G Credit Supply Effects

In this appendix, we explore extensions and test the robustness of our empirical findings in Section 6.

First, we consider alternative fixed effects specifications. Table G.2 omits the firm-time fixed effects and replaces those by variations of location-, size-, and industry-time fixed effects, which extends the sample to include firms that borrow from a single lender. Second, loans differ by contract terms such as maturity, whether they are adjustable- or fixed-rate loans, 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. Table G.3 shows the updated estimation results. For both extensions, our results are similar to our baseline estimates.

Third, we extend the sample to include bank-firm observations that also cover credit lines. Table G.4 shows that our results remain much the same for this extended sample. Fourth, 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 Table G.5. The findings for value changes of AFS securities remain the same for 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.

Fifth, we extend the sample backwards as far as possible to include periods of monetary easings. Table G.6 shows the updated results for the period 2016:Q4-2023:Q1. While our key findings remain, the coefficients reduce somewhat in magnitude. This comparison indicates that the effects are larger following a sharp unexpected monetary tightening as occurred in 2022. To further explore the possibility of asymmetric effects, we separate positive and negative AFS value changes in Table G.7. We find larger and statistically significant effects for negative AFS value changes, though we cannot reject that the estimates are different from the ones of positive AFS value changes at standard confidence levels.

Sixth, 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 Table G.8. The estimated coefficients β increase in magnitude and are even more precisely estimated, showing that such extensive margin adjustments further strengthen our findings.[37]

Seventh, we reestimate regression (6.1) for various horizons to portray the dynamic response of credit. Table G.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.

Eighth, we test whether the identified supply effects apply not only to credit quantities but also to interest rates charged on loans. Table G.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 that indicate the identification of supply adjustments. At the three-quarter horizon, the responses are statistically different from zero at the 5 percent confidence level. However, compared with the credit responses, the statistical significance is weaker overall.[38]

And, finally, we test for a pretrend 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). Table G.11 shows that our findings vanish for this alternative setup.

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[37] 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.

[38] We note that although this evidence supports a rise in interest rates, it is not strictly necessary since our model mechanism ultimately works through quantities, as constrained firms adjust other margins such as investment to offset credit lost due to crowding out. While crowding out occurs via credit spread increases in our model, it could also occur via credit rationing as in e.g., Stiglitz and Weiss (1981), with a smaller increase or no increase in spreads, due to information frictions not present in our model.

Table G.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 G.2: Omitting Firm-Time Fixed Effects.

	(i)	(ii)	(iii)	(iv)
Δ Value AFS	4.58**	6.09**	3.47**	5.45**
	(1.91)	(2.31)	(1.51)	(2.32)
Δ Value HTM			-4.59**	-3.15
			(2.05)	(2.04)
Fixed Effects				
Location × Size × Time	✓		✓	
Location × Size × Time × Industry		✓		✓
Bank & AC × Time	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓
R-squared	0.25	0.46	0.26	0.46
Observations	51,242	25,906	51,242	25,906
Number of Firms	12,544	7,719	12,544	7,719
Number of Banks	28	28	28	28

Notes: Estimation results for regression (6.1). Columns (i) and (iii) include location-size-time fixed effects based on U.S. states and percentiles of the total asset distribution and columns (ii) and (iv) include location-size-time-industry fixed effects, which additionally use 2-digit NAICS 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 G.3: 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). Column (i) shows the baseline estimate using firm-time fixed effects, column (ii) extends the fixed effects by whether the loan is syndicated, column (iii) by the loan's maturity based on three bins (less than one quarter, less than one year, and more than one year), column (iv) by whether the loan carries an adjustable or a floating rate, and column (v) uses all three additional characteristics. 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 G.4: 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 × Purpose		✓		✓
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 G.5: 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 × Purpose		✓		✓
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 G.6: 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 × Purpose		✓		✓
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 G.7: Asymmetric Effects.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Δ Value AFS (-)	3.38**	5.62***			3.24**	5.50***
	(1.49)	(1.63)			(1.48)	(1.60)
Δ Value AFS (+)			3.66	3.77	3.07	2.80
			(4.06)	(5.18)	(4.00)	(5.04)
Fixed Effects						
Firm × Time	✓		✓		✓	
Firm × Time × Purpose		✓		✓		✓
Bank & AC × Time	✓	✓	✓	✓	✓	✓
Bank Controls	✓	✓	✓	✓	✓	✓
R-squared	0.56	0.55	0.56	0.55	0.56	0.55
Observations	41,561	33,290	41,561	33,290	41,561	33,290
Number of Firms	2,303	1,897	2,303	1,897	2,303	1,897
Number of Banks	35	35	35	35	35	35

Notes: Estimation results for regression (6.1), separating positive and negative AFS value changes. All specifications include firm-time fixed effects that additionally vary by the loan purpose in columns (ii), (iv), and (vi). 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 G.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 × Purpose		✓		✓
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 G.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 G.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 $h = 1, 2, \ldots$. 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 G.11: 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 × Time	✓		✓	
Firm × Time × Purpose		✓		✓
Bank & AC × 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. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

H Mechanism

In this section, we further explore the mechanisms explaining our results and contrast them with alternative channels.

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

$$\frac{L_{i,j,t+2} - L_{i,j,t}}{0.5 \cdot (L_{i,j,t+2} + L_{i,j,t})} = \beta_1 \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} + \beta_2 \cdot \frac{\Delta Value^{AFS}_{j,t}}{Assets_{j,t}} \cdot Cap_{j,t} + \gamma X_{j,t} + \kappa_j + u_{i,j,t} \,, \tag{H.1}$$

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 (H.1) are reported in Table H.1. Across the vari-

Table H.1: Bank Capital Positions.

	(i)	(ii)	(iii)
Δ Value AFS	5.85 (4.51)	6.04 (4.90)	7.49 (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 (H.1). 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. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

ous 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, confirming a prediction 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.

Interest Rate Risk Channel. 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 of regression (6.1) that are summarized in Table H.2 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 D.5 for details). The estimation results with these additional controls are shown in column (ii) of Table H.2. If anything, our findings slightly strengthen in 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 with 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 H.2 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

Table H.2: 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. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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 into our baseline regression (6.1).[39]

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 $t+1$.[40]

Column (iv) of Table H.2 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.

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[39] We use banks' net income change as opposed to changes in the net interest margin to account for other non-interest income changes. However, the results are unaffected by this choice. They equally hold when controlling for changes of net interest margins instead.

[40] 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 D.5 for details).

I Effects at the Firm Level

Table I.1: Firm Level Effects - Credit Line Access.

	Δ Total Debt		Investment		Δ Cash	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Δ Value AFS	6.17**		5.31**		10.46**	
	(3.09)		(2.67)		(4.48)	
Δ Value AFS × No CL		6.81**		6.69**		10.85**
		(3.10)		(2.65)		(4.54)
Δ Value AFS × CL		-3.16		-16.49**		4.40
		(8.69)		(7.23)		(10.41)
Fixed Effects						
Firm	✓	✓	✓	✓	✓	✓
Time	✓	✓	✓	✓	✓	✓
Firm Controls	✓	✓	✓	✓	✓	✓
R-squared	0.73	0.73	0.72	0.72	0.66	0.66
Observations	69,934	69,934	82,472	82,472	81,900	81,900
Number of Firms	19,046	19,046	22,162	22,162	22,116	22,116
Number of Banks	29	29	30	30	30	30

Notes: Estimation results for regression (8.1) where $y_{i,t}$ is either total debt in columns (i) and (ii), fixed assets in columns (iii) and (iv), or cash holdings in columns (v) and (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 the set of all bank controls used in previous regressions and deposit and net income changes from column (iv) of Table H.2 aggregated to the firm level using debt shares across lenders. Columns (ii), (iv), and (vi) separate firms as to whether they have any unused credit line capacity in our data ("CL") or not ("No CL"). Standard errors in parentheses are clustered by firm. Sample: 2021:Q1 - 2023:Q1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.