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BOOK VALUE RISK MANAGEMENT OF BANKS:
LIMITED HEDGING, HTM ACCOUNTING, AND RISING INTEREST RATES

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ABSTRACT

In the face of rising interest rates in 2022, banks mitigated interest rate exposure of the accounting value of their assets but left the vast majority of their long-duration assets exposed to interest rate risk. Data from call reports and SEC filings shows that only 6% of U.S. banking assets used derivatives to hedge their interest rate risk, and even heavy users of derivatives left most assets unhedged. The banks most vulnerable to asset declines and solvency runs decreased existing hedges, focusing on short-term gains but risking further losses if rates rose. Instead of hedging the market value risk of bank asset declines, banks used accounting reclassification to diminish the impact of interest rate increases on book capital. Banks reclassified $1 trillion in securities as held-to-maturity (HTM) which insulated these assets book values from interest rate fluctuations. More vulnerable banks were more likely to reclassify. Extending Jiang et al.'s (2023) solvency bank run model, we show that capital regulation could address run risk by encouraging capital raising, but its effectiveness depends on the regulatory capital definitions and can by eroded by the use of HTM accounting. Including deposit franchise value in regulatory capital calculations without considering run risk could weaken capital regulation's ability to prevent runs. Our findings have implications for regulatory capital accounting and risk management practices in the banking sector.

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1. Introduction

In 2022 the Federal Reserve Bank responded to high inflation by increasing interest rates. This tightening led to large decline in the value of long-duration assets on bank balance sheets and exposed several hundred banks to risk of solvency runs (Jiang et al. 2023). Several runs took place including the failure of SVB bank, the largest bank failure since the Great Recession. This sequence of events raised significant questions about whether banks insured themselves against interest rate risk and about the potential loopholes in the current regulatory system that may have enabled banks to avoid doing so. However, the existing literature on the extent to which banks actively manage their exposure to interest rate risk is relatively limited.[2]

In this paper, we document several new findings on the limited extent to which banks hedged their asset interest rate exposure from the perspective of market values. We then show that banks instead decreased the interest rate sensitivity of the book value of their assets by changing securities accounting treatment, reclassifying then as held-to-maturity (HTM). This allowed banks to decrease the sensitivity of their regulatory (book) capital to interest rate increases. Then, building on the model of Jiang et al. (2023), we interpret these findings in a banking model featuring interest rate risk, solvency runs, bank capital regulation, recapitalization option, and accounting rules. We conclude by drawing some implications for the regulatory framework governing banks.

We assemble three complementary data sources to shed light on the scale and importance of banks' hedging activity. The first source is 10K and 10Q filings from SEC Edgar for all publicly traded bank holding companies comprising 258 banks in 2022 (including SVB and First Republic). Because hedging information is not reported consistently across banks, we hand collect and systematize the data. The second source is bank call report data. All FDIC-insured banks whose assets exceed the reporting threshold of $5 billion report the notional value of non-trading purpose interest rate swaps in their call reports. Thus, this data has the widest coverage, comprising almost 94% of all bank assets including private banks, but is limited to interest rate swaps. Last, we gather asset duration information from the 62 publicly traded banks that disclosed such data in their 2021 and 2022 10Ks. This allows us to measure the total exposure of banks' assets to interest rate risk, combining both asset risk as well as derivatives use.

We find very limited use of interest rate hedging, suggesting that even accounting for derivatives use, banks' assets were significantly exposed to interest rate risk at the end of 2021, prior to the monetary tightening. In the most comprehensive sample, over three quarters of all reporting banks reported no material use of interest rate swaps at the end of 2021, before the monetary tightening. Interest rate swap use is concentrated among larger banks who hedge a small amount of their assets. Swap users represent about three quarters of all bank assets, but on average, hedge only

[2] For assessments of U.S. banks' exposure to credit and interest rate risk in periods preceding our sample period and the 2022 monetary tightening episode see, among others, Begenau et al. (2015), Kelly et al. (2016), Drechsler et al. (2017, 2021), Egan et al. (2017), Atkeson et al. (2018), Begenau and Stafford (2019), and Xiao (2020).

four percent of their assets and about one quarter of their securities. We find similar results using broader measures of hedging from the 258 publicly traded (larger) banks. Over 60% of these banks do not report any hedges. The largest banks that do hedge, hedge only about 9% of their assets and less than one third of their securities. Overall, the largest banks hedge the most, but their hedges still leave the vast majority of their interest rate risk of assets unhedged.

The notion that banks' assets are exposed to considerable interest rate risk, even after accounting for their hedging strategies, is substantiated by the sample of 62 banks that disclose the duration of their total assets, including derivatives. With an average duration of 4.6 (and ignoring convexity) the implied losses for about two percentage point (p.p.) increase in the 10-year Treasury yield that occurred in our sample period would amount to 9.2 percent of asset value, totaling about $2 trillion in aggregate (considering that overall bank assets amount to $24 trillion). In other words, the use of hedging and other interest rate derivatives was not large enough to offset the vast majority of the loss in the value of U.S. banks' assets quantified by Jiang et al. (2023).

We find little evidence that the banks most at risk of asset declines or solvency runs were more likely to hedge interest rate risk prior to monetary tightening at the end of 2021. While banks more at risk were more likely to use some interest rate swaps, the amounts were small. Using more comprehensive hedging data from 10-Ks if anything we find that riskier banks hedged less than other banks prior to the monetary tightening. Overall, riskier banks such as SVB hedged interest rate risk to a broadly *similar degree* than other banks prior to interest rate increases.

We also show that riskier banks *decreased* the amount of hedging activity during the period of monetary tightening. A case study of the failed Silicon Valley Bank (SVB) is illustrative. SVB hedged about 12% of all securities at the end of 2021. By the end of 2022, they hedged only 0.4% of all securities. This may seem puzzling since standard risk management practice would predict the opposite. The sold hedges had been profitable because of interest rate increases but were insufficient to cover mounting losses on asset values. Selling profitable hedges allowed weak banks to increase current (accounting) profits, and at the same time take risks that would generate losses borne by the FDIC on the downside. These reductions in hedges by the banks with more fragile funding are suggestive of gambling for resurrection.

In the second part of the paper, we show that banks used an accounting treatment to insulate the book value of their assets from interest rate swings. In other words, while banks did very little to hedge the market value of their assets, they significantly decreased the sensitivity of their book asset values to interest rate risk.

Banks can classify the securities on their balance sheet as Available-for-Sale (AFS) or Held-to-Maturity (HTM). The book value of AFS securities must reflect their market value, so if the value of these securities declines as interest rates increases, then their book value reflects this decrease as well. Alternatively, banks can classify securities as HTM, declaring that they have both the intent and the ability to hold the securities until maturity. Then, banks can avoid recording unrealized mark-to-market losses in their balance sheets and statements of comprehensive income. As discussed in Jiang et al. (2023), the market value of long duration fixed income securities on bank balance sheets declined between 10% and 30% during 2022. Unless banks valued these securities using HTM accounting, their balance sheets and statements of comprehensive income would have to reflect these losses.

We document that banks extensively used HTM accounting prior to the monetary tightening, and further increased its use as interest rates started to rise. At the beginning of 2022, about one-third of the $6 trillion of securities held by commercial banks were valued using HTM accounting. Banks transferred almost $1 trillion of their existing AFS securities to HTM during 2021 and 2022, thus avoiding recognizing losses on these assets simply by using a new accounting label. By the end of 2022, the share of bank securities valued using HTM increased to 45%, or $2.75 trillion. Based on our estimation, U.S. banks were able to avoid recognizing $175 billion in losses due to these reclassifications at the end of 2022. Instead of hedging the market value of assets against interest rate risks, the banks actively sought to insulate the book value of their assets, regulatory capital, and statements of income from declining market prices.

We also document that the least healthy and least stable banks were more likely to reclassify securities to HTM. Banks with lower capital ratios, a higher share of run-prone uninsured depositors, and longer-duration securities were more inclined to reclassify securities from AFS to HTM during 2021 and 2022. For instance, only one percent of banks reclassified securities from AFS to HTM if they relied on uninsured deposits for less than 20% of their total deposit funding. In contrast, over ten percent of banks with uninsured deposits accounting for more than half of their deposit funding reclassified securities from AFS to HTM. These effects are particularly pronounced for banks financing longer-duration securities portfolios with a substantial share of run-prone uninsured deposits. These results suggest that weak banks used reclassification to obscure asset losses that resulted from interest rate increases. The extensive reclassification may also explain how risky banks managed to escape scrutiny from investors, depositors, and regulators. After all, SVB itself only failed in the first quarter of 2023 despite having unrealized losses that exceeded its common equity at least since the end of the third quarter of 2022.

One obvious question is why fragile banks were allowed to use the HTM classification even though that went against what was prescribed in the accounting standard. We find that banks audited by the reputed Big-4 auditing firms are not significantly less likely to reclassify securities from AFS to HTM. We also find some differences in reclassification rates across banks depending on their primary regulator. Specifically, banks that are solely supervised by national regulators and not supervised by state banking departments are less likely to reclassify securities even when we tightly match for differences in size across these types of banks and control for a host of factors that might affect reclassification rates. These findings offer suggestive evidence that stricter external scrutiny might lead to differences in the enforcement of HTM accounting rules. We conclude that a more robust enforcement of the existing HTM accounting rules may be necessary to prevent banks from utilizing the HTM classification to obscure the true state of their balance sheets.

Finally, we show that there is little connection between banks' limited use of interest rate hedging and HTM accounting. A potential regulatory impediment to hedging is that banks must not use hedge accounting for interest rate hedges that are meant to cover the risks of HTM securities though it can be used to hedge AFS securities. A "back-of-the-envelope" computation suggests that the accounting standards for hedging of fixed-rate instruments could not have been a binding constraint on most banks' decisions to hedge interest rate risk. As we document, the notional amount of hedging instruments account, on average, for less than 50% of the value of AFS securities held by large publicly listed banks. So, banks could double their hedging without running into the HTM constraint. Empirically, we find no statistical correlation between the share of securities classified as HTM and the ratio of interest rate swaps to assets used by banks. We also do not find a relationship between HTM reclassification and changes in banks' hedging activities. In sum, these findings suggest that hedge accounting is, at best, a convenient scapegoat for banks' low usage of derivatives covering interest rate risk.

Overall, our empirical findings suggest that banks did not hedge the vast majority of their interest rate exposure in terms of market values, but used HTM accounting and reclassification rules to insulate the book and regulatory value of their assets instead. This practice could potentially enable them to mitigate the impact of capital requirements. To understand this better we next develop a simple stylized framework. This allows us to interpret our findings and derive some implications for bank regulation.

We build on the solvency bank run model of Jiang et al. (2023) by incorporating bank capital requirements and the ability of bank shareholders to infuse additional capital. This extension enables us to examine how accounting rules influence the effectiveness of capital regulations in situations where risk-free interest rates increase. Our analysis includes exploring the potential for bank solvency runs and assessing the motivations of bank owners to either raise additional capital or proactively hedge their interest rate exposure. In doing so we shed light on how capital raising incentives – and capital regulation -- interacts with hedging actions as well as HTM accounting decisions taken by banks.

Our model yields several insights. First, we show that due to limited liability, bank equity holders may not want to eliminate run risk by recapitalizing or insuring part of their assets to interest rate risk. This is even if the bank equity value is positive in the good equilibrium (e.g., due to a high deposit franchise value). In that sense banks engage in "gambling for resurrection" type of behavior: underinsuring their assets and (or) not raising substantial amounts of capital hoping that the run equilibrium would not manifest itself. This insight is broadly consistent with our empirical findings showing that banks did not insure substantial portion of their interest rate risk exposure.

Second, bank capital regulation can eliminate run risk by providing banks with more incentives to raise capital, but it crucially depends on how regulatory capital is defined. Here, we adopt a broad perspective on regulatory capital, encompassing both explicit regulatory constraints and implicit constraints that could lead to interventions by regulators.[3] In this regard, our model shows that the option of HTM accounting can dilute the effects of capital regulation resulting in a positive run risk. This finding aligns with our empirical analysis, which reveals widespread usage of HTM accounting reclassifications during recent periods of monetary tightening by banks. According to our framework, such strategic actions may have been employed by banks to conceal the adverse effects of higher interest rates on the value of their assets, thereby reducing the imperative to raise additional capital to mitigate run risk.

Our model does not directly delve into the welfare implications of bank capital regulation, as such analysis goes beyond the scope of our simple stylized framework. Nonetheless, our framework offers several insights that could be pertinent in this context. First, our model presents a rationale for policy interventions in the banking sector. As we show in our framework and consistent with our empirical findings, due to limited liability, equity holders may lack sufficient incentives to forestall a bank run by raising additional capital, even if the equity value is highly valuable in the absence of a run. Moreover, if bank failures are socially costly, encompassing potential deadweight costs and negative externalities, it may be beneficial to incentivize bank equity holders to raise more capital (or insure their assets) beyond their privately optimal level. Our model suggests that achieving this objective could be facilitated by imposing capital requirements on banks.

Second, the efficacy of such regulation hinges on the precise definition of regulatory capital. If regulatory capital is defined based on the cost of assets and liabilities, it does not accomplish much in this regard as the book value would be invariant to changes in interest rates for a given composition of assets and liabilities. Our framework also implies including deposit franchise value in the absence of run in the regulatory capital calculation can weaken the effects of capital regulation on bank incentives to prevent run risk and bank insolvency. Recognizing that uninsured deposits are particularly runnable implies that the regulatory capital condition could involve the solvency run threshold developed by Jiang et al. (2023). This would ensure that banks have sufficient capital to withstand the uninsured depositor runs.

[3] We note that the influence of HTM accounting on banks' explicit regulatory capital is contingent upon the accounting standards adhered to by banks. Notably, banks have the option to employ the AOCI filter, which permits them to exclude unrealized losses in AFS securities from regulatory capital (Kim et al. 2019). Conversely, larger advanced approach banks are precluded from utilizing the AOCI filter, leaving them with asset migration to HTM as the sole recourse to mitigate the impacts of capital regulation. Our analysis adopts a comprehensive perspective on regulatory capital, encompassing both *explicit* and *implicit* capital constraints. For instance, if a bank experiences notable declines in asset value under AFS accounting, it could breach its explicit regulatory capital requirements. Furthermore, such reported declines in asset value might prompt regulatory intervention, even if they do not immediately impact reported regulatory capital.

Finally, our analysis shows that HTM accounting can dilute the effects of such capital regulation. It suggests that strengthening regulations governing the utilization of HTM accounting practices could enhance the effectiveness of bank capital requirements in mitigating the risk of bank runs.

Related Literature: Our paper is most closely related to Jiang et al. (2023) who develop a conceptual framework and an empirical methodology to analyze the effect of rising interest rates on the value of U.S. bank assets and bank stability. We contribute to their analysis by examining the strategies employed by banks to manage interest rate risk and showing that the vast majority of bank interest rate risk exposure they document was unhedged with derivative securities.

Our paper is also related to a vast literature on bank risk and specifically their interest rate risk management practices that we cannot fully cover here. Within this literature, Begenau et al. (2015), Kelly et al. (2016), Drechsler et al. (2017, 2021), Egan et al. (2017), Atkeson et al. (2018), Begenau and Stafford (2019), and Xiao (2020) provide recent assessments of U.S. banks' exposure to credit and interest rate risk in periods preceding the 2022 monetary tightening episode we focus on. A significant portion of prior research in this domain has concentrated on periods characterized by relatively low and stable interest rates. In contrast, we focus on a period marked by a substantial increase in interest rates and present evidence on both the use of derivative instruments and the accounting classification of bank asset holdings, both before and during the rise of rates. Finally, consistent with our findings, McPhail et al. (2023) also provide evidence that interest rate swap positions are not economically significant in hedging the interest rate risk of bank assets.

In our analysis, we have concentrated on examining banks' exposure to interest rate risk on the *asset side* of their operations. The established literature in banking highlights that banks operating in concentrated markets and possessing a robust deposit franchise may exhibit a slower response in increasing their deposit rates in reaction to rising interest rates. This slower response could enable them to generate positive returns on their deposits (e.g., Hannan and Berger 1991; Neumark and Sharpe 1992; Drechsler et al. 2017; Egan et al. 2017). Recently, Drechsler et al. (2021) contend that the deposit franchise offers hedging benefits, allowing banks to effectively engage in "*maturity transformation without an interest rate risk*." This suggests that banks, particularly those with a robust deposit franchise, may not find it necessary to hedge their exposure to interest rate risk on the asset side. However, as discussed earlier, Jiang et al. (2023) theoretically and empirically demonstrate that these deposit franchise benefits can be eroded precisely in situations where they would have been most valuable, due to "solvency runs." The critical factor in this context is the presence of a sufficient mass of uninsured depositors who may opt to withdraw their deposits due to concerns about bank solvency following monetary policy tightening. The decline in bank asset values following interest rate hikes can erode or completely unravel any hedging benefits associated with the deposit franchise, leading to solvency runs and a withdrawal of deposits from certain banks. As a result, banks are exposed to significant interest rate risk, and our findings, including their limited hedging of this risk and the reclassification of assets to HTM, are incongruent with strategies aimed at fundamentally addressing this risk.

Our paper is also connected to a broad accounting literature that we are unable to comprehensively cover here. Specifically, our work is closely related to the accounting literature on risk management practices and loss disclosure, such as the work of Bischof et al. (2021). They investigate banks' disclosures and loss recognition during the 2007-2009 financial crisis, demonstrating that, leading up to the Global Financial Crisis, banks' disclosures about relevant risk exposures were relatively sparse.

Finally, our work is also related to emerging body of work that addresses the 2023 regional banking crisis. In addition to the study by Jiang et al. (2023), other papers in this literature include, among others, the contributions by Cookson et al. (2023), Drechsler et al. (2023), Haddad et al. (2023), Jiang et al. (2023b), Flannery and Sorescu (2023), Gopalan and Granja (2024), Kim, Kim, and Ryan (2023), and Koont et al. (2023).

2. Background: Accounting for Hedges

We provide a brief overview of bank accounting for securities and derivatives, the two primary asset categories relevant in hedging transactions. We briefly address why book values of bank assets may not reflect asset values when these are held to maturity, and how hedging some assets may lead to additional fluctuations in earnings.

When banks report assets in their financial disclosures, two categories are relevant to hedging transactions: debt securities and derivatives. Debt securities can be classified at management discretion based on their intent as either available for sale ("AFS") or held to maturity ("HTM").[4] AFS securities can be sold at the bank discretion, and their value is marked to market (fair value) with unrealized gains and losses reported in "other comprehensive income." HTM assets are designated to be held to maturity, with the bank planning to collect the cash flows. HTM are recorded and held at cost, with differences between cost and fair value disclosed in footnotes. Hedging HTM securities would require banks to acknowledge changes in the value of these assets (which are held at cost) and reflect them directly on their income statement. This accounting treatment reduces banks' incentives to hedge HTM securities if they perceive such fluctuations in reported earnings as costly. Because AFS securities are marked to market, such accounting disincentives to their hedging do not exist.

Banks account for derivatives at their fair value with changes in their value over the year recorded in earnings. Management can instead elect "hedge accounting" with derivatives. This is the case if the derivatives hedge either fair value risk or cash flow risk of an asset. Broadly, interest rate swaps are classified as fair value hedges with offsetting gains and losses (from both the derivative and hedged item) accounted for in earnings.

[4] Debt securities can also be classified as "trading", a third classification that's typically relevant only for specific banking models, such as Credit Suisse.

The actual disclosures of hedges come with several complications, which somewhat complicate the computation of banks' hedging. Hedges need only be disclosed in footnotes for derivative instruments (and other transactions) that management assesses as "material". Disclosures must provide financial statement users an idea about the volume of derivative activity (e.g., notional dollar amounts), but there is variation across banks in the amount of detail that is disclosed. Moreover, not all derivatives (including swaps) are designated as hedges. Generally, there are categories of derivatives, "derivatives used for hedging", "derivatives not used for hedging", and "derivatives used for customer-related activities". Some of these derivatives will effectively serve as hedges for each other or other assets / liabilities of the bank. But they will not be designated as hedges for accounting purposes. This further complicates any accounting of bank hedging.

3. Data, Sample, and Measurement

We use multiple data sources to study the scale and importance of banks' hedging activity and use of HTM accounting. First, we employ bank call report data to obtain information on these activities. Banks whose total assets exceed $5 billion are required to report the notional value of interest rate swaps for non-trading purposes in Schedule RC-L. Some banks with assets below this $5 billion threshold also elect or are required by their primary federal regulators to report the notional amount of their non-trading interest rate swaps. In total, there are 1,271 banks reporting interest rate swaps. Table 1 shows that the group of banks reporting the notional value of their interest rate swaps comprise about 95% of the total assets in the banking system.

All banks must report information about the total amortized cost and fair value of securities classified as HTM or AFS at the end of each quarter. But no field in the call reports directly indicates the value of securities that banks decide to reclassify or relabel from the AFS to the HTM portfolio. Instead, the call reports provide a group of variables that collectively allow us to identify if a bank reclassified AFS securities from their AFS to the HTM portfolios and to reasonably estimate the value of all securities that a bank reclassified from the AFS to the HTM portfolio. Appendix B offers additional details about the procedure that we use to identify reclassifications from the call report data. Finally, we also use the regulatory call reports to compute other key bank characteristics used in the analysis such as a bank's capitalization and reliance on uninsured deposits.

We also collect information on banks' hedging activities and use of HTM accounting from 10-K and 10-Q filings that publicly traded bank holding companies submitted to the Securities and Exchange Commission (SEC) for fiscal years ending in 2021 and 2022. The main advantage of using this data source is that it enhances our ability to measure banks' hedging activities and their decisions to relabel AFS securities as HTM within the group of banks that file with the SEC. In particular, we broaden our measures of hedging activities by collecting information about banks' use of derivative instruments other than interest rate swaps to hedge interest rate risk. We also use banks' disclosures to measure the value of securities that banks reclassify or relabel from the AFS to the HTM portfolios. The information about hedging activities and reclassification of securities into HTM is not reported in a standardized format. We hand-collect this information from the notes to the consolidated financial statements and we standardize it to make it as comparable as possible across banks. Appendix B provides further details on the collection of these data sets. We link the 10-K and 10-Q filings to bank call reports using the CRSP-FRB link table provided by the Federal Reserve Bank of New York.

We use these data sources to compute multiple measures of banks' hedging activity. Using the call report sample, we examine the extensive margin of banks' hedging by creating an indicator variable for whether a bank reports any use of interest rate swaps for non-trading purposes. We examine the intensive margin of hedging activity by computing hedging ratios that evaluate the extent to which banks' assets are hedged. In particular, we use the notional value of the interest rate swaps of each reporting bank and divide it by total assets to obtain the main hedging ratio used in our analysis. We further compute alternative measures of hedging intensity that take the ratio between the notional amount of interest rate swaps and the total securities or total AFS securities held by each bank.

We complement our call-report based measures of hedging activity with additional measures of hedging intensity and exposure to interest rate risks based on hand-collected data from 10-K and 10-Q filings. In particular, we use banks' voluntary disclosures of the notional value of all derivative instruments that hedge interest rate risks to compute measures of hedging intensity. These measures capture hedging activities more broadly because they cover other hedging instruments such as futures, forward, or option contracts. We also lever this hand-collected data from the 10-K and 10-Q filings to obtain measures of the average duration of investment securities portfolios by the end of 2021 and 2022. Both samples cover the largest banks across the size distribution as we show in Figure A1. All large banks with assets above $5 billion are subject to the disclosure mandate that form the basis of call report data. Figure A1 shows that the largest bank holding companies in the US banking system are all publicly traded. As a result, our 10-K and 10-Q measures also cover a very large fraction of the assets in the banking system.

Finally, we compute measures that reflect banks' use of HTM accounting. Here, our focus is on learning about banks' deliberate decisions to reclassify securities that had been previously labeled as AFS. We compute both an indicator variable for whether a bank reclassified securities to HTM between 2021 and 2022 and a measure of the intensive margin of reclassification, which is the ratio between the value of reclassified securities and total assets. For large public banks and a few other banks that publicly disclose their annual reports, we compute these measures using hand-collected information from their 10-K, 10-Q, and annual report filings. For all other banks, we supplement these measures by using a group of variables in the call reports that collectively allow us to identify a reclassification of securities from AFS to HTM.

4. Banks' Use of Interest Rate Hedging prior to Monetary Tightening

4.1 Descriptive Evidence

We begin our empirical analysis by providing basic descriptive statistics about banks' use of interest rate hedges. In Table 1 and Figure 1, we show that few banks hedged their interest rate exposure prior to the monetary tightening. Only 290 of 1,271 banks report using interest rate swaps for non-trading purposes. Therefore, over three quarters of all reporting banks report no use of interest rate swaps. The predominant users of swaps are large banks, which also represent the majority of assets held at U.S. banks. Banks representing $17 trillion or 77% of all assets in the U.S. banking system report some use of interest rate swaps. But the notional amount of the interest rate swaps held by these banks represent, on average, only about four percent of their assets. Overall, about 94% of aggregate assets in the U.S. banking system are not hedged by interest rate swaps (Figure 1B). By contrast, Jiang et al. (2023) show in a calibration exercise that more than 70% of bank assets were exposed to interest rate risk over this time period. Even if we ignore loans and restrict our attention to securities, we find that the interest rate swaps of these banks cover, on average, only between one fifth to one fourth of the mark-to-market value decline in the value of their securities. In sum, the extent of hedging seems insufficient to significantly protect banks' balance sheets against the rise of interest rates.

Banks use derivative instruments other than interest rate swaps to hedge interest rate risk. In Table 1 and Figure 1A, we use information obtained from voluntary disclosures in 10-Ks and 10-Qs to provide further descriptive statistics about banks' hedging activities. These statistics consider all derivative instruments that banks use to hedge their interest rate risks. In this group of banks, over 60% do not report on hedging activities and only 62 banks report their duration. Among banks that choose to report hedging, banks below $250 billion in assets hedge about 5% of their total assets whereas banks whose assets exceed $250 billion hedge almost 9% of their total assets, or about 30% of their security holdings. In other words, even banks that choose to report their hedging activity do not hedge the interest rate exposure of most of their securities, let alone loans and other assets.

The idea that banks' assets are exposed to substantial interest rate risk after hedging is corroborated on the sample of 62 banks that report the duration of their total assets, including derivatives. With an average duration of 4.6 (and ignoring convexity) the implied losses for a two percentage points increase in the 10-year Treasury yield that occurred during the recent monetary tightening would add up to more than 9% of asset value. Jiang et al. (2023) find that marked-to-market bank assets declined by an average 10% across all banks during that period not accounting for risk hedges. This evidence further supports the notion that the size of banks' hedging activity was not large enough to offset most of the $2.2 trillion loss in the value of U.S. banks' assets.

Having not sufficiently hedged the value of their assets against the rise of interest rates prior to the monetary tightening, how did banks insulate their reported balance sheets from mounting losses in the value of their securities during the monetary tightening of 2022? The answer to this question possibly lies in the current accounting standards governing the valuation of securities. Banks can avoid recording unrealized mark-to-market losses in their balance sheets and statements of comprehensive income if they classify their securities as HTM. In Figure 2A, we show that in the beginning of 2022, only about one-third or about $2 trillion out of the $6 trillion of securities held by U.S. banks were valued using HTM accounting. This breakdown between AFS securities and HTM securities in the aggregate balance sheet of the banking system changed drastically during the monetary tightening period. By the end of 2022, U.S. banks still held approximately $6 trillion in securities but 45% of those securities, or $2.75 trillion were now valued using HTM accounting.

This large shift in the breakdown between AFS and HTM securities during 2022 indicates that banks actively sought to insulate their balance sheets and statements of comprehensive income from recognizing declining security prices during 2022. We show in Figure 2B that banks reclassified almost $1 trillion of their existing AFS securities to HTM during 2021 and 2022. These reclassifications fully account for the reallocation between AFS and HTM securities that occurred between 2021 and 2022 and allowed banks to avoid recording accounting losses on these assets simply by slapping a new label upon their existing securities. During 2021, U.S. banks reclassified about $220 billion in securities with JPMorgan Chase alone accounting for $104.5 billion of the total amount. The reclassification activity accelerated considerably as the Federal Reserve began raising interest rates during the first and second quarters of 2022 with banks reclassifying more than half a trillion of securities during these two quarters.

In Figure 3, we show that banks' deliberate actions to reclassify large swathes of their securities portfolios as HTM allowed them to avoid recording significant accounting losses. We estimate the amount of losses that banks avoided by reclassifying securities to HTM following the methodology in Jiang et al (2023). We obtain asset maturity and repricing data from the call reports and we use exchange-traded mortgage-backed securities and treasury indices to estimate the value of the securities that were transferred to the HTM category. Figure 3A shows that the estimated losses on reclassified securities increase steadily during 2022 and amounted to approximately $175 billion in the fourth quarter of 2022. To put this amount in perspective, we show that the CET1 capital (prior to adjustments) of the group of banks that reclassified securities was about $1.05 trillion at the end of 2022. The estimated losses on securities reclassified from AFS to HTM would wipe out more 15% of these banks' capital if these accounting losses were to impact regulatory capital. In Figure 3B, we show significant heterogeneity in the severity of these estimated losses as a percentage of each bank's CET1 capital at the end of 2022. The estimated "hidden" losses account, on average, for 20% of the CET1 capital of reclassifying banks. But for more than ten percent of reclassifying banks, we estimate that they avoided recognizing losses representing more than half of their equity capital.

5. Cross-sectional Evidence: Hedging prior to Monetary Tightening

We find that U.S. banks hedge only a small fraction of their asset exposure to interest rate risk. It is nonetheless possible that the most fragile banks could have had incentives to make their balance sheets more resilient by hedging a greater portion of their assets prior to the monetary tightening.

We find little evidence that banks whose assets were most exposed to interest rate risk or whose liabilities were most fragile hedged a much larger fraction of their assets at the end of 2021. In Figures 4, 5, and 6, we split our call report sample into twenty equal-sized bins based on different measures of interest rate risk exposure. In Figure 4, we explore how the extensive margin of hedging varies across measures of capitalization (Figure 4A), reliance on uninsured deposits as a measure of deposit fragility (Figure 4B), and the share of long-term securities as a measure of exposure to interest rate risks (Figure 4C). Figure 4A indicates that banks with lower levels of capitalization, specifically those with lower Equity to Asset ratios, were slightly more inclined to hedge at least some of their assets. Figures 4B and 4C suggests that banks relying more heavily on uninsured deposits and holding a greater share of long-term securities were more likely to hedge at least some of their assets. But when we focus on the relation between these measures of bank fragility and the intensive margin of hedging in Figure 5, we find that, conditional on hedging at least some assets, banks hedge a very small percentage of their assets and that this hedging intensity, though related to their risk exposure, is not economically meaningful.

In Figure 6, we examine the composite effect and find that banks with lower capitalization, that rely more on uninsured deposits, and whose assets were more vulnerable to rising interest rates did not hedge a significantly larger proportion of their assets than other banks. The interest rate swaps of the group of banks with the most uninsured leverage cover, on average, less than 2.5% of their assets whereas swaps account for about 1.5 percent of assets for the group of banks with median uninsured leverage. The difference between the hedging intensity of the group of banks with the most fragile deposit structure and that of other banks is, therefore, economically small and driven almost entirely by differences in the extensive margin. We find similar results when we turn our attention to the hedging data voluntarily disclosed by public bank holding companies in their SEC filings. In Figure 7, we find a weak negative relation between bank capitalization and hedging (Figure 7A). Moreover, in this subsample, we find that banks with stronger reliance on uninsured deposits and stronger asset exposures to interest rate risks hedge substantially less (Figures 7B and 7C).

Overall, our cross-sectional evidence about banks' use of hedging is quite noisy but it generally does not indicate a clear and economically meaningful relationship between our measures of interest rate exposure and banks' hedging activities before the monetary tightening. A potential explanation for the absence of a strong positive relationship between exposure to interest rate risk and hedging activity could be that banks with large interest rate risk exposures classified a larger fraction of their assets as HTM. The banks that are most exposed to interest rate risks may lack incentives to hedge if they use the HTM classification on most of their securities. Their balance sheets and measures of accounting income would already be insulated from declines in security values and any hedges of the interest rate risk of these securities would not qualify for hedge accounting under current accounting standards.

Figure 8 shows that, if anything, there is a negative relation between exposure to interest rate risk and use of HTM accounting prior to the monetary tightening. Figures 8A and 8B show that weakly capitalized banks and banks with greater reliance on uninsured deposits classified a smaller fraction of their assets as HTM. The results of Figure 8C are more ambiguous and point to weak relation between asset exposure to interest rate risks and the share of securities classified as HTM prior to the monetary tightening.

In summary, the results in this section suggest that banks hedged only a minor portion of the assets exposed to interest rate risks, and the fraction of assets hedged did not exhibit a strong and economically meaningful relation with their interest rate risk exposure before monetary tightening. We also do not find evidence consistent with the idea that banks most exposed to interest rate risks did not hedge against these risks because they valued more of their securities using HTM accounting.

6. Gambling for Resurrection during the Monetary Tightening of 2022

6.1 Changes in Hedging Behavior

Next, we document how banks adjusted their hedging activities during the period of monetary tightening. A case study of the recently failed Silicon Valley Bank (SVB) is illustrative. SVB hedged about 12% of all its securities at the end of 2021. By the end of 2022, it had reduced these hedges to 0.4%. In other words, as interest rates rose, SVB reduced its hedging of interest rate risk. Because these hedges had gone up in value, selling or removing them was seen as an opportunity to record accounting profits. On the other hand, selling hedges increased the duration of its asset from 3.7 to 5.6 years, exposing the bank to significant additional losses if interest rates increased any further as they did. In other words, SVB traded off increasing current accounting profits for more exposure to interest rate risk. Given that the bank would have collected the profits had the rates declined, but the FDIC would absorb losses if SVB failed, this action by SVB is reminiscent of a classic “gambling for resurrection”.

We show that the case of SVB was not an exception. As Figure 9 shows, more than a quarter of the publicly traded banks that reported hedging derivatives experienced declines in various hedging ratios. We divide all publicly traded banks that reported hedging derivatives into four groups based on their hedging ratio adjustments from 2021:Q4 to 2022:Q4. The bottom (top) quartile includes banks that experienced the largest decline (increase) in their hedging ratios. We then plot the evolution of average hedging ratios in each group over the course of 2022. For banks in the bottom quartile, the share of total assets that are covered by hedging derivatives declined by about 3 percentage points (p.p.) from 2021:Q4 to 2022:Q4 (Figure 9A). This is a large change. The best way to observe this is to look at the decline in hedging derivatives scaled by total securities or AFS securities. Banks in the bottom quartile see a decline in hedging ratios by -30 p.p. and -40 p.p., respectively (Figure 9B and 9C).

We next dig deeper into the heterogeneity across banks. Selling (or closing) hedges during 2022 was more likely for banks with fragile funding structures. On the liabilities side, banks with a higher uninsured leverage, i.e., more fragile funding, were more likely to sell (or close) hedges (Figure 10A). The magnitude is substantial, with swap coverage decreasing by several percentage points of assets. Banks with lower capitalization also reduced their hedging intensity to a greater extent than other banks (Figure 10B). On the asset side, we show that banks with greater ex-ante exposures to interest rate risk through their holdings of long-term securities decreased their use of interest rate swaps to a greater extent than other banks (Figure 10C).

We find a similar pattern of reduced hedges when examining the overall duration of bank assets for the limited set of banks that reported this information (including SVB). During 2022, these banks increased the duration of their assets from 4.6 to 5.1 (Figure 11A). The duration increases were largest for banks with the highest uninsured leverage such as SVB, although the SVB case was extreme even among banks with very fragile funding (Figure 11B). In other words, one might imagine that banks, which were more exposed to solvency runs would have mitigated those runs by increasing their hedging. Instead, they sold or reduced their hedges, recorded an accounting profit, but exposed themselves to more interest rate risk. Changes in hedging among these banks suggests that SVB was likely not the only bank potentially engaged in gambling for resurrection.

6.2 Reclassification of Securities to the HTM category

The evidence presented thus far begs the question of how these fragile banks escaped outside scrutiny that would expose their deteriorating capital positions. We argue that the accounting rules governing the valuation of securities and, in particular, the use of the HTM accounting to value securities at least partly explains why banks were able to avoid significant pushback from investors, regulators, and other stakeholders. Again, the case of SVB is illustrative of the forces at play. At the end of 2021, SVB held $125 billion in securities out of which 78% or $98 billion were valued using HTM accounting. By the end of the second quarter of 2022, SVB had unrealized losses of $10 billion on these HTM securities and at the end of the third quarter these losses had escalated to $16 billion. These unrealized losses remained unrecognized in the financial statements of SVB and, at the end of the third quarter of 2023, amounted to the entire common equity tier 1 capital of SVB. Because of HTM accounting, SVB did not have to adjust the value of these securities in their balance sheet and financial statements at any point during 2022 and it was not until the first quarter of 2023 that swirling concerns about SVB's financial condition precipitated a massive run (e.g., Cookson et al., 2023) that led to its inevitable demise.

Most banks did not use the HTM classification to the same extent as SVB. But as we have shown previously, U.S. banks collectively reclassified almost $1 trillion dollars in securities to the HTM category effectively insulating U.S. banks from recording estimated losses of $175 billion in their balance sheets. In this section, we ask whether these reclassifications were operated mostly by strong banks that had both the intent and ability to hold these securities until their maturity or if, on the contrary, reclassifications of AFS securities into HTM were predominantly made by fragile banks that purposefully wanted to "hide" the impact that potential losses would have on their already-frail balance sheets.

We explore the relationship between measures of exposure to interest rate risk and banks' proclivity to reclassify securities from AFS to HTM in Figure 12. Figure 12A shows a strong negative relation between levels of regulatory capital and the propensity to reclassify assets from AFS to HTM. Similarly, Figure 12B indicates a strong positive relation between the banks' exposure to interest rate risks through their holdings of long-duration assets and the propensity to transfer assets from AFS to HTM. Figure 12C repeats the analysis using the share of uninsured deposits at the bank as a measure of fragile deposit funding. The plot shows that banks with greater reliance on run-prone uninsured depositors were also more likely to reclassify securities to HTM during 2021 and 2022. Finally in Figure 12D, we repeat the analysis in Figure 12C after splitting the sample between below- and above-median share of long-term securities. The idea is to assess whether banks that are more exposed to interest rate risk and are also financed primarily by run-prone uninsured depositors are incrementally more likely to transfer assets from AFS to HTM. We find a significantly stronger association between the significance of uninsured deposits in bank funding and asset reclassification when banks have significant asset exposures to interest rate risks. Overall, the results of Figure 12 strongly indicate that more fragile banks were more likely to reclassify securities from AFS to HTM during this period.

We further probe the relation between these bank characteristics and their decisions to transfer securities from AFS to HTM in Table 2. We estimate cross-sectional regressions in which the dependent variable is a dummy variable that takes the value of one if the bank reclassified securities from AFS to HTM during 2021 and 2022 and the main variables of interest are the measures of capitalization, less stable funding, and exposure to interest rate risk. We also include asset percentile dummies to control non-parametrically for the impact of bank size. We cluster standard errors at the level of the bank's state headquarters.

The results in Table 2 further support the idea that more fragile banks were also more likely to reclassify securities from AFS to HTM. Column (1) indicates that a one-standard deviation increase in the capital ratio is associated with a 7 p.p. lower likelihood of reclassification. The results of Column (2) suggest that a bank that is 100% financed by uninsured deposits would be 8.6 p.p. more likely to reclassify securities into HTM than a bank with no uninsured deposits. In Column (3), the results show that banks with higher exposure to interest rate risks through their holdings of high-duration longer term securities are also significantly more likely to reclassify assets. Column (4) shows that the interaction between the exposure to run-prone depositors and the exposure to interest rate risk matters. Banks with a high share of exposure to uninsured deposits are incrementally more likely to reclassify if they also have greater exposures to longer-term securities. In Column (5), we show that that the explanatory power of each of these variables is not subsumed when we include them together in a multivariate specification and when we add additional controls for the ratio of securities to total assets in each bank and for the percentage of securities that is classified as AFS at the beginning of 2021. In Panel B, we use as dependent variable a measure of the percentage of securities that each bank reclassified to the HTM securities between 2021 and 2022. We find similar results when we use this measure that takes into account the intensive margin of asset reclassification.

7 Regulatory Framework and Gambling for Resurrection

The evidence presented above suggests that the least healthy and stable banks engaged in a series of actions resembling gambling for resurrection. This underscores crucial questions about the effectiveness of the current regulatory framework and its enforcement in either curbing or facilitating such behavior. In the following analysis, we delve into these questions, aiming to draw some implications for the bank regulatory framework.

The demise of SVB put the accounting rules governing the valuation of government bonds and mortgage-backed securities under the microscope. The rationale for HTM accounting is that if a bank holds a security until its maturity, then the short-term dislocations between the book and market value of the securities eventually wash out. The critical requisite that the accounting standards impose for using HTM accounting is that banks declare that they have both the intent and the ability to hold the securities until they mature such that the bank does not have to close the position at a significant accounting loss. Otherwise, banks must value their securities using AFS accounting, which forces them to mark the securities in their balance sheets using current market prices and to recognize unrealized losses on those securities in their statements of comprehensive income. With the benefit of hindsight, it is clear that SVB might have had the intent but did not have the ability to hold these securities until their maturity.

The HTM accounting rules do not appear to have been strongly enforced since the letter and spirit of these rules seem to be in direct conflict with our empirical evidence that the banks least able to hold these securities until maturity were the ones that were most likely to reclassify large chunks of their portfolios to HTM. Put differently, bank auditors and supervisors likely failed to properly evaluate the reasonableness of banks' claims that they had the ability to hold these reclassified securities until their maturity.

We investigate whether there are differences in the likelihood that a bank reclassifies securities depending on their auditors and primary bank supervisors. In particular, we examine if banks audited by the reputed Big-4 auditing firms (Deloitte & Touche, Ernst & Young, KPMG, and PriceWaterHouseCoopers) were less likely to transfer securities than banks audited by other firms. We also examine if banks were more or less likely to reclassify securities to HTM depending on the identity of their primary bank regulator. Agarwal et al. (2014) and Granja and Leuz (2023) document significant differences in accounting scrutiny across regulators. We follow these studies in asking whether banks were less likely to reclassify securities if they were supervised by the Office of the Comptroller of the Currency (OCC) rather than by state banking departments.

In Table 3 we estimate cross-sectional regressions (similar to Table 2) in which the main variables of interest are dummy variables that indicate whether the bank was audited by a Big-4 auditing firm and whether the bank's primary regulator was the OCC, FDIC, or Federal Reserve. In Columns (5)-(8), we implement a matching procedure based on Iacus et al. (2012) to ensure covariate balance in terms of the size and percentage of securities held across banks with and without a Big-4 auditor and across banks with different primary regulators. However, we note that the results of this empirical exercise should be interpreted with caution, as the selection of a private auditor and primary regulator could be highly endogenous. This endogeneity may be driven by unobservable characteristics that could be related to the banks' willingness to comply with accounting standards.

The results of Table 3 indicate that Big-4 audited banks are not statistically less likely to reclassify securities during 2021 and 2022. Consistent with the idea that the OCC-regulated banks are more strictly supervised than state-regulated banks, we find that OCC-banks are significantly less likely to reclassify securities. The results are consistent with the idea that even the most reputed private auditors did not curb banks' efforts to transfer securities from AFS to HTM in order to avoid recognizing accounting losses. That the OCC-supervised banks were less likely to reclassify securities is, however, suggestive that stricter enforcement of accounting standards resulted in fewer reclassifications.

Another important outstanding question about the recent crisis is whether existing regulations weakened or constrained banks' incentives to protect their balance sheets against interest rate risks. Here too, accounting standards were blamed for weakening incentives to hedge these risks. The reason is that the rules for hedge accounting state that a derivative instrument only qualifies for hedge accounting if the underlying securities are marked-to-market in banks' balance sheets and statements of income (ASC 815-20-25-12(d), 15(f), -42(c)(2), and -43(d)(2)). If a security is classified as HTM, then its hedge does not classify for hedge accounting because changes in the value of the derivative would not be offsetting any mark-to-market fluctuations in the balance sheet valuation of the underlying security. Put differently, the notion of hedging the interest rate risk in a security classified as held-to-maturity is inconsistent with the held-to-maturity classification.

We investigate whether the use (and abuse) of the HTM classification represented an obstacle to banks' hedging activities and could at least partly explain why banks hedged such a small fraction of their assets. A quick "back-of-the-envelope" computation suggests that the accounting standards for hedging of fixed-rate instruments could not have been a binding constraint on most banks' decisions to hedge interest rate risk. After all, we show in Table 1 that the notional amount of hedging instruments account, on average, for less than 50% of the value of AFS securities held by large publicly listed banks. We nevertheless examine more formally if HTM accounting likely weakened incentives for banks to hedge their interest rate risks. In particular, we (i) use cross-sectional variation to assess if banks that classify a larger share of their securities as HTM hedge a relatively smaller fraction of their assets, (ii) use within-bank variation to examine whether changes in the share of securities classified as HTM is associated with a decline in the share of a bank's assets protected by hedges, and (iii) examine if reclassifications of securities from AFS to HTM forces banks to remove or sell hedges on securities.

We present the results of this analysis in Table 4. The results consistently suggest that the share of securities classified as HTM is statistically unrelated to the ratio of interest rate swaps to assets used by banks. We find a null-result regardless of whether we use cross-sectional variation in the share of HTM securities used by banks, within-bank changes in the share of assets classified as HTM, or changes in the share of assets classified as HTM that are induced by accounting reclassification of securities from AFS to HTM. Overall, our findings suggest that hedge accounting is, at best, a convenient scapegoat for banks' low usage of derivatives covering interest rate risk.

8. A Stylized Banking Framework with Interest Rate Risk, Capital Regulation, HTM Accounting, and Recapitalization Option

Our findings suggest that banks did not hedge the vast majority of their interest rate exposure and utilized HTM accounting rules to conceal asset-side losses. This practice could potentially enable them to mitigate the impact of explicit and implicit capital requirements. In this section, we present a simple stylized framework to interpret these findings and derive some implications for bank regulation. In order to do so, we build on the solvency bank run model of Jiang et al. (2023) by incorporating bank capital requirements and the ability of bank shareholders to infuse additional capital. This extension enables us to examine how accounting rules influence the effectiveness of capital regulations in situations where risk-free interest rates increase. Our analysis includes exploring the potential for bank solvency runs and assessing the motivations of bank owners to either raise additional capital or proactively hedge their interest rate exposure. In doing so we shed light on how capital raising incentives – and capital regulation -- interacts with hedging actions as well as HTM accounting decisions taken by banks.

8.1 Setup

A bank has long-dated assets and liabilities (deposits) in place. For simplicity we consider the initial bank asset and liability structure as given.

8.1.1 Bank Assets and Liabilities

Assets: Bank assets are normalized to a historical cost value of 1. They are invested in risk-free liquid perpetuities (e.g., T-bonds with infinite maturity) with an average coupon of r. The assets are completely liquid: the bank can always sell them at their present value of coupons discounted at the risk-free rate. At the risk-free rate r_f, the market value of bank assets is given by $\frac{r}{r_f}$.

Liabilities: The bank's existing liabilities comprise deposits with face value d. The bank therefore has (book) capital $e_b = 1 - d$. Existing depositors can keep their deposits with the bank or withdraw them to invest in outside goods such as a money market fund or deposits at other banks, which earn $\mu(r_f) < r_f$. The external rate increases in the risk-free rate $1 > \mu'(r_f) > 0$. On the other hand, if the bank fails, depositors realize a flow cost of failure $\nu_f > r_f$; in other words, prevailing rates do not compensate depositors if they think the bank will fail for sure. This payoff structure captures the idea that depositors are willing to pay to obtain deposit services and want to use these services if the bank is sound, but depositors prefer to withdraw their funds to keeping them in the bank, if the bank will fail. In this setting, banks have market power in the deposit market, which may give rise to franchise value.[5]

8.1.2 Capital Regulation and Accounting Rules

Banks are subject to capital regulation. Regulatory capital ratio e_r is tied to the market value of assets except for assets classified as hold-to-maturity (HTM) that are valued at their book value. Banks' regulatory capital needs to be at or above the regulatory limit $\bar{e}$, otherwise the regulators will intervene. We assume that $1 - d \geq \bar{e}$ meaning that the book value of bank capital is above the regulatory limit. If the bank classifies a share of its assets as the HTM assets, then its regulatory capital equals to:

$$e_r = \boldsymbol{a}(1) + (1 - \boldsymbol{a})\left(\frac{r}{r_f}\right) - d \qquad (1)$$

This calculation can reflect either the explicit regulatory capital assessments or the implied level of bank capital based on the reported value of banks' assets that regulators consider in their decisions. If the regulatory capital ratio is below the capital requirement, $\bar{e}$, the bank is required to raise new equity capital or cease operation in which case the shareholders receive nothing (zero value). To classify one unit of assets to HTM accounting has a cost θ.

8.1.3 Timing

The timing is as follows:

- Bank starts with a given asset and liability structure summarized by (d, r).
- Interest rate r_f is realized for a distribution of $F(r_f)$. For simplicity we assume that the realization of r_f is an absorbing state.

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[5] See, among others, Hannan and Berger (1991), Neumark and Sharpe (1992), Drechsler et al. (2017), and Egan et al. (2017), and Wang et al. (2022) for evidence of bank market power in the deposit market.

- Given the realization of r_f, the bank equity holders that maximize the value of bank equity, decide whether to raise additional equity in the form of cash and what fraction of the bank's assets to re-classify as HTM.
- Depositors assess banks' solvency condition and decide whether to withdraw their deposits.

8.2 Structure of Market Equilibrium without Recapitalization

As a benchmark we first consider the case analyzed in Jiang et al. (2023) without additional capital injections and where we assume that absent of a bank run, the bank meets the regulatory capital constraint.

As shown in Jiang et al (2023), we have the following equilibrium structure:

(i) If $\frac{r}{r_f} - d \geq 0$, there is no possibility of a bank run. In this case the market value of equity equals $e_m^{No\ Run} = \frac{r}{r_f} - d\left[\frac{\mu(r_f)}{r_f}\right]$.

(ii) If $\frac{r}{r_f} - d < 0$ and $e_m^{No\ Run} = \frac{r}{r_f} - d\left[\frac{\mu(r_f)}{r_f}\right] \geq 0$ two possible equilibria exist: a no run equilibrium when the market value of equity is $e_m^{No\ Run}$ and a run equilibrium when the market value of equity is zero.

(iii) If $\frac{r}{r_f} - d\left[\frac{\mu(r_f)}{r_f}\right] < 0$ the only equilibrium is the bank being insolvent, and the equity value is zero.

In our analysis that follows, our attention will focus on the instances of r_f realizations that fulfill the two conditions outlined in (ii). Specifically, this implies that in the absence of the run, the market value of bank equity remains positive, yet the equilibrium with the solvency bank run is also plausible.

8.3 Structure of Market Equilibrium with Recapitalization

Next, we explore the scenario in which the bank is permitted to raise additional equity, but we still do not consider the capital regulation.

Observing the risk-free rate r_f, the bank decides whether to raise additional equity to eliminate the run-risk. As shown in Jiang et al (2023), a run equilibrium is supported if the market value of equity conditional on depositor run is negative, i.e., if $\frac{r}{r_f} - d < 0$. If a run equilibrium is supported, we assume that there is an ϵ likelihood of depositor run, which is zero otherwise.[6]

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[6] It is straightforward to extend our framework to study the bank incentives to raise capital in relation to their initial capitalization and duration of their assets by formally separating the bank's assets into cash and long-term assets, as in Jiang et al. (2023). Banks with longer duration assets will be more susceptible to bank runs. We could also incorporate the mix of uninsured/insured deposits into our framework, as in Jiang et al. (2023). In this extension, banks

To eliminate the run risk, the bank needs to raise at least $\left(d - \frac{r}{r_f}\right)$ of capital, which it will hold in the form of zero duration cash. We assume that it costs the existing shareholders τ to raise a dollar of external equity in addition to issuing an equity claim against the new capital.

Without capital regulation, the bank's shareholders inject new equity if the net value of equity after recapitalization to existing shareholders exceeds the value from no capital injection:

$$\underbrace{\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f} + \left(d - \frac{r}{r_f}\right)}_{Equity\ value\ after\ recapitalization} - \underbrace{(1+\tau)\left(d - \frac{r}{r_f}\right)}_{Recapitalization\ cost} > \underbrace{(1-\epsilon)\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) + \epsilon \times 0}_{Equity\ value\ absent\ recapitalization} \quad (2)$$

In other words, the bank raises additional equity capital if the expected benefit of saving the deposit franchise exceeds the net cost borne by shareholders:

$$\underbrace{\epsilon\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right)}_{Benefit} > \underbrace{\tau\left(d - \frac{r}{r_f}\right)}_{Cost} \quad \Rightarrow \frac{r}{r_f} - d\frac{\mu(r_f)}{r_f} > \frac{\tau}{\epsilon}\left(d - \frac{r}{r_f}\right) \quad (3)$$

To comprehend the impact of the bank's limited liability on equity-raising incentives, let's explore a scenario where there is no limited liability (and no deposit insurance). In this case, during a bank run, equity holders are obligated to fully compensate all depositors, which costs them the deposit shortfall of $\left(\frac{r}{r_f} - d\right)$. In this case the condition (2) becomes:

$$\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f} - \tau\left(d - \frac{r}{r_f}\right) > \underbrace{(1-\epsilon)\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) + \boldsymbol{\epsilon} \times \left(\frac{r}{r_f} - d\right)}_{Equity\ value\ absent\ recapitalization\ and\ with\ no\ limited\ liability} \quad (4)$$

which translates into the following condition:

$$d - d\frac{\mu(r_f)}{r_f} > \frac{\tau}{\epsilon}\left(d - \frac{r}{r_f}\right) \quad (5)$$

Comparing the condition (5) with (3) it is clear that the limited liability limits the range of parameters for which recapitalization will happen since $d > \frac{r}{r_f}$.

8.4 Structure of Market Equilibrium with Recapitalization and Capital Regulation

We will now incorporate capital regulation into our model. Initially, we will examine the case where the bank classifies all its assets under either HTM or AFS accounting. Subsequently, we will consider an intermediate scenario where the bank has the option to determine the proportion

with a greater proportion of uninsured deposit funding (assuming other factors remain constant) become more susceptible to run risk. In our simplified model, banks with a higher share of uninsured deposits can be construed as having a higher run probability ϵ. See Section 8.5.3 for more discussion.

of assets classified as HTM. In all these cases, HTM accounting only affects capital regulation, and the equity holders' valuation always depends on the market value. Thus, HTM accounting creates a wedge between equity holders' valuation and capital regulation.

8.4.1 HTM Accounting

If the bank follows HTM accounting, the regulatory capital constraint is trivially satisfied since $1 - d \geq \bar{e}$. In this case the bank recapitalization policy will be as described by (3).

8.4.2 AFS Accounting

If the bank follows AFS accounting, its regulatory capital constraint will be $\frac{r}{r_f} - d \geq \bar{e}$. Note that this means that conditional on satisfying the regulatory capital constraint, there will be no risk of the run since the regulatory capital constraint is tighter than no run condition as long as $\bar{e} > 0$.

The bank will be willing to raise $\left(d - \frac{r}{r_f} + \bar{e}\right)$ to satisfy the regulatory capital constraint under the AFS accounting if the following conditions holds:

$$\underbrace{\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}}_{Benefit} > \underbrace{\tau\left(d - \frac{r}{r_f} + \bar{e}\right)}_{Cost} \tag{6}$$

Comparing the condition (6) with condition (3) implies that under the AFS accounting, the bank is more likely to raise the additional capital if the risk of bank run ϵ is not too high.[7]

8.4.3 Choice of Accounting Standard

Finally, we consider the case where the bank can choose its accounting standards. If there was no cost difference between the AFS and HTM accounting, the bank would always choose the HTM accounting, and the bank recapitalization choice will be as in Section 8.4.1.

Now, let's examine a scenario where the bank incurs a cost of θ to classify 1 unit of assets into HTM accounting. This cost could represent the inflexibility of carrying an asset classified as HTM until its maturity (Kim, Kim, and Ryan 2019; Kim, Kim, and Ryan, 2023). If it is more expensive to reclassify a unit of book equity to HTM accounting than to raise one unit of capital, i.e., $\theta > \tau$, the bank would never choose the HTM accounting, and the recapitalization choice will be as in Section 8.4.2.

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[7] In particular, bank is more likely to raise the additional capital under the AFS accounting if $\frac{\tau}{\epsilon}\left(d - \frac{r}{r_f}\right) > \tau\left(d - \frac{r}{r_f} + \bar{e}\right) \Rightarrow \epsilon < \frac{d - \frac{r}{r_f}}{d - \frac{r}{r_f} + \bar{e}}$.

The interesting scenario is when $\theta < \tau$, indicating that it is more expensive to raise one unit of capital than to reclassify a unit of book equity to HTM accounting. In this scenario, the higher cost of recapitalization makes bank equity holders prefer reclassifying bank's assets to HTM rather than to raise additional capital to just satisfy their regulatory capital constraint. Yet, asset reclassification does not help reduce run risk while recapitalization does. We next discuss this trade-off in detail.

Let's assume that the bank is at the regulatory capital constraint if it follows HTM accounting (i.e., $1 - d = \bar{e}$). If it wants to satisfy its regulatory capital constraint to avoid the shutdown, the bank has two strategies. First, it can raise no capital and reclassify all its assets as HTM. With this strategy, the bank satisfies the regulatory capital constraint but does not eliminate the risk of runs. Thereby, equity holders receive the following value:

$$\underbrace{(1-\epsilon)\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) + \epsilon \times 0}_{Equity\ value\ absent\ recapitalization} - \underbrace{\theta \times 1}_{Cost\ of\ HTM\ reclassifcation}. \tag{7}$$

Alternatively, the bank can raise $\left(d - \frac{r}{r_f}\right)$ of capital and reclassify a share of its assets (a) to HTM accounting. The recapitalization will eliminate the risk of runs and relax the regulatory capital constraint. After this recapitalization, the bank needs to only reclassify a share of its assets (a) to HTM to satisfy the regulatory capital constraint:

$$\underbrace{\left(d - \frac{r}{r_f}\right)}_{New\ capital} + \underbrace{a \times 1 + (1-a) \times \left(\frac{r}{r_f}\right) - d}_{Regulatory\ capital\ before\ capital\ injection} = \bar{e} \Rightarrow a^* = \frac{\bar{e}}{\left(1 - \frac{r}{r_f}\right)} = \frac{1-d}{\left(1 - \frac{r}{r_f}\right)} < 1 \tag{8}$$

This strategy yields the following value to initial shareholders:

$$\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) - \underbrace{\tau\left(d - \frac{r}{r_f}\right)}_{Cost\ of\ recapitalization} \underbrace{- \theta \times a^*}_{Cost\ of\ partial\ HTM\ reclassifcation}. \tag{9}$$

The existing equity holders will prefer recapitalization with partial asset reclassification to no recapitalization with full asset reclassification if the value in (9) is higher than the value in (7); that is if:

$$\underbrace{\epsilon\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right)}_{Benefit\ from\ eliminating\ run\ risk} - \underbrace{\tau\left(d - \frac{r}{r_f}\right)}_{Cost\ of\ recapitalization} + \underbrace{(1-a^*) \times \theta}_{\substack{Cost-savings\ from\\ partial\ reclassifcation}} \geq 0 \tag{10}$$

$$\Rightarrow \frac{r}{r_f} - d\frac{\mu(r_f)}{r_f} \geq \frac{\tau}{\epsilon}\left(d - \frac{r}{r_f} - \frac{(1-a^*)\times\theta}{\tau}\right)$$

It is noteworthy that the incentives to raise additional capital are greater under condition (10) in comparison to (3) but are diminished compared to (6) if the risk of bank run is not too high. This indicates that the potential for asset reclassification to HTM accounting partially mitigates the influence of capital regulation on the incentives to raise additional capital. We summarize this discussion in the proportion below.

Proposition 1: Let's assume that the bank is at the regulatory capital constraint if it follows HTM accounting ($1 - d = \bar{e}$). Combining the above expression, we have the following equilibrium strategies:

(i) The bank will not raise additional capital nor engage in HTM accounting reclassification if neither of the two strategies yield positive value to existing equity holder.[8] In this case the bank is closed, and the value of its equity is zero.

(ii) The bank will raise $\left(d - \frac{r}{r_f}\right)$ of capital and reclassify $\left(\frac{1-d}{1-\frac{r}{r_f}}\right)$ of assets to HTM accounting if $\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) \geq \frac{\tau}{\epsilon}\left(d - \frac{r}{r_f} - \frac{(1-a^*)\times\theta}{\tau}\right)$ and

$$\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) - \tau\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) - \theta \times a^* \geq 0, \text{ where } a^* = \frac{1-d}{\left(1-\frac{r}{r_f}\right)}.$$

(iii) The bank will raise no capital and reclassify all assets to HTM accounting if

$$\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) < \frac{\tau}{\epsilon}\left(d - \frac{r}{r_f} - \frac{(1-a^*)\times\theta}{\tau}\right) \text{ and } (1-\epsilon)\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) - \theta \times 1 \geq 0.$$

8.5 Implications

The stylized framework outlined above carries several implications that we discuss below and confront with our empirical findings. First on their own, bank equity holders may not have sufficient incentives to eliminate run risk by recapitalizing or insuring part of their assets to interest rate risk. This is even if the bank equity value is positive in the good equilibrium (e.g., due to a high deposit franchise value). Second, bank capital regulation can eliminate run risk by providing banks with more incentives to raise capital, but it crucially depends on how regulatory capital is defined. In this regard, the option of HTM accounting can dilute the effects of capital regulation resulting in positive run risk. Finally, including deposit franchise value in the no run equilibrium

[8] The condition under which neither strategy yields positive return to existing equity holders is $\theta > \frac{1}{a^*}\left(\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right) - \tau\left(d - \frac{r}{r_f}\right)\right)$ and $\theta > (1-\epsilon)\left(\frac{r}{r_f} - d\frac{\mu(r_f)}{r_f}\right)$ where $a^* = \frac{1-d}{\left(1-\frac{r}{r_f}\right)}$.

in the regulatory capital calculation can weaken the effects of capital regulation on bank incentives to raise capital to prevent run risk.

8.5.1 Limited Incentives for Recapitalization or Interest Risk Insurance to Avert Bank Runs

Our stylized model demonstrates that limited bank liability diminishes the incentive for bank equity holders to bolster their capital as a precautionary measure against solvency-related bank runs. In our framework, our emphasis was on ex-post capital injections. It is straightforward to reinterpret our analysis as also offering insights into ex-ante insurance for bank interest rate exposure. Within our framework, ex-post capital injections can be seen as equivalent to basic ex-ante insurance contracts, provided that the expected costs of such insurance (above its actuarially fair value) are comparable to the costs associated with raising additional capital.

To illustrate this equivalence in a simple example, suppose that interest rates have two states with high interest rates realization occurring with probability p. Consider a decision to raise $\left(d - \frac{r}{r_f}\right)$ of capital to prevent the bank run at the net cost of $\tau\left(d - \frac{r}{r_f}\right)$ if the realization of the interest rate is high. Note that the ex-ante cost of this strategy is $p\tau\left(d - \frac{r}{r_f}\right)$. Alternatively, the bank equity holders could buy the insurance contract, paying the bank $\left(d - \frac{r}{r_f}\right)$ in high interest rate states to eliminate the risk of runs. We assume that the net cost of this contract (above its actuarially fair value) is $p\tau\left(d - \frac{r}{r_f}\right)$, the same as the expected recapitalization cost (the expected benefits of recapitalization to equity holders are also identical). Hence, the conditions we derived above for whether bank would want to recapitalize, would be identical to the ones governing the insurance decision.

The correspondence between ex-post capital injections and ex-ante insurance within our framework implies that our earlier discussion on limited incentives for ex-post capital injections can be reframed as a discussion on the constrained motivations for insuring bank assets against their interest rate exposure.

This insight is broadly consistent with our empirical findings showing that banks did not insure substantial portion of their interest rate risk exposure. It is also consistent with very limited bank capital injections that happened during the recent monetary tightening (Figure A3)). Overall, our model shows how bank equity holders with limited liability can rationally engage in "gambling for resurrection" type of behavior: underinsuring their assets and (or) not raising substantial amounts of capital hoping that the run equilibrium would not manifest itself.

8.5.2 HTM Accounting Dilutes the Impact of Capital Regulation for Bank Stability

Our model demonstrates that bank capital requirements can effectively mitigate run risk by enhancing banks' incentives to bolster their capital. However, the efficacy of such regulations is contingent upon the definition of regulatory capital. Our framework highlights that banks might exploit the option of HTM accounting to mitigate the impact of capital regulations (explicit or implicit), leading to a potentially positive run risk. This finding aligns with our empirical analysis, which reveals widespread usage of HTM accounting reclassifications during recent periods of monetary tightening by banks. According to our framework, such strategic actions may have been employed by banks to conceal the adverse effects of higher interest rates on the value of their assets, thereby reducing the imperative to raise additional capital to mitigate run risk.

8.5.3 Cross-Sectional Implications

It is straightforward to extend our framework to study the bank incentives to raise capital in relation to their initial capitalization and asset duration. This could be done by formally separating the bank's assets into cash and long-term assets, as in Jiang et al. (2023). We could also incorporate the mix of uninsured/insured deposits into our framework, as in Jiang et al. (2023). As shown by Jiang et al. (2023), all else equal, banks with lower initial capitalization, longer duration assets, and higher share of uninsured depositors will be more susceptible to bank runs.

This extension of our model has couple of implications. Firstly, institutions facing such susceptibility may exhibit increased incentives to raise capital or secure a portion of their assets to mitigate exposure to run risk. However, our model reveals that banks exposed to runs may lack sufficient incentives to eliminate run risk by raising capital or insuring their assets. This finding may provide insights into our cross-sectional results, where we observe some weak evidence that banks potentially more exposed to runs (lower capitalization, longer-duration assets, higher share of uninsured deposits) appear to hedge their assets to a certain extent. Nevertheless, these effects are generally modest in the aggregate, with the majority of banking assets remaining unhedged.

Secondly, given that banks with lower initial capitalization and longer-duration assets face greater exposure to asset losses, they will inherently have stronger incentives, under similar conditions, to employ HTM accounting practices to conceal the impact of these losses on their regulatory capital. This aligns with our empirical findings, indicating that banks exhibiting characteristics associated with runs tend to have a higher propensity for engaging in the HTM asset reclassification.

8.5.4 Implications for Bank Capital Regulation

Our model does not directly delve into the welfare implications of bank capital regulation, as such analysis goes beyond the scope of our simple stylized framework. Nonetheless, our framework offers several insights that could be pertinent in this context.

First, our model presents a rationale for policy interventions in the banking sector. As we show in our framework, due to limited liability, equity holders may lack sufficient incentives to forestall a bank run by raising additional capital, even if the equity value is highly valuable in the absence of a run. Moreover, if bank failures are socially costly, encompassing potential deadweight costs and negative externalities, it may be beneficial to incentivize bank equity holders to raise more capital (or insure their assets) beyond their privately optimal level. Our model suggests that achieving this objective could be facilitated by imposing capital requirements on banks. However, the efficacy of such regulation hinges on the precise definition of regulatory capital.

If regulatory capital is defined based on the book value of assets and liabilities it does not accomplish much in this regard as the book value would be invariant to changes in interest rates for a given composition of assets and liabilities. One could think that we should then mark-to-market both assets and liabilities of banks. This could be challenging though as the value of bank liabilities depends on the deposit franchise value that can collapse in the run equilibrium. In particular, using the market value of equity in the case of no run $e_m^{No\ Run} = \frac{r}{r_f} - d\left[\frac{\mu(r_f)}{r_f}\right]$ can actually dilute the effects of bank capital requirements on incentives to raise capital. To understand it in the simple example, consider the case when the deposit franchise value perfectly hedges the asset value changes due to higher interest rates (as in Dreschler et al. 2021). Then, the regulatory bank capital will be invariant to interest rates, despite the potential of run risk as shown in Jiang et al. (2023). This would eliminate the impact of capital requirements on incentives to raise capital. What is critical therefore is an assessment that compares marked-to-market value of all bank assets with the book value of its non-equity liabilities, $\frac{r}{r_f} - d$, which represents the bank run threshold. If this value is negative the banks would be forced to raise additional capital, preventing a run. Recognizing that uninsured deposits are particularly runnable implies that the regulatory capital condition could involve the solvency run threshold developed by Jiang et al. (2023). This would ensure that banks have sufficient capital to withstand the uninsured depositor runs.

Finally, our analysis shows that HTM accounting can dilute the effects of such capital regulation when banks are afforded discretion in determining the valuation of their assets (e.g., book vs market value). It suggests that strengthening regulations governing the utilization of HTM accounting practices could therefore enhance the effectiveness of bank capital requirements in mitigating the risk of bank runs.

9. Concluding Remarks

We examine the strategies employed by banks to navigate interest rate risk amid a period of escalating interest rates. We focus on the 2022 monetary tightening, which witnessed a substantial increase in interest rates leading to a large decline in the value of long-duration assets for banks. Utilizing data from call reports and SEC filings, our analysis reveals that banks did not significantly employ interest rate swaps to hedge this substantial risk exposure. Only 6% of the aggregate assets in the U.S. banking system were hedged by interest rate swaps. Notably, the most vulnerable banks further diminished their already limited hedges in 2022, allowing them to report accounting profits while exposing their assets to additional rate increases. Additionally, banks collectively reclassified approximately $1 trillion of their securities as HTM, providing a shield for their balance sheets and income statements from recognizing asset losses that might otherwise attract scrutiny. Banks with lower capital ratios, a higher share of run-prone uninsured depositors, and a larger proportion of assets exposed to interest rate risks were more inclined to reclassify securities to HTM.

We interpreted these findings by expanding on Jiang et al.'s (2023) bank run model, incorporating bank capital requirements, accounting standards, and the ability of bank shareholders to inject additional capital. Our model provides several insights. First, we demonstrate that, due to limited liability, bank equity holders may not be inclined to eliminate run risk by recapitalizing or insuring part of their assets against interest rate risk. This holds true even if the bank equity value is positive in the good equilibrium (e.g., due to a high deposit franchise value). In this sense, they engage in a "gambling for resurrection" type of behavior—underinsuring their assets and/or not raising substantial amounts of capital, hoping that the run equilibrium will not manifest itself. This insight aligns with our empirical findings, which indicate that banks did not insure a substantial portion of their interest rate risk exposure.

Second, bank capital regulation has the potential to mitigate run risk by creating stronger incentives for banks to raise capital. However, the effectiveness of this approach critically hinges on the definition of regulatory capital. Notably, the adoption of HTM accounting can diminish the impact of capital regulation, leading to a positive run risk outcome. Our empirical analysis supports this observation, revealing a prevalent use of HTM accounting reclassifications during recent periods of monetary tightening within the banking sector.

Overall, our findings highlight the importance of evaluating risk management practices within the banking sector. The actions by banks we document bear resemblance to a classic "gambling for resurrection" strategy: in the scenario if runs do not occur, equity would have reaped profits, but in the case of the run, uninsured debtors and the FDIC would absorb the losses. Moreover, our findings cast doubt upon whether auditors and supervisors were able to assure that the reclassifying banks had the ability to hold these securities until their maturity.

While our analysis does not directly delve into the welfare implications of bank regulation, nonetheless, it offers several insights that could be pertinent in this context. First, our model presents a rationale for policy interventions in the banking sector. As we show in our framework and consistent with our empirical findings, due to limited liability, equity holders may lack sufficient incentives to forestall a bank run by raising additional capital, even if the equity value is highly valuable in the absence of a run. Moreover, if bank failures are socially costly, encompassing potential deadweight costs and negative externalities, it may be beneficial to incentivize bank equity holders to raise more capital (or insure their assets) beyond their privately optimal level.

Our model suggests that achieving this objective could be facilitated by imposing capital requirements on banks. This could be done by aligning bank capital ratios more closely with those of less regulated lenders, as documented in the work of Jiang et al. (2020). [9] The efficacy of such regulation hinges on the precise definition of regulatory capital.

If regulatory capital is defined based on the book value of assets and liabilities it does not accomplish much in this regard as the book value would be invariant to changes in interest rates for a given composition of assets and liabilities. Our framework also implies that including the deposit franchise value absent of run in the regulatory capital calculation can weaken the effects of capital regulation on bank incentives to prevent run risk and bank insolvency. Recognizing that uninsured deposits are particularly runnable implies that the regulatory capital condition could involve the solvency run threshold developed by Jiang et al. (2023). This would ensure that banks have sufficient capital to withstand the uninsured depositor runs.

Our analysis has implications on how banks disclose their risk management practices and their current asset values. It shows that HTM accounting can dilute the effects of capital regulation. Strengthening regulations governing the utilization of HTM accounting practices could therefore enhance the effectiveness of bank capital requirements in mitigating the risk of bank runs. On the more extreme end, one might consider abolishing of HTM accounting. It is important, however, to carefully ponder the consequences of such a choice. During the Global Financial Crisis of 2007–2009, there were significant concerns that mark-to-market accounting amplified the crisis. Thus, there might be important trade-offs to consider in choosing between mark-to-market and historical cost accounting. Moreover, implementation of such rules/regulations, overseen by multiple regulators with overlapping jurisdictions, may be challenging (Agarwal et al. 2014).

Discussions along these lines evoke similar contentious debates that unfolded post the 2007 financial crisis, where some argued that insufficient progress was made on bank risk management strategies and capital requirements (see Admati et al., 2013, 2014, and Bischof et al., 2021). These discussions also resonate with historical studies suggesting that access to deposit insurance can elevate bank insolvency risk by incentivizing risky behavior (see Calomiris and Jaremski 2019).

[9] Such capital and risk-management regulations should also take into account non-bank institutions (shadow banks) that provide several services like banks and have gained market share that reflects in part the regulatory actions on banks (see Buchak et al. 2018 and 2022). These institutions are predominantly financed with short-term uninsured debt, but they are also significantly better capitalized than banks on average (Jiang et al. 2020). See Corbae and D'Erasmo (2021), Buchak et al. (2022), Begenau and Landgvoit (2022) for recent quantitative studies of impact of regulatory policies on banks.

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Table 1: Summary Statistics

The top panel of the table shows aggregate statistics based on banks' hedging activity in 2021:Q4. The samples are based on call reports and 10Ks/10Qs. The bottom two panels of the table present the statistics using average values of all the banks in each category as of 2021:Q4. The numbers in parentheses are standard deviations. The second panel uses call reports. The first three rows in this panel are based on a sample of banks that are required to report rate swaps. The last three rows in this panel are based on a sample of banks that report non-zero interest rate swaps. The third panel uses 10K/10Q filings. It is based on a sample of publicly traded banks that report hedges in their 10K/10Q filings. We remove outliers by winsorizing the full sample at 5th and 95th percentiles. Column 1 shows these statistics for all the banks, column 2 for banks with assets below 10 billion, column 3 for banks with assets above 10 billion but below 250 billion, and column 4 for banks with assets above 250 billion. Data Sources: Bank Call Reports, 10Qs, and 10Ks.

	(1) All Banks	(2) Asset <10B	(3) Asset [10B,250B]	(4) Asset >250B
Assets of FDIC-insured banks	23.5T	3.4T	6.9T	13.2T
Assets of banks required to report rate swap	22.2T	1.8T	6.9T	13.2T
# Banks required to report rate swap	1,271	1,117	141	13
Assets of banks w/ non-zero rate swap	16.9T	0.7T	3.8T	12.4T
# Banks w/ non-zero rate swap	290	203	76	11
Assets of publicly traded banks w/ hedge	7.4T	0.3T	2.8T	4.4T
# Publicly traded banks w/ hedge	98	48	44	6
Assets of publicly traded banks reported duration	5.0T	0.1T	1.5T	3.4T
# Publicly traded banks reported duration	62	27	31	4
Rate Swap/Asset	0.9	0.7	2.1	3.0
	(2.1)	(1.9)	(2.8)	(2.9)
Rate Swap/Security	5.7	4.6	13.1	16.8
	(14.4)	(13.1)	(19.9)	(20.1)
Rate Swap/AFS Security	7.7	6.1	17.8	24.9
	(19.9)	(18.0)	(27.3)	(28.2)
Rate Swap/Asset | Non-Zero Rate Swap	3.8	3.8	3.8	3.6
	(2.7)	(2.7)	(2.7)	(2.8)
Rate Swap/Security | Non-Zero Rate Swap	24.3	24.6	24.2	19.9
	(20.7)	(20.5)	(21.5)	(20.4)
Rate Swap/AFS Security | Non-Zero Rate Swap	31.8	31.6	32.8	29.4
	(29.4)	(29.5)	(29.7)	(28.4)
Hedge/Asset	5.4	5.3	5.0	8.7
	(4.8)	(4.8)	(4.7)	(3.7)
Hedge/Security	36.1	43.9	28.4	30.6
	(40.5)	(47.6)	(32.7)	(15.8)
Hedge/AFS Security	44.9	52.2	36.6	46.9
	(46.4)	(52.6)	(39.8)	(31.3)
Duration	4.6	4.6	4.5	5.9
	(1.4)	(1.2)	(1.0)	(3.6)

Table 2: Bank Fragility and Reclassification into HTM

This table reports the coefficients of OLS regressions examining the relation between measures of bank fragility and banks' decision to transfer assets from AFS to HTM. The dependent variable in Panel A is a dummy variable that takes the value of one if the bank reclassified assets from AFS to HTM between 2021 and 2022. The dependent variable in Panel B is the ratio between the total amount of transferred securities and total securities in the AFS and HTM portfolios. Tier 1 Capital Ratio is Tier 1 capital divided by total assets. % Uninsured Deposits is the ratio between uninsured deposits and total deposits. % Long Term securities is the ratio between total securities with maturity or repricing exceeding 15 years and the total securities. Baseline controls include a set of indicator variables for asset percentile and controls for the share of AFS securities in banks' securities portfolios and for the percentage of securities in total assets. Standard errors are presented in parentheses and are clustered at the state level. ***, **, and *, represent statistical significance at 1%, 5%, and 10% levels, respectively.

Panel A: Dummy Variable for Reclassification to HTM

	(1)	(2)	(3)	(4)	(5)
	I(Reclassification to HTM)=1				
Tier 1 Capital Ratio	-0.007***				-0.019***
	(0.002)				(0.005)
% Uninsured Deposit		0.086***		0.019	0.099***
		(0.024)		(0.024)	(0.029)
% Long Term Securities			0.109***	-0.024	0.098***
			(0.019)	(0.038)	(0.018)
% Long Term Securities × % Uninsured Deposits				0.332***	
				(0.098)	
Share of AFS Securities					0.009
					(0.007)
Securities (% Assets)					0.109***
					(0.020)
Observations	5027	4978	4850	4818	4818
Adjusted R^2	0.097	0.099	0.109	0.116	0.120
Asset Percentile	Yes	Yes	Yes	Yes	Yes

Panel B: % Assets Reclassified to HTM

	(1)	(2)	(3)	(4)	(5)
	% Assets Reclassified to HTM				
Tier 1 Capital Ratio	-0.005***				-0.010***
	(0.002)				(0.003)
% Uninsured Deposit		0.058**		0.020	0.060**
		(0.028)		(0.027)	(0.028)
% Long Term Securities			0.064***	-0.002	0.060***
			(0.015)	(0.027)	(0.015)
% Long Term Securities × % Uninsured Deposits				0.163**	
				(0.061)	
Share of AFS Securities					0.009
					(0.007)
Securities (% Assets)					0.032*
					(0.016)
Observations	4853	4821	4850	4818	4818
Adjusted R^2	0.014	0.016	0.020	0.023	0.023
Asset Percentile	Yes	Yes	Yes	Yes	Yes

Table 3: External Scrutiny and Reclassification into HTM

This table reports the coefficients of OLS regressions examining the relation between measures of bank fragility and banks' decision to transfer assets from AFS to HTM. The dependent variable in Panel A is a dummy variable that takes the value of one if the bank reclassified assets from AFS to HTM between 2021 and 2022. The dependent variable in Panel B is the ratio between the total amount of transferred securities and total securities in the AFS and HTM portfolios. The main variables of interested are dummy variables that take the value of one if the banks is audited by a big-4 auditing firm or if the bank is primarily regulated by the OCC, FDIC, and Federal Reserve. Baseline controls include a set of indicator variables for asset percentile and controls for the share of AFS securities in banks' securities portfolios and for the percentage of securities in total assets. In columns (5)–(8), we coarsen exact match (Iacus et al., 2012) the sample to achieve covariate balance between the size and securities portfolio composition across banks with and without big-4 auditing and different types of regulators. Standard errors are presented in parentheses and are clustered at the state level. ***, **, and *, represent statistical significance at 1%, 5%, and 10% levels, respectively.

Panel A: Dummy Variable for Reclassification to HTM

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	I(Reclassification to HTM)=1							
Big4Auditor	-0.003				0.043			
	(0.044)				(0.055)			
OCC		-0.011*				-0.035**		
		(0.006)				(0.015)		
FDIC			0.010*				0.018*	
			(0.005)				(0.010)	
Fed.Reserve				0.014*				0.011
				(0.007)				(0.017)
Observations	1964	4818	4818	4818	1702	1892	1921	1882
Adjusted R^2	0.134	0.120	0.120	0.120	0.156	0.183	0.121	0.157
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ptile Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Coarsened Exact Matching	No	No	No	No	Yes	Yes	Yes	Yes

Panel B: % Assets Reclassified to HTM

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	% Assets Reclassified to HTM							
Big4Auditor	-0.042**				-0.021			
	(0.016)				(0.018)			
OCC		-0.006				-0.016*		
		(0.005)				(0.009)		
FDIC			-0.001				0.000	
			(0.005)				(0.009)	
Fed.Reserve				0.014*				0.006
				(0.007)				(0.010)
Observations	1964	4818	4818	4818	1702	1892	1921	1882
Adjusted R^2	0.041	0.023	0.023	0.024	0.039	0.059	0.036	0.039
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ptile Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Coarsened Exact Matching	No	No	No	No	Yes	Yes	Yes	Yes

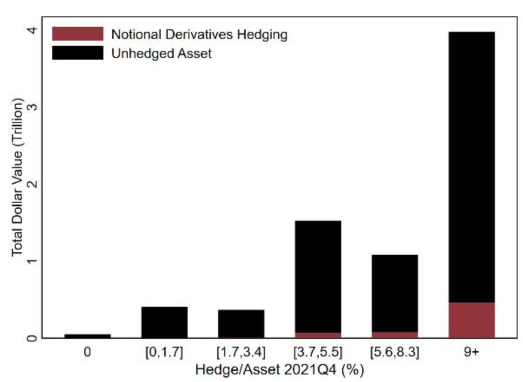
Table 4: Hedging and HTM Security

This table reports the coefficients of OLS regressions examining the relation between hedging and banks' holding of HTM securities. The dependent variable is interest rate swap to asset ratios. Share of HTM Securities measures the share of securities classified as HTM out of total securities. Reclassification to HTM takes the value of one if the bank reclassified assets from AFS to HTM between 2021 and 2022. % Assets Reclassified to HTM is the ratio between the total amount of reclassified securities and total securities in the AFS and HTM portfolios. Tier 1 Capital Ratio is Tier 1 capital divided by total assets. % Uninsured Deposits is the ratio between uninsured deposits and total deposits. % Uninsured Deposits is the ratio between uninsured deposits and total deposits. % Long Term securities is the ratio between total securities with maturity or repricing exceeding 15 years and the total securities. Securities (% Assets) is the security to asset ratio. Baseline controls include a set of indicator variables for asset percentile. Standard errors are presented in parentheses and are clustered at the state level. ***, **, and *, represent statistical significance at 1%, 5%, and 10% levels, respectively.

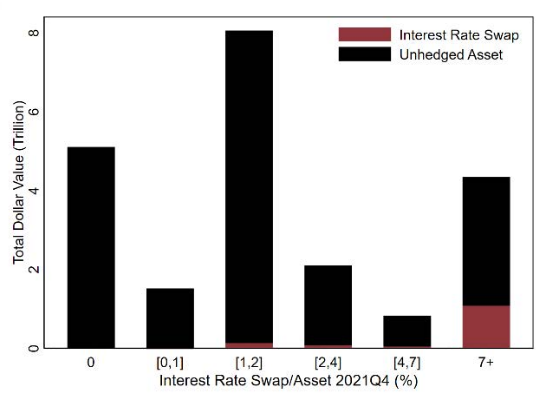
	(1)	(2)	(3)	(4)
	Interest Rate Swap / Asset			
Share of HTM Securities	0.006	0.009		
	(0.019)	(0.009)		
Reclassification to HTM			0.003	
			(0.005)	
% Assets Reclassified to HTM				-0.000
				(0.003)
Securities (% Assets)	-0.039	0.072*	0.073**	0.073**
	(0.025)	(0.036)	(0.036)	(0.036)
Tier 1 Capital Ratio	-0.022*	-0.041*	-0.041	-0.040
	(0.011)	(0.024)	(0.024)	(0.024)
% Uninsured Deposits	-0.034**	-0.065	-0.066	-0.068
	(0.013)	(0.046)	(0.045)	(0.045)
% Long Term Securities	0.026	-0.027	-0.025	-0.026
	(0.021)	(0.031)	(0.030)	(0.030)
Observations	2392	2386	2386	2386
Adjusted R^2	0.019	0.799	0.799	0.799
Asset Ptile Dummies	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
Bank FE	No	Yes	Yes	Yes

Figure 1: Aggregate Hedged and Unhedged Asset Value – 2021

This figure plots the aggregate hedged and unhedged asset values based on 2021:Q4 10Ks and 10Qs (Panel a) and 2021:Q4 call reports (Panel b). In Panel (a), the red bars indicate the notional value of hedges of all banks in each hedging ratio bucket. The black bars indicate the total unhedged asset value of all banks in each hedging ratio bucket, where unhedged asset value is calculated as total assets minus the notional value of hedge. The first bucket includes banks with zero notional value of hedge, and the remaining hedging ratio buckets are constructed by dividing banks with non-zero hedging into 5 equal-sized groups based on their notional value of hedge to total asset ratio in 2021:Q4. In Panel (b), the red bars indicate the total notional value of interest rate swaps of all banks in each hedging ratio bucket. The black bars indicate the total unhedged assets of all banks in each hedging ratio bucket, where unhedged assets are calculated as total assets minus the notional value of interest rate swaps. In Panel (b), the first bucket includes banks with zero interest rate swaps, and the remaining hedging ratio buckets are constructed by dividing banks into 5 equal-sized groups based on their interest rate swap to total asset ratio in 2021:Q4. *Data Sources*: Bank Call reports and 10Ks and 10Qs.



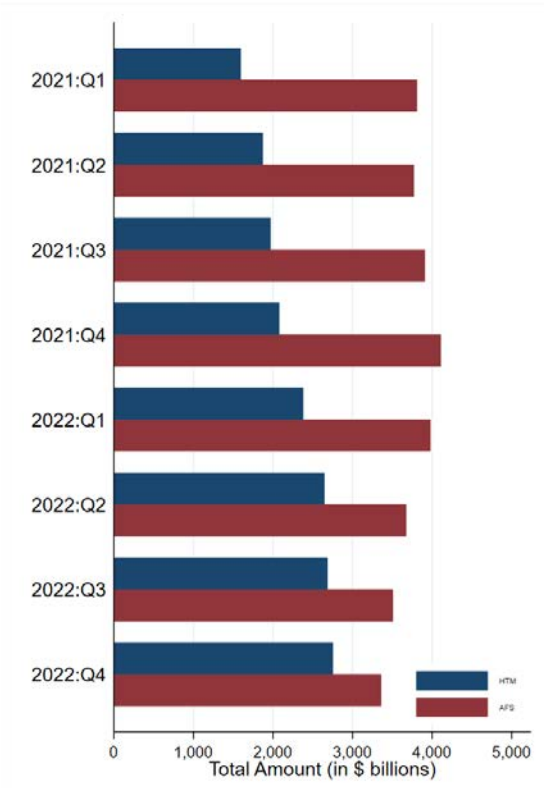
(a) Hedge/Asset (10K)



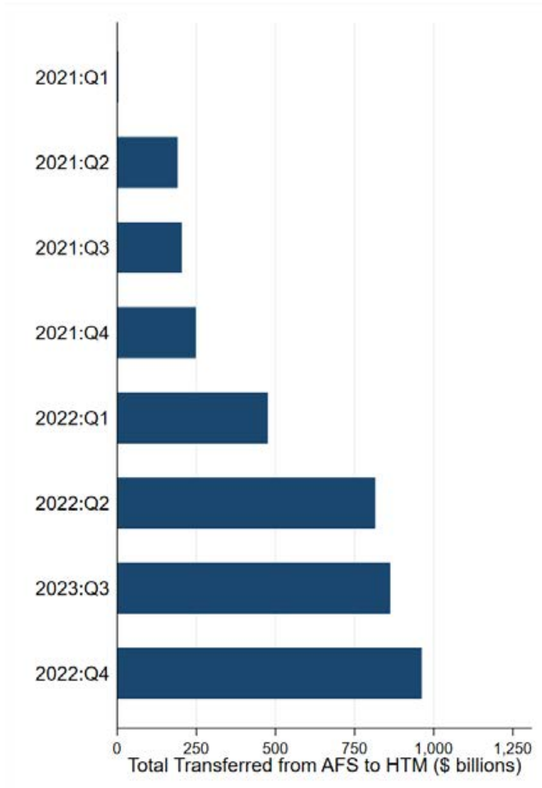
(b) Interest Rate Swap/Asset (call reports)

Figure 2: Aggregate Securities Classified as Held-to-Maturity (HTM) and Available-for-Sale (AFS)

This figure plots the breakdown of Total Securities between HTM and AFS (Panel A) and the total amounts of securities being reclassified from AFS to HTM by U.S Banks (Panel B). *Data Sources:* Bank Call reports, bank holding company 10Qs, and 10Ks.



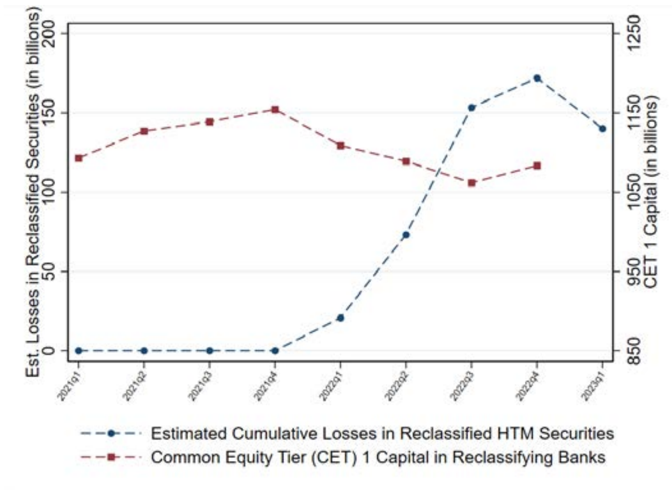
(a) Total AFS and HTM securities



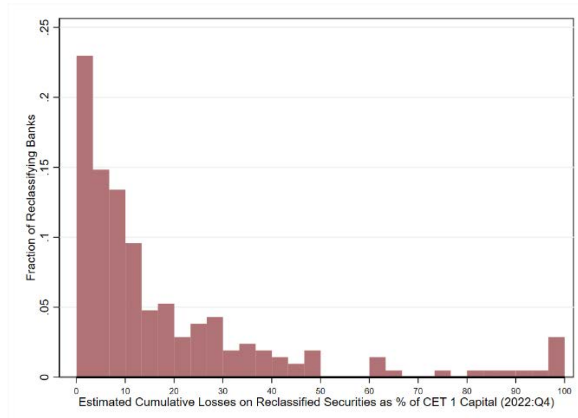
(b) Total amounts reclassified

Figure 3: Estimated Losses on Reclassified Securities

This figure presents the estimated losses on reclassified securities. Panel A shows the time series of the estimated cumulative losses on reclassified HTM securities and the common equity tier (CET) 1 capital of banks that reclassified their securities. Panel B shows the histogram of the estimated losses on reclassified securities for each bank as a fraction of their respective CET1 capital at the end of 2022. *Data Sources:* Bank call reports.



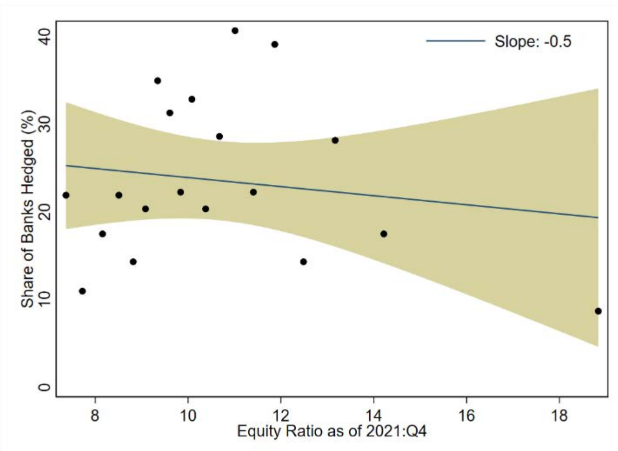
(a) Time Series



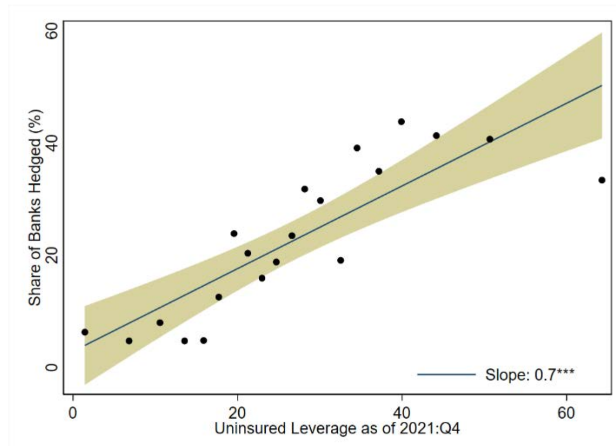
(b) Histogram

Figure 4: Bank Use of Interest Rate Swaps --- Extensive Margin

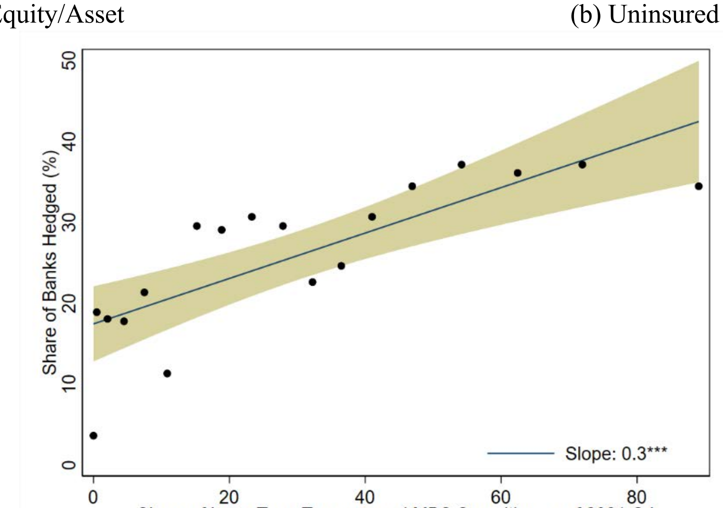
This figure presents binned scatterplot of 2021:Q4 hedging against equity ratio (Panel A), uninsured leverage ratio (Panel B), and long-term security ratio (Panel C) as of 2021:Q4. Uninsured leverage is calculated as uninsured deposit divided by total asset. Long-term security ratio is the ratio between total securities with maturity or repricing exceeding 15 years and the total securities. The underlying sample includes all banks that are required to report their use of interest rate swaps in 2021:Q4. We divide sample into 20 equal-sized bins and plot the share of banks with positive interest rate swaps in each bin against the average equity ratio, uninsured leverage ratio, and long-term security ratio in that bin, respectively. The shaded area shows the 95% confidence interval. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). *Data Sources:* Bank call reports in 2021:Q4.



(a) Equity/Asset



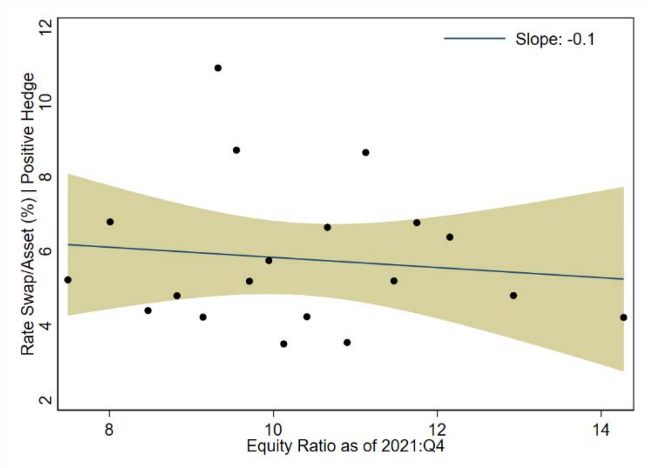
(b) Uninsured Leverage



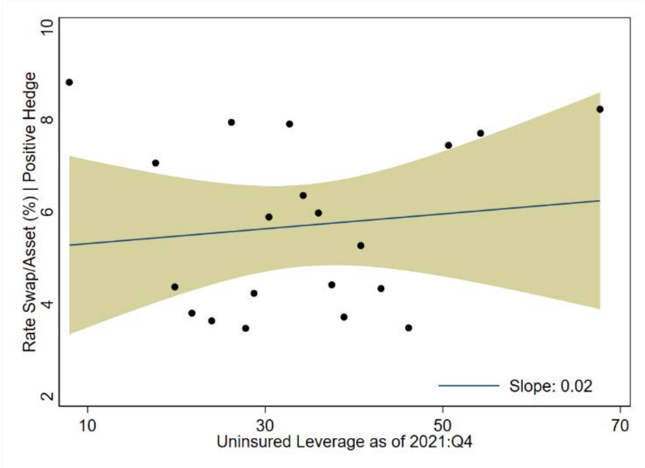
(c) Long-Term Security/Asset

Figure 5: Bank Use of Interest Rate Swaps --- Intensive Margin

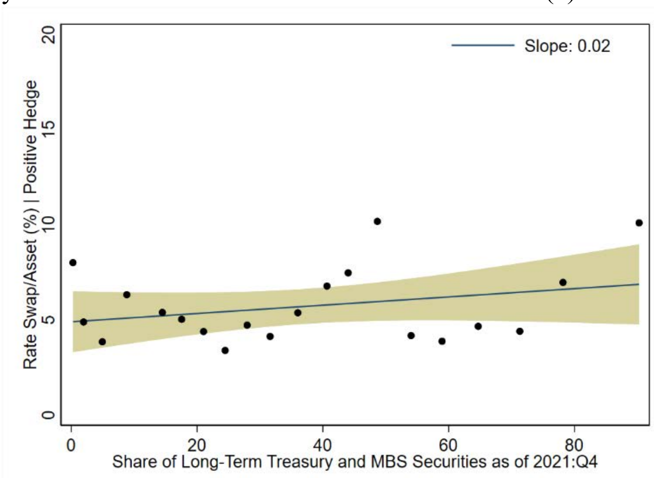
This figure presents binned scatterplot of 2021Q4 hedging against equity ratio (Panel A), uninsured leverage ratio (Panel B), and long-term security ratio (Panel C) as of 2021:Q4. Uninsured leverage is calculated as uninsured deposit divided by total asset. Long-term security ratio is the ratio between total securities with maturity or repricing exceeding 15 years and the total securities. The underlying sample includes all banks that reported positive interest rate swaps in 2021Q4. We divide sample into 20 equal-sized bins and plot the average interest rate swaps to asset ratio in each bin against the average equity ratio, uninsured leverage ratio, and long-term security ratio in that bin, respectively. The shaded area shows the 95% confidence interval. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). *Data Sources:* Bank call reports in 2021:Q4.



(a) Equity/Asset



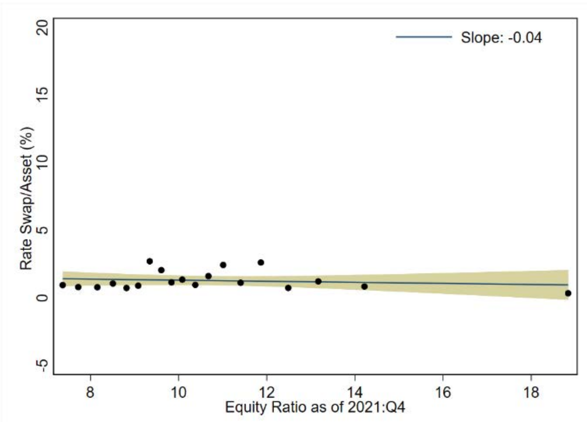
(b) Uninsured Leverage



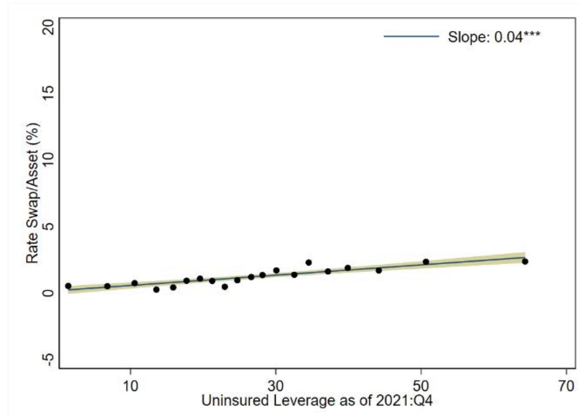
(c) Long-Term Security/Asset

Figure 6: Bank Use of Interest Rate Swaps --- Net Margin

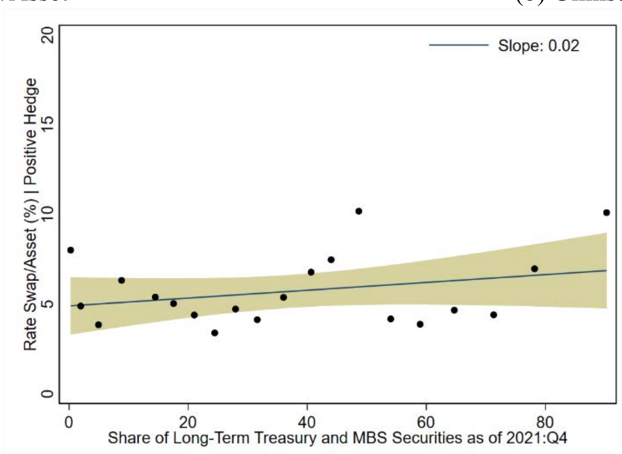
This figure presents binned scatterplot of 2021Q4 hedging against equity ratio (Panel A), uninsured leverage ratio (Panel B), and long-term security ratio (Panel C) as of 2021:Q4. Uninsured leverage is calculated as uninsured deposit divided by total asset. Long-term security ratio is the ratio between total securities with maturity or repricing exceeding 15 years and the total securities. The underlying sample includes all banks that are required to report their use of interest rate swaps in 2021Q4. We divide sample into 20 equal-sized bins and plot the average interest rate swaps to asset ratio in each bin against the average equity ratio, uninsured leverage ratio, and long-term security ratio in that bin, respectively. The shaded area shows the 95% confidence interval. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). *Data Sources*: Bank call reports in 2021:Q4.



(a) Equity/Asset



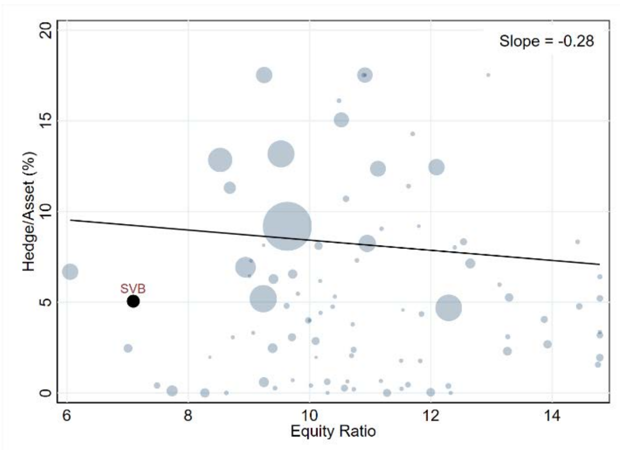
(b) Uninsured Leverage



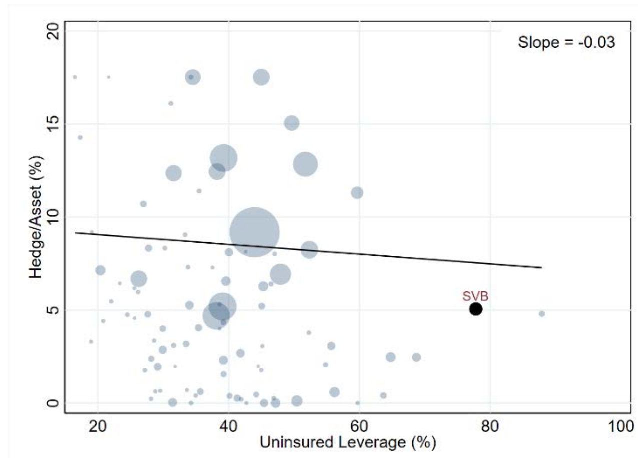
(c) Long-Term Security/Asset

Figure 7: Hedging Ratios and Bank Exposure to Interest Rate Risk- 2021

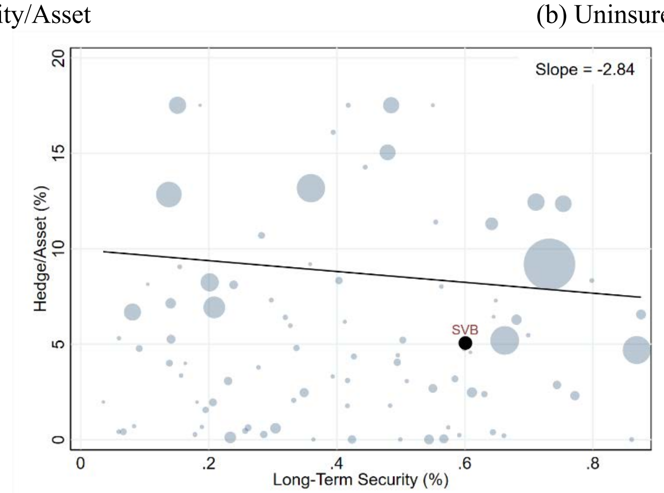
This figure plots hedging ratio for publicly traded banks calculated using information in 10K and 10Q against two measures of bank exposure to interest rate risk. Panel (a) plots hedge to asset ratio against equity ratio as of 2021:Q4. Panel (b) plots hedge to asset ratio as of 2021:Q4 against uninsured leverage ratio as of 2021:Q4. Panel (c) plots hedge to asset ratio as of 2021:Q4 against long-term security to asset ratio as of 2021:Q4. . Uninsured leverage is calculated as uninsured deposit divided by total asset. Long-term security ratio is the ratio between total securities with maturity or repricing exceeding 15 years and the total securities. In all panels, the bubble size indicates the asset size. The lines in each panel are the best fit lines based on weighted least squares. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). *Data Sources*:10Ks and 10Qs and bank call reports.



(a) Equity/Asset



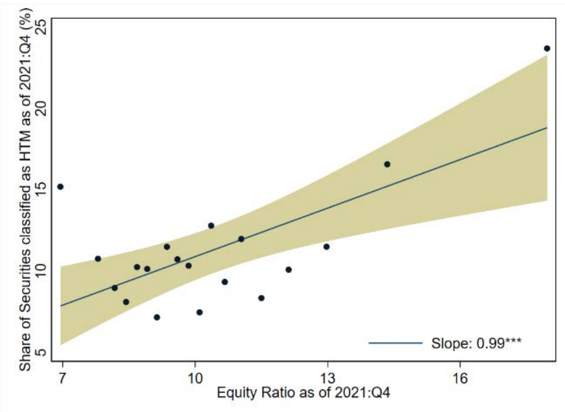
(b) Uninsured Leverage



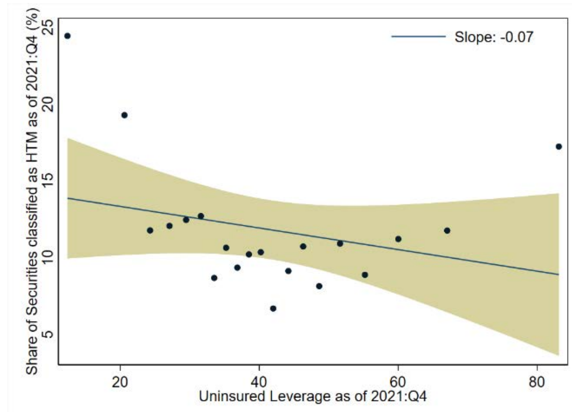
(c) Long-Term Security/Asset

Figure 8: Share of Securities Classified as HTM

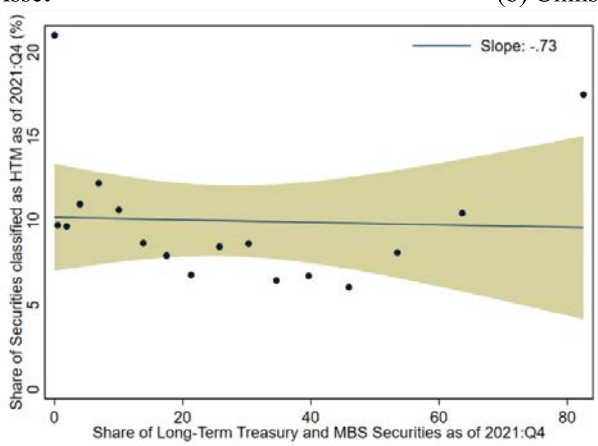
This figure presents binned scatterplot of 2021Q4 share of securities classified as HTM against equity ratio (Panel A), uninsured leverage ratio (Panel B), and long-term security ratio (Panel C). The underlying sample includes all banks that filed call reports in 2021Q4. We divide sample into 20 equal-sized bins and plot the average share of securities classified as HTM in each bin against the average equity ratio, uninsured leverage ratio, and long-term security ratio in that bin, respectively. The shaded area shows the 95% confidence interval. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). Data Sources: Bank call reports in 2021:Q4.



(a) Equity/Asset



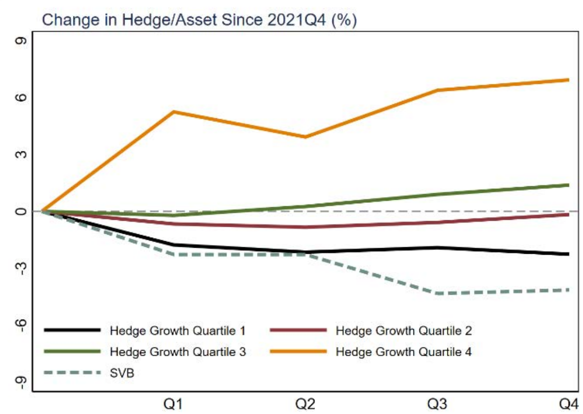
(b) Uninsured Leverage



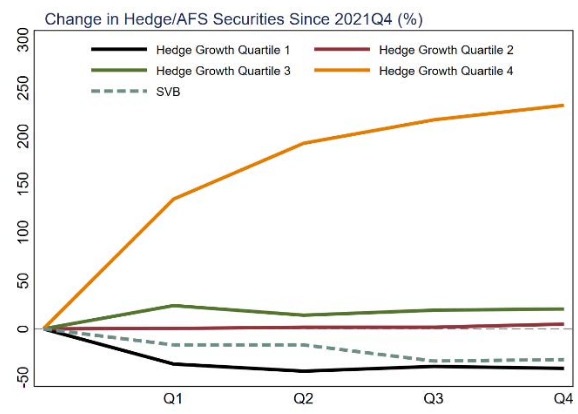
(c) Long-Term Security/Asset

Figure 9: Time Series Change in Hedges – 10K and 10Q

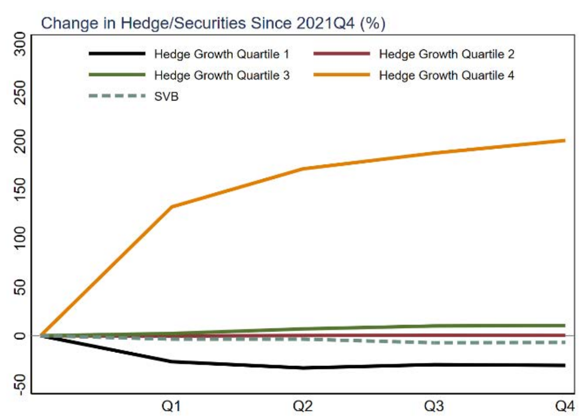
This figure plots quarterly hedging growth relative to 2021:Q4 using hedging information from 10K and 10Q. It plots the growth from 2022:Q1 till 2022:Q4. Hedging growth is calculated as change in notional value of hedging ratios obtained from publicly traded banks' 10Ks and 10Qs. In Panel (a), we divide banks into four equal-sized bins based on their hedge/asset growth from 2022:Q1 to 2022:Q4 and plot the average value of banks in each bin every quarter. In Panel (b), we divide banks into four equal-sized bins based on their hedge/AFS security growth from 2022:Q1 to 2022:Q4 and plot the average value of banks in each bin every quarter. In Panel (c), we divide banks into four equal-sized bins based on their hedge/security growth from 2022:Q1 to 2022:Q4 and plot the average value of banks in each bin every quarter. We do the same exercise for SVB and plot the evolution of its hedging ratios over the same time period. *Data Sources:* 10Ks and 10Qs.



(a) Hedge/Asset



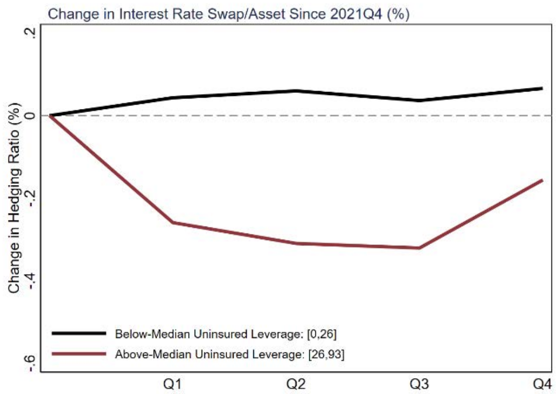
(b) Hedge/AFS Security



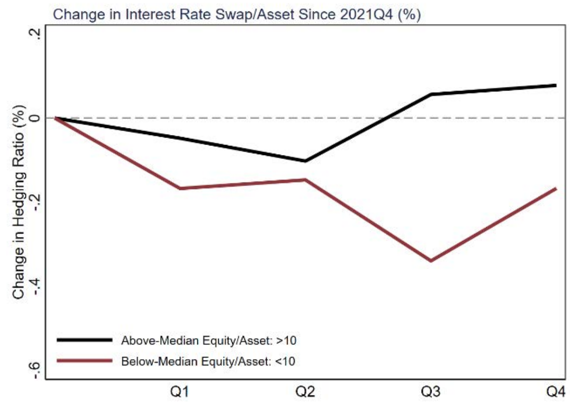
(c) Hedge/Security

Figure 10: Change in Hedging by Bank Balance Sheet Characteristics

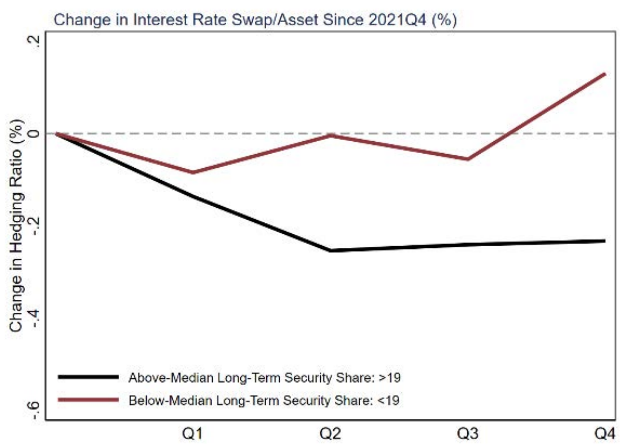
This figure plots quarterly hedging growth relative to 2021:Q4 using interest rate swap to asset ratio. It plots the growth from 2022:Q1 till 2022:Q4. In Panel (a), we divide banks into two equal-sized bins based on their uninsured leverage ratios in 2021:Q4. In Panel (b), we divide banks into two equal-sized bins based on their equity to asset ratio in 2021:Q4. In Panel (c), we divide banks into two equal-sized bins based on their long-term security to asset ratio in 2021:Q4. In all panels, we plot the mean value of banks in each bin. *Data Sources:* Bank call reports.



(a) Uninsured Leverage



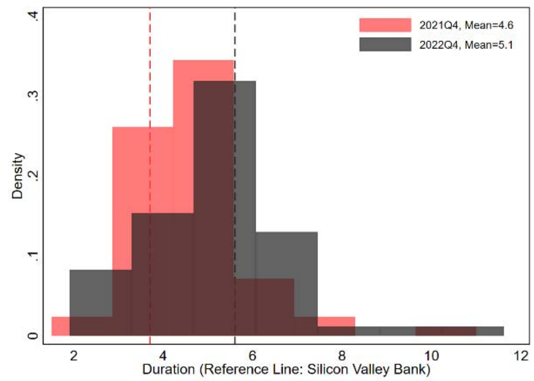
(b) Equity/Asset 2021Q4



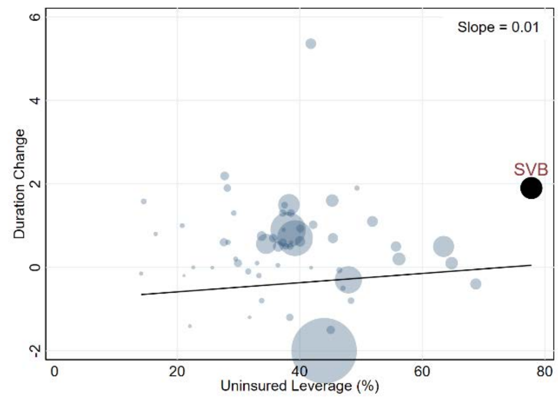
(c) Long-Term Security/Asset

Figure 11: Duration

This figure plots duration of assets of publicly traded banks as reported in their 10K and 10Q. Panel (a) plots the histograms (density) of asset duration in 2021:Q4 and 2022:Q4. The reference lines in Panel (a) indicate Silicon Valley Bank's (SBV) values. SVB's duration in 2021:Q4 is 3.7 and in 2022:Q4 is 5.6. Panel (b) plots the change in asset duration from 2021:Q4 to 2022:Q4 against uninsured leverage ratio in 2021:Q4. In Panel (b), the bubble size indicates bank asset size in 2021:Q4. SVB is labeled in the plot. The line in panel(b) is the best fit lines based on weighted least squares. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). *Data Sources:* Bank call reports and 10Ks and 10Qs



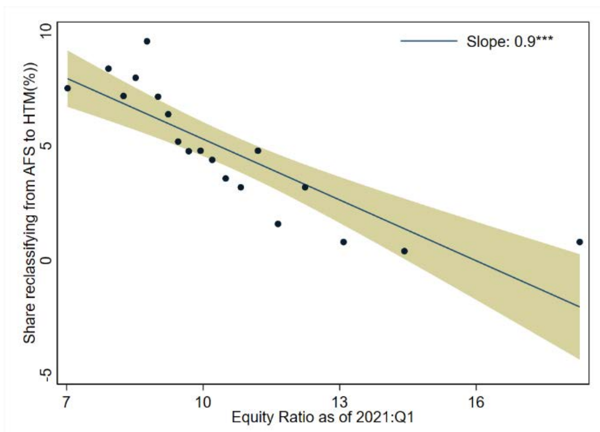
(a) Duration Distribution



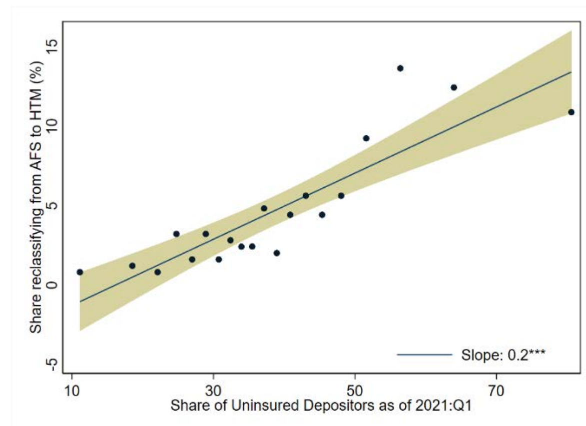
(b) Change in Duration

Figure 12: Bank Fragility and Reclassification of Securities to HTM

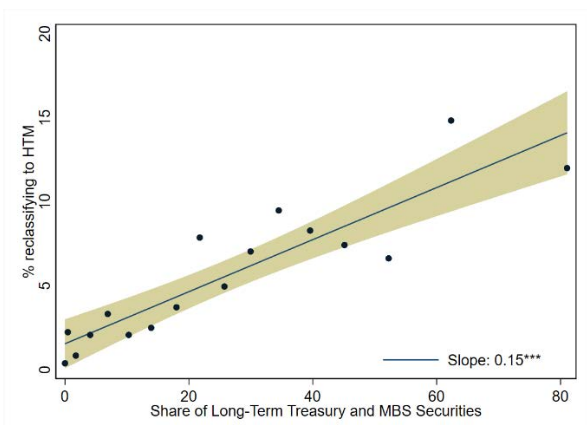
This figure presents binned scatterplot of 2021Q4 hedging against equity ratio (Panel A), uninsured leverage ratio (Panel B), and long-term security ratio (Panel C). The underlying sample includes all banks that are required to report their use of interest rate swaps in 2021Q4. We divide sample into 20 equal-sized bins and plot the average interest rate swaps to asset ratio in each bin against the average equity ratio, uninsured leverage ratio, and long-term security ratio in that bin, respectively. The shaded area shows the 95% confidence interval. The slope and statistical significance are reported in each panel (with ***, ** and * implying significance at 1%, 5% and 10% levels respectively). *Data Sources*: Bank call reports in 2021:Q4.



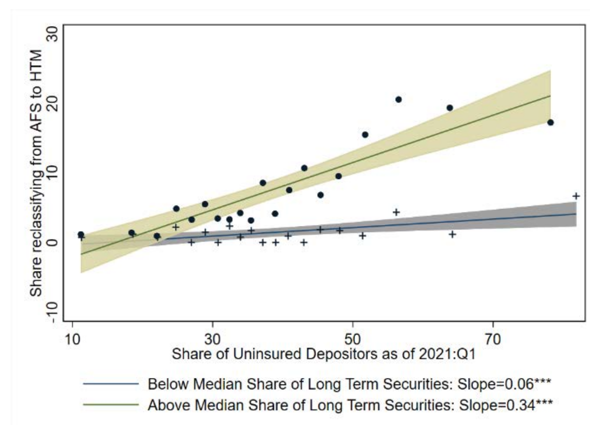
(a) Equity/Asset



(b) Uninsured Leverage



(c) Long-Term Security/Asset



(d) Long-Term Security/Asset x Uninsured

Appendix

Table A1: Summary Statistics – 2022

The top panel of the table shows aggregate statistics based on banks' hedging activity in 2022:Q4. The samples are based on call reports and 10Ks/10Qs. The bottom two panels of the table present the statistics using average values of all the banks in each category as of 2022:Q4. The numbers in parentheses are standard deviations. The second panel uses call reports. The first three rows in this panel are based on a sample of banks that are required to report rate swaps. The last three rows in this panel are based on a sample of banks that report non-zero interest rate swaps. The third panel uses 10K/10Q filings. It is based on a sample of publicly traded banks that report hedges in these filings. We remove outliers by winsorizing the full sample at 5th and 95th percentiles. Column 1 shows these statistics for all the banks, column 2 for banks with assets below 10 billion, column 3 for banks with assets above 10 billion but below 250 billion, and column 4 for banks with assets above 250 billion. *Data Sources*: Bank Call Reports, 10Qs, and 10Ks.

	(1) All Banks	(2) Asset <10B	(3) Asset [10B,250B]	(4) Asset >250B
Assets of FDIC-insured banks	23.6T	3.4T	7.1T	13.1T
Assets of banks required to report rate swap	22.0T	1.8T	7.1T	13.1T
# Banks required to report rate swap	1,218	1,060	145	13
Assets of banks w/ non-zero rate swap	16.3T	0.7T	4.0T	11.7T
# Banks w/ non-zero rate swap	270	180	80	10
Assets of publicly traded banks w/ hedge	7.6T	0.2T	3.0T	4.4T
# Publicly traded banks w/ hedge	97	44	47	6
Assets of publicly traded banks reported duration	5.1T	0.1T	1.7T	3.3T
# Publicly traded banks reported duration	65	27	34	4
Rate Swap/Asset	0.9	0.6	2.4	3.9
	(2.2)	(1.9)	(3.3)	(3.5)
Rate Swap/Security	5.4	3.9	14.4	19.9
	(13.9)	(11.9)	(20.5)	(20.1)
Rate Swap/AFS Security	7.6	5.4	19.7	41.6
	(19.3)	(16.3)	(27.7)	(34.2)
Rate Swap/Asset | Non-Zero Rate Swap	4.0	3.7	4.4	5.1
	(3.2)	(3.1)	(3.4)	(3.1)
Rate Swap/Security | Non-Zero Rate Swap	23.6	22.4	25.9	25.8
	(20.4)	(20.1)	(21.4)	(19.2)
Rate Swap/AFS Security | Non-Zero Rate Swap	32.4	29.7	35.6	54.1
	(28.2)	(27.5)	(28.7)	(28.4)
Hedge/Asset (10K)	6.5	6.1	6.4	11.0
	(6.3)	(6.3)	(6.4)	(4.2)
Hedge/Security (10K)	39.9	44.0	36.0	41.0
	(39.1)	(43.4)	(37.3)	(16.5)
Hedge/AFS Security (10K)	59.9	61.4	53.4	101.0
	(56.4)	(60.6)	(50.9)	(58.5)
Duration	5.1	4.9	5.1	5.7
	(1.6)	(1.4)	(1.6)	(2.8)

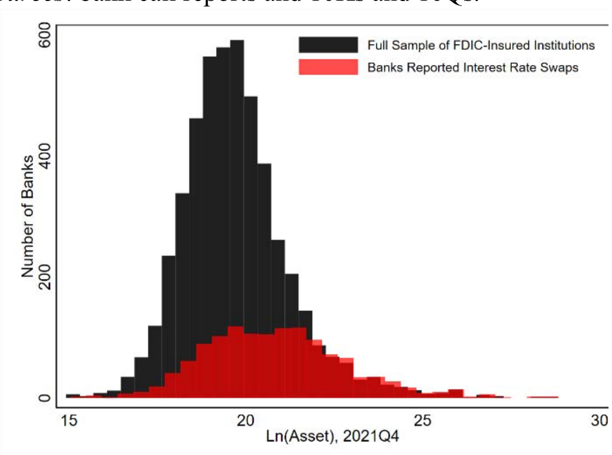
Table A2: Descriptive Statistics on AFS and HTM Assets

The top panel of the table shows aggregate statistics about available-for-sale (AFS) and held-to-maturity (HTM) securities and loans in 2022:Q4. The bottom panel of the table presents the statistics using average values of all the banks in each category as of 2022:Q4. The numbers in parentheses are standard deviations. The samples are based on call reports. Column 1 shows these statistics for all the banks, column 2 for banks with assets below 10 billion, column 3 for banks with assets above 10 billion but below 250 billion, and column 4 for banks with assets above 250 billion. *Data Sources:* Bank Call Reports.

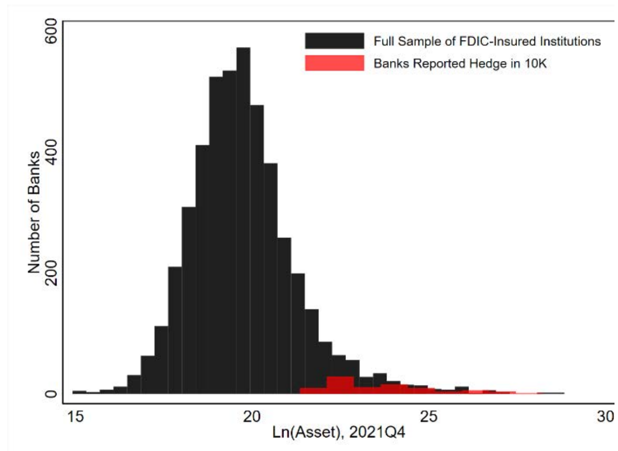
	(1) All Banks	(2) Asset <10B	(3) Asset [10B,250B]	(4) Asset >250B
Assets of FDIC-insured banks	23.6T	3.4T	7.1T	13.1T
Aggregate AFS Security	2.9T	612B	1.0T	1.2T
Aggregate HTM Security	2.8T	128B	538B	2.1T
Aggregate AFS Loan	0.1T	20B	31B	62B
Aggregate HTM Loan	11.9T	2.2T	4.4T	5.3T
AFS Security/Asset	20.5	20.7	15.3	14.6
	(15.9)	(15.9)	(12.9)	(12.9)
HTM Security/Asset	3.8	3.7	6.8	15.1
	(9.4)	(9.4)	(9.5)	(11.6)
AFS Loan/Asset	0.3	0.3	0.5	0.4
	(2.5)	(2.5)	(2.3)	(0.6)
HTM Loan/Asset	60.0	60.0	63.3	39.1
	(18.6)	(18.6)	(16.9)	(19.4)
Number of Banks	4723	4565	145	13

Figure A1: Data and Sample

This figure compares our sample coverage to the full sample of FDIC-insured financial institutions in 2021:Q4 call report data. Panel (a) plots the histogram (frequency) of the logarithm of asset values for banks in the full sample as well as banks that are required to report their use of interest rate swaps. Panel (b) plots the histogram (frequency) of the logarithm of asset values for banks in the full sample as well as the publicly traded banks that report notional value of hedge in 2021. In panel (a) the assets of sample analyzed is close to 95% of the assets of all the FDIC insured institutions. In panel (b) the assets of sample analyzed is 68% of the assets of all the FDIC insured institutions. *Data sources*: bank call reports and 10Ks and 10Qs.



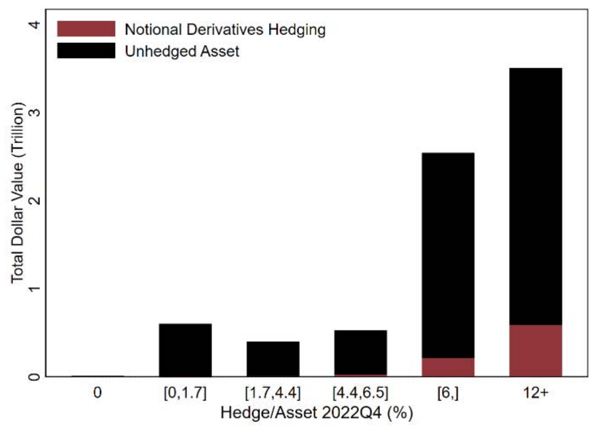
(a) Call Report



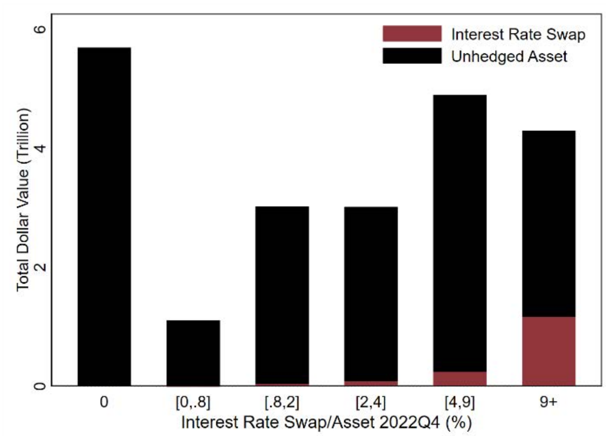
(b) 10K

Figure A2: Aggregate Hedged and Unhedged Asset Value - 2022

This figure plots the aggregate hedged and unhedged asset values based on 2022:Q4 10Ks (Panel a) and 2022:Q4 call reports (Panel b). In Panel (a), the red bars indicate the notional value of hedges of all banks in each hedging ratio bucket. The black bars indicate the total unhedged asset value of all banks in each hedging ratio bucket, where unhedged asset value is calculated as total assets minus the notional value of hedge. The first bucket includes banks with zero notional value of hedge, and the remaining hedging ratio buckets are constructed by dividing banks with non-zero hedging into 5 equal-sized groups based on their notional value of hedge to total asset ratio in 2022:Q4. In Panel (b), the red bars indicate the total notional value of interest rate swaps of all banks in each hedging ratio bucket. The black bars indicate the total unhedged assets of all banks in each hedging ratio bucket, where unhedged assets are calculated as total assets minus the notional value of interest rate swaps. In Panel (b), the first bucket includes banks with zero interest rate swaps, and the remaining hedging ratio buckets are constructed by dividing banks into 5 equal sized groups based on their interest rate swap to total asset ratio in 2022:Q4. *Data Sources*: Bank Call reports and 10Ks and 10Qs.



(a) Hedge/Assets
(10K)



(b) Interest Rate Swaps/ Assets
(Call Report)

Figure A3: Aggregate Capital Injection (Net of Dividend) in 2022

This figure plots the quarterly aggregate bank capital injection net of dividends in 2022. We add up sale, conversion, acquisition, or retirement of capital stock, cash dividends declared on preferred stocks, and cash dividends declared on common stocks. The negative values indicate net reduction in equity. *Data sources: Bank call reports.*