# Held-to-Maturity Accounting and Bank Runs

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**Abstract**

How does held-to-maturity accounting, aimed to limit the impacts of banks' unrealized capital loss on the regulatory capital measures, affect banks' exposure to deposit run risks when policy rates increase? And how should regulatory policies on HTM accounting be designed jointly with bank capital? This paper addresses these questions from both empirical and theoretical perspectives. We find that banks with lower equity capital ratios and higher uninsured deposit shares tend to increase the share of assets in held-to-maturity accounts during periods of monetary tightening. Disciplined by these findings, we develop a model of bank runs in which banks classify long-term assets as HTM or MTM by trading off the cost of equity issuance to meet the capital requirement when interest rate increases today against elevated future run risks when interest rate increases further in the future. Our analysis suggests that when banks underestimate interest rate risks or have limited liability to depositors once they default, imposing a cap on held-to-maturity long-term assets and mandating more equity capital issuance may reduce the run risks of mid-sized banks in equity.

**Keywords:** Held-to-Maturity, Marked-to-Market, Interest-Rate Risks, Bank Run, Uninsured Deposit.

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# 1 Introduction

The collapses of regional banks such as Silicon Valley Bank (SVB), Signature Bank, and First Republic Bank in the first half of 2023 shed light on how accounting rules on debt securities influence banks' fragility via the measured regulatory capital. Under the current accounting rules, bonds that are held-to-maturity (HTM) are not required to be measured at fair value (or market value) on the balance sheet.[1] As banks aren't required to factor the market value of HTM securities into their total capital calculation, fluctuations of market values of HTM debt securities are not reflected in their balance sheets. This might give banks incentive to manipulate HTM accounting to satisfy regulatory capital requirement, when interest rate increases create unrealized capital loss for banks' long-term assets.[2] Indeed, as FDIC (2024) reports, *"Unrealized losses on available-for-sale and held-to-maturity securities increased by 39 billion USD to 517 billion USD in the first quarter…This is the ninth straight quarter of unusually high unrealized losses since the Federal Reserve began to raise interest rates in the first quarter of 2022."*

While HTM accounts help commercial banks to meet capital requirements without incurring costly equity issuance, it adds to the fragility of the banking system to interest rate risks. To avoid including the unrealized asset losses in the regulatory capital measures, distressed banks may tend to reclassify a significant fraction of their long-term assets in the held-to-maturity (HTM) bucket so that these securities are not marked to their market value.[3] However, when the bank suddenly needs liquidity to meet deposit withdrawal due to further interest rate increases, and has to liquidate a part of an HTM portfolio, all the remaining HTM securities must be transferred to the Available-for-Sale (AFS) or Marked-to-Market (MTM) category. Since MTM securities are carried at fair value, transferring tainted HTM securities results in an immediate unrealized holding gain or loss being recorded in equity on the date of transfer (FASB ASC 320-10-35-10). The immediate loss could trigger bank runs by depositors.

Take SVB for an example. At the end of 2022, 43% of SVB's total assets (91.3 billion USD) were comprised of HTM debt security. However, the market value was only 76.2

[1] Under Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) Topic 320, *Investments — Debt Securities*, bonds that are HTM are not required to be measured at market value on the balance sheet.

[2] Unrealized capital losses equal the security's amortized cost minus the fair value, according to the Call Report Instructions for Schedule RC (item 26.b).

[3] According to Granja (2023), U.S. banks transferred 0.9 trillion USD to their HTM portfolios by relabeling securities as HTM during the interest rate increases in 2022. In the beginning of 2022, only about one-third of the 6 trillion USD of securities held by commercial banks were valued using HTM accounting. By the end of 2022, the banking system still held approximately 6 trillion USD in securities but 45% of those securities, or 2.75 trillion USD, were now valued using HTM accounting.

billion USD, or 15.1 billion USD unrealized capital loss. With only 16.3 billion in book equity, this loss would have reduced equity to 1.2 billion USD. When it sold all its AFS securities for a 1.8 billion USD loss on March 8, 2023, which, by raising concerns on whether SVB might be forced to sell its HTM securities, fueled a bank run by its uninsured depositors.

What affects banks' incentive to classify assets as HTM versus MTM? How should regulatory policies on HTM accounting be designed to trade off the volatility of the measured regulatory capital due to interest rate risks against the liquidity risks by classifying a disproportionate amount of assets as HTM? And how should such regulations on bank accounting rules interact with bank regulations on minimum capital requirements?

This paper addresses these questions from both empirical and theoretical perspectives. Empirically, using bank-level data from Call Reports, we find that banks with a larger share of uninsured deposits and a lower capital ratio tend to be more exposed to HTM securities when the Fed funds rate increases. In addition, banks with a higher share of uninsured deposits in total deposits tend to have lower deposit rate spread and greater deposit flow sensitivity to changes in policy interest rates. They have lower profit margins and a less stable depositor base.

Disciplined by these findings, we develop a simple multi-period model with bank runs. Banks face interest rate shocks in the first two periods and are subject to the minimum capital requirement. There are two types of depositors: insured depositors, whose outside option is to hold cash, and uninsured depositors, who can access money market mutual funds at some switching cost. The key model ingredient is the option for banks to classify their long-term assets into the HTM or MTM account, differentiated by whether their future book returns are discounted by a pre-determined or current-period interest rate.

In such a framework, banks face an intertemporal trade-off between holding MTM and HTM long-term assets. When the policy rate increases in the first period, if banks put their long-term security into MTM account, an increase in interest rates would cause a shortfall of their regulatory capital, which forces them to resort to costly equity issuance to meet the capital requirement. Alternatively, banks can classify their long-term security into the HTM account, which helps shield their measured regulatory capital from going under the capital requirement, avoiding costly equity issuance. The use of HTM account, however, increases the run probability in the next period if the policy rate increases further. If banks do not have enough cash holding and MTM security to meet the deposit withdrawal due to interest rate increases, they have to sell their HTM security for liquidity. But any transfer of long-term assets from HTM account to MTM account causes all assets in the HTM account to be marked to market, which would lead to a sharp capital loss being recorded in equity and a large decrease in banks' market value due to the high cost of equity issuance necessary to meet the capital requirement. Accordingly, it triggers runs by uninsured depositors. Hence, while HTM can avoid the costly equity issuance to meet capital requirement in the current period, it may increase the probability of a bank run in the next period.

Our model predicts that banks with higher equity ratios reduce their HTM share in response to policy rate increases, prioritizing liquidity hoarding to mitigate future bank run risks. Conversely, banks with sufficiently low equity ratios retain more long-term assets in the HTM account following policy rate hikes in the hope of a future low-interest-rate environment. If the long-term assets are held in the MTM account, banks with lower equity ratios (in market value) need to incur higher equity issuance costs to meet the capital requirement when the interest rate increases, which increases the marginal benefit of holding HTM security. This is despite the fact that they anticipate higher risks of bank runs during significant interest rate increases.

Underestimation of interest rate risks and higher uninsured deposit ratios further drive banks to increase HTM holdings during tightening periods. Banks with higher uninsured deposit ratios have lower deposit market power (high deposit beta) and thus lower deposit franchise or bank value. Accordingly, the marginal benefit of holding MTM security to prevent bank runs goes down, encouraging them to hold more assets in the HTM account. This prediction explains why, in reality, banks with lower equity ratios and higher uninsured deposit ratios, such as SVB, tend to increase the share of HTM debt securities in total assets as interest rate increases, and why these banks became more exposed to run risks as policy rate increased further.

Within this framework, we explore the optimal regulatory policy on bank capital and HTM accounting by solving the regulator's optimization problem with a mix of equity issuance and HTM share cap. We show that in such an environment, the optimal policy mix between forced equity capital issuance and cap on held-to-maturity long-term assets depends on both the equity issuance cost and banks' initial equity holdings. Across banks with different initial equity levels, we find that for a medium-sized bank in terms of its equity, the optimal regulatory policy combines mandated equity capital issuance with an HTM share cap. Banks with lower equity ratios issue no extra equity capital. Only for banks with a sufficiently high initial capital, the optimal policy does not require a cap on HTM share to prevent bank runs.

Our analysis also suggests that the effectiveness of optimal regulatory policy on reducing the bank run risks depends on the wedge between banks' subjective probability of interest rate increases and the corresponding objective probability, as well as the limited liability protection banks enjoy. When banks underestimate interest rate risks or are shielded by limited liability, imposing a cap on held-to-maturity long-term assets and mandating equity capital issuance may reduce the run risks for medium-sized banks, as measured by regulatory capital.

Our paper is one of the first to study the role of HTM accounting in the presence of interest rate risks. Another paper is Granja et al. (2024), which also studies banks' incentive to asset classification into HTM accounting in the presence of interest rate risks. In both papers, the benefits of holding HTM shares over MTM share is to satisfy the minimum capital requirement without new equity issuance. Our paper differs from Granja et al. (2024), however, in the following dimension: First, in Granja et al. (2024) the marginal cost of holding HTM accounting is exogenous and captured by a parameter, while our paper explicitly links such a cost to the probability of uninsured deposit runs. Second, in Granja et al. (2024), run risks are exogenous and constant while in our paper it endogenously depends on HTM security shares, interest rate changes and initial equity position. Third, in terms of policy implications, Granja et al. (2024) studies how the presence of HTM accounting weakens the effectiveness of capital regulation in containing run risks, while ours focuses on the optimal regulation on HTM accounting and its interaction with capital requirement, due to the endogenous responses of run risks to HTM accounting and thus, the trade-off of HTM accounting.

Our paper contributes to the emerging literature on banks' interest rate risks and bank runs from both theoretical and empirical perspectives. Drechscher et al. (2021) is the pioneer in this line of literature, and argue that the interest rate risks due to maturity mismatch can be hedged by banks' market power on the liability side. Motivated by the SVB episode, Drechsler et al. (2023) extend the above framework to allow for bank runs and argue that runs by uninsured depositors can lead to imperfect hedge against interest rate risks. Jiang et al. (2023a) found evidence that marked-to-market loss together with a high uninsured deposit ratio led to SVB bank run and financial instability and develop a simple model to explain this.[4] To our knowledge, our paper is the first to study the role of HTM accounting on banking vulnerability and the optimal regulation on HTM accounts, and its interaction with the regulation on capital requirement.

Our paper also contributes to the literature on the role of financial accounting on bank asset vulnerability. Kim et al. (2023) and Granja (2023) found evidence that banks reclassify long-term securities from AFS to HTM when the policy rate hikes. Jiang et al. (2023b) found that mortgage-backed securities expose banks to housing price changes while marked as HTM on banks' balance sheets. Our findings highlight the role of banks' equity ratio in their incentive to manipulating HTM accounting in the presence of interest rate risks.

While the literature on uninsured deposits focuses on the recent episodes of banking

[4] See also Acharya et al. (2023), Miao et al. (2023), and DeMarzo et al. (2024).

crises, we extend the analysis to pre-SVB periods dated from 2010. On the liability side, we find that the uninsured deposit ratio affects banks' deposit betas on both rates and flows. On the asset side, we find that uninsured deposits and HTM accounting can cause banks to adjust the accounting for long-term assets regularly. The reclassification incentives increase with the bank's exposure to uninsured deposits. An exception is Chang et al. (2023). They find evidence that banks better at risk-taking attract more uninsured deposits. Sorting is a long-run phenomenon. We take banks' initial deposit base as given and focus on banks' balance sheet adjustment and manipulation.

This paper is structured as follows. Section 2 describes the data construction and summary statistics, and presents the empirical evidence on how HTM accounting and bank balance sheet respond to policy rate changes. Section 3 presents the two-period model. Section 4 characterizes the equilibrium. Section 5 derives policy implications.

# 2 Empirical Evidence

## 2.1 Data Sources

We obtain the bank data from U.S. Call Reports provided by the Federal Reserve Bank of Chicago. The data covers quarterly information on all U.S. commercial banks' balance sheets and income statement items, including loan amounts, deposits, interest expenses, assets, bank types, uninsured deposits, securities held to maturity or available for sale (thus marked to market), etc. Using the FDIC bank identifier, we merge Call Reports with data from the Federal Deposit Insurance Corporation (FDIC). The merged data spans from 2010Q1 to 2023Q2. The sample period starts in 2010 because there was a structural change in uninsured deposit regulation in 2009 that increased the deposit insurance limit from 100K USD to 250K USD. As in Figure 1, the total uninsured deposit in the U.S. experienced a sharp drop in 2009 because of the regulatory change. This pattern is also similar for uninsured deposits of large banks. We measure the policy rate using the Fed funds effective rate from Federal Reserve Economic Data (FRED).

## 2.2 Summary Statistics

Table 2 provides summary statistics for our bank-quarter sample (See Appendix A for detailed data definition of variables). In Table 2, column (1) shows that, on average, uninsured deposits take about 32% of total deposits and 27% of total assets. Columns (2) and (3) show the difference between banks with low and high uninsured deposit (UD) ratios. Banks with higher UD ratios are larger in terms of deposit quantity than those with low UD ratios (18.6 vs. 19.7).

## 2.3 Equity Ratio and Sensitivity of HTM Share to Policy Rate Changes

In this section, we examine how the sensitivities of securities and HTM share to policy rates vary with the equity ratio. We want to know whether banks with higher equity ratios hold more securities during monetary tightening periods, particularly whether they are classified as held-to-maturity (HTM) securities or available-for-sale (AFS, marked-to-market) securities.

We start by running the following regression

$$\begin{aligned}\Delta y_{it} &= \alpha_0 + \left[\beta_0 + \beta_1 er_{it-1}\right] \Delta FF_t \\ &+ \alpha_1 er_{it-1} + \alpha_2 Bank\ Size_{it} + \alpha_3 Bank\ Type_{it} + \alpha_4 HHI_{it-1} + \alpha_i + \alpha_y + \alpha_q + \epsilon_{it}\end{aligned} \tag{1}$$

where $\Delta y_{it}$ is the change in log level of securities held in AFS or HTM accounts or the share of HTM security in total security for an individual bank $i$ from quarter $t-1$ to $t$. $\Delta FF_t$ is the contemporaneous change in the Fed funds effective rate. $er_{it-1}$ is the equity ratio for bank $i$ at time $t-1$. The coefficient $\alpha_i$ represents the bank fixed effects, controlling for time-invariant unobserved heterogeneity across banks. $\alpha_y$ represents the year fixed effect, controlling for macroeconomic shocks other than monetary policy; and $\alpha_q$ represents the quarter fixed effect to control for seasonal factors.[5] In addition, we include bank types and bank asset sizes as time-varying bank-specific controls. $\epsilon_{it}$ is cluster at bank level.

Column (1) in Table 4 reports the estimation results for the total security. The estimated effect of the Fed funds rate on total security is negative at the 0.01 significance level when the equity ratio is zero. However, for banks with higher equity ratios, this effect becomes positive at the 0.01 significance level, as indicated by the positive coefficient on the interaction term between $\Delta FF_t$ and the equity ratio. Specifically, when the equity ratio exceeds approximately 8.3%, the overall effect of the Fed funds rate on total security turns positive. Additionally, the estimated effect of the equity ratio on the change in the log of security is positive at the 0.01 significance level.

Columns (2) and (3) report the estimated effects of changes in the Fed funds rate on the change in log level of securities in AFS and HTM accounts, respectively. The results indicate that the equity ratio influences the transmission of the Fed funds rate differently for AFS and HTM securities. Banks with higher equity ratios tend to increase securities in the AFS account and decrease securities in the HTM account during periods of monetary tightening. The coefficients on the interaction term between $\Delta FF_t$ and the equity ratio are positive for AFS and negative for HTM, both significant at the 0.01 level.

Column (4) illustrates how the HTM share changes with the Fed funds rate. The estimated effect of the Fed funds rate on the HTM share is slightly negative at the 0.01

[5] All the results remain robust if we control for the time fixed effect instead.

significance level for banks with zero equity ratio. However, this effect becomes significantly more negative for banks with higher equity ratios, as indicated by the positive coefficient on the interaction term between $\Delta FF_t$ and the equity ratio. In response to future interest rate increases, banks can either increase their HTM share to lock in asset returns or decrease it to avoid future liquidity shortages. Banks with lower equity ratios maintain their HTM share in response to rising Fed funds rates, anticipating a heightened risk of bank runs during substantial interest rate hikes. In contrast, banks with higher equity ratios decrease their HTM holdings and prioritize liquidity hoarding to mitigate the risk of bank runs.

To explore the non-linear relationship between equity ratios and HTM share sensitivity to policy rates, we present two additional findings. First, as depicted in Table 5, banks with a high uninsured deposit ratio tend to maintain their HTM share during periods of monetary tightening, even for those with high equity ratios. This decision is motivated by their anticipation of a heightened probability of future uninsured depositor runs, prompting them to secure current asset return. Second, Table 6 demonstrates that banks relying heavily on equity financing (equity ratio greater than the median) increase their HTM share in response to interest rate hikes. This strategic response stems from their liability side's reduced sensitivity to interest rate shocks with substantial equity financing, thereby lowering the likelihood of bank runs. Consequently, they prefer to secure their returns by increasing their HTM share.

In Appendix B, we demonstrate the robustness of our results using the equity-to-deposit ratio as an alternative measure of capital abundance. We also show that the positive effect of the equity ratio on the transmission of monetary policy to HTM share persists when using a monetary policy shock (Nakamura and Steinsson, 2018) instead of the federal funds rate.

### 2.4 Uninsured Deposit Ratio and Deposit Betas

In this section, we examine how the sensitivities of deposit growth and deposit rates to policy rates vary with the uninsured deposit ratio. The rate-drive deposit flows and banks profit margin from depositors We call the sensitivities of deposit growth and deposit rates to policy rates the deposit growth beta and deposit rate beta, respectively. We start with evidence on the correlation between deposit rate beta, deposit growth beta, and uninsured deposit ratio. We then establish the empirical relationship between deposit betas and uninsured deposit ratio, controlling for bank-specific characteristics such as the bank's size, type, and market share.

#### 2.4.1 Correlation between Uninsured Deposit Ratio and Deposit Betas

To obtain the cross-bank correlation between deposit betas and uninsured deposit ratio, we first estimate bank-specific deposit betas by running the following panel regression

$$\Delta y_{it} = \alpha_i + \alpha_y + \alpha_q + \beta_i \Delta FF_t + \epsilon_{it} \tag{2}$$

where $\Delta y_{it}$ is the change in deposit rate or log difference of deposit quantity for an individual bank $i$ from quarter $t$ to $t+1$. $\Delta FF_t$ is the contemporaneous change in the Fed funds effective rate. The coefficient $\alpha_i$ represents the bank fixed effects, controlling for time-invariant unobserved heterogeneity across banks. $\alpha_y$ represents the year fixed effect, controlling for macroeconomic shocks other than monetary policy; and $\alpha_q$ represents the quarter fixed effect to control for seasonal factors. The coefficient $\beta_i$ captures the sensitivity of deposit rate or quantity of deposit to changes in the Fed funds rate. Depending on the dependent variable, we refer to $\beta_i$ as either the deposit rate beta or deposit growth beta of bank $i$. Bank-specific betas are winsorized at 0.5% and 99.5% level to eliminate outliers.

We study the cumulative effect of policy rate changes on deposit rate or quantity by running the following regression

$$\Delta y_{it} = \alpha_i + \alpha_y + \alpha_q + \sum_{\tau=0}^{3} \beta_{i\tau} \Delta FF_{t-\tau} + \epsilon_{it} \tag{3}$$

The cumulative deposit rate or growth beta for bank $i$ is defined as the sum of the estimated $\beta$ across four quarters, i.e., $\sum_{\tau=0}^{3} \beta_{i\tau}$.

After we estimate the deposit betas for individual banks, we sort all banks into 20 equal-sized bins according to their uninsured deposit ratio. Each bin contains 212 banks. We then plot the average deposit betas by bins against the uninsured deposit ratio. The top panel of Figure 2 shows that banks with higher uninsured deposit ratios tend to have higher contemporaneous or cumulative deposit rate beta. The correlation between uninsured deposit ratio and contemporaneous deposit rate beta is 0.295 and significant at 1 % (see column 1 of Table 7). By contrast, banks with higher uninsured deposit ratios tend to have lower deposit flow beta. The correlation between the uninsured deposit ratio and deposit growth beta is -0.035 and significant at 1 % (column 3 of Table 7). Intuitively, banks with a higher share of uninsured deposits tend to be more vulnerable to deposit runs when interest rates increase. This shows up as a more negative deposit growth beta as the uninsured deposit ratio increases. To retain rate-sensitive uninsured depositors, banks with larger uninsured deposit ratios adjust more than deposit rates in response to policy rate changes. This shows up as an increase in deposit rate beta as the uninsured deposit ratio increases.

### 2.4.2 Baseline Regressions on Uninsured Deposit Ratio and Deposit Betas

While the above scattered plots show a positive correlation between deposit beta and uninsured deposit ratio, such a relationship could be confounded by many factors. For example, banks with higher uninsured deposit ratios could have lower deposit market power, thus a higher sensitivity of deposit rate beta to the policy rate. To alleviate the concern for omitted variable bias, we include market concentration for individual banks, measured by the standard Herfindahl-Hirschman index (HHI). Moreover, the relationship between the uninsured deposit ratio and deposit rate beta could be non-linear, as the probability of deposit run is likely to be non-linear in the uninsured deposit ratio. Therefore, we construct a dummy variable that equals one if the uninsured deposit ratio exceeds some threshold value. We then interact it with the policy rate and test whether banks with higher uninsured deposit ratios have higher (lower) deposit rate (growth) beta. We start by running the following regression

$$\begin{aligned}\Delta y_{it} &= \alpha_0 + [\beta_0 + \beta_1 \mathbb{1}(ud_{it-1} > \tau_1)]\,\Delta FF_t + \beta_2 \Delta FF_t * HHI_{it-1} \\ &\quad + \alpha_1 \mathbb{1}(ud_{it-1} > \tau_1) + \alpha_2 \textit{Bank Size}_{it} + \alpha_3 \textit{Bank Type}_{it} + \alpha_4 HHI_{it-1} + \alpha_i + \alpha_y + \alpha_q + \epsilon_{it},\end{aligned}$$

where $\Delta y_{it}$ is the change in deposit rate or log difference of deposit quantity, $\Delta FF_t$ is the change in fed funds effective rate, $ud_{it}$ is the share of uninsured deposit in total deposit. $\tau_1$ is a certain threshold, and we set it as the median of uninsured deposits as a benchmark. $\mathbb{1}(ud_{it-1} > \tau_1)$ is a dummy variable that equals one if bank $i$'s uninsured deposit ratio at time $t-1$ is larger than the threshold $\tau_1$. Both $HHI$ and its interaction with Fed funds rate are included as control variables. In addition, we include bank types and bank asset sizes as time-varying bank-specific controls. $\epsilon_{it}$ is clustered at bank level. The coefficient of interest is $\beta_1$, which measures the impacts of the uninsured deposit ratio on the deposit beta.

Columns (1) and (2) of Table 8 reports the estimation results for deposit rate. It shows that the estimated effects of both Fed funds rate and the uninsured deposit rate on individual banks' deposit rate are positive at the 0.01 significance level. The estimated $\beta_1$ is positive at the 0.01 significance level, suggesting banks with higher uninsured deposit ratios have higher deposit rate beta. Our estimated $\beta_1$ is robust to including $HHI$ and its interaction with $\Delta FF_t$. Note that the estimated coefficient on the interaction term between changes in Fed funds rate and $HHI$ is negative and significant at 1% level (column 2), which is consistent with the empirical findings of the existing literature (Drechscher et al.

(2017)) that banks with higher market concentration are associated with lower deposit (rate) beta.

Columns (3) and (4) of Table 8 report the estimation results for deposit quantity growth. In contrast to the deposit rate, the estimated effects of both the Fed funds rate and its interaction with the uninsured deposit ratio dummy on deposit growth are negative and significant at 1 percent. The estimated $\beta_1$ suggests that banks with higher uninsured deposit ratios would experience larger deposit outflow in response to an increase in the Fed funds rate. Interestingly, the estimated $\beta_2$ is positive at 1% significance level, which indicates that banks with higher market share would experience less deposit outflow in response to an increase in the Fed funds rate. Again, our estimated deposit quantity betas are robust to the inclusion of $HHI$ and its interaction with Fed funds rates.

We further explore the relationship between deposit beta and uninsured deposit ratio by estimating the deposit beta by quantiles of uninsured deposit ratio. To this end, we construct ten dummy variables corresponding to each quantile of the uninsured deposit ratio and interact these dummies with the Fed funds rate. We run the following regression

$$\begin{aligned}\Delta y_{it} = \alpha_0 + \sum_{j=1}^{10} \beta_j \Delta FF_t * \mathbb{1}(ud_{it-1} \in \text{jth quantile}) \\ + \alpha_1 Bank\ Size_{it} + \alpha_2 Bank\ Type_{it} + \alpha_3 HHI_{it-1} + \alpha_4 \Delta FF_t * HHI_{it-1} + \alpha_i + \alpha_y + \alpha_q + \epsilon_{it},\end{aligned} \tag{4}$$

where $\mathbb{1}(ud_{it-1} \in \text{jth quantile})$ is a dummy variable that equal to one if bank $i$'s uninsured deposit ratio $ud_{it-1}$ falls into quantile $j$. Our coefficients of interest is $\beta_j$.

Columns (1) and (2) of Table 9 report the estimated deposit rate beta by quantiles. For both columns, the estimated $\beta_j$ for all quantiles are positive and significant at 1 percent level, with the magnitude of the point estimates increasing in quantiles (except the bottom one). This suggests that banks in a higher quantile of uninsured deposit ratios have higher deposit rate beta on average. Columns (3) and (4) show that the estimated deposit growth beta is negative for all quantiles and significant at 0.01 significance level. Similar to the pattern of deposit rate beta, the absolute value of deposit quantity beta increases monotonically in quantiles.

To summarize, we find that banks' uninsured deposit ratio has a significant effect on their deposit rate and growth betas. Banks with a higher uninsured deposit ratio experience a larger deposit rate increase and deposit outflow when the Fed funds rate increases. Such an effect is robust to the presence of bank market concentration.

# 3 Baseline Model

We introduce interest-rate risk, and HTM vs MTM accounting, capital requirements, and capital issuance costs to a banking model in the spirit of Diamond and Dybvig (1983), and Allen and Gale (2009).

Time lasts for two periods, indexed by $t = 0, 1$. The economy is populated with a continuum of banks, a unit measure of depositors. Banks are identical. Each depositor is endowed with a unit of wealth. Banks convert deposits and their own capital into long-term asset holdings.

### Interest Rates and Asset Values

We assume consecutive shocks to long-term interest rates in periods 0 and 1. The long-term interest rate shocks affect the market value of banks' long-term assets, such as Treasury securities. Let the realized market value of these assets after a policy rate shock be denoted $q$. The initial market value of banks' long-term assets at the beginning of period 0 is normalized to 1. After the period-0 policy rate shock, the market value of long-term assets becomes $q_0$. The realized asset value of banks' long-term assets at period 1

$$q = \begin{cases} q_0 & \text{w.p. } 1-p, \\ q_1 & \text{w.p. } p. \end{cases} \tag{5}$$

With the probability of $p$, banks expect that the policy rate further changes at period 1, with the market value of banks' long-term assets moves from $q_0$ to $q_1$; otherwise, banks expect that the market value of banks' long-term assets remains at $q_0$. The probability $p$ is banks' subjective belief about future interest rate risk.

We assume that $q_1 < q_0 < 1$. At period 0, the market value of banks' long-term assets drops from 1 to $q_0$. At period 1, these market value may decreases further to $q_1$. The assumed order of market value of long-term assets (interest rates) is summarized in Assumption 1.

**Assumption 1** *Market value of banks' long-term assets satisfy the following orders:*

$$q_1 < q_0 < 1. \tag{6}$$

### Depositors

There are $1 - u$ insured depositors and $u$ uninsured depositors. Each depositor is endowed with a unit of wealth. All of them are matched with one of the banks in the continuum at the beginning of the period of 0. Insured and uninsured depositors are evenly distributed across banks. So, a bank receives a unit measure of deposits, a $u$ fraction of which are uninsured.

Depositors, particularly the uninsured, observe the policy rate at the beginning of each period and decide whether to withdraw their deposits. We assume that $\lambda$ uninsured depositors withdraw their funds at the beginning of period 1 if the market value of banks' long-term assets falls to $q_1$. These withdrawals are rate-driven deposit outflows. The rate-driven outflow $\lambda$ is an exogenous parameter in the benchmark model. We microfound it in the full model.

Uninsured depositors can also withdraw their deposits when they expect banks to be insolvent. We call these panic-driven deposit outflows. We assume that uninsured depositors have an outside option of holding cash, which gives them a promised value 1. Uninsured depositors withdraw if they anticipate that the value of an uninsured bank deposit is less than that of holding cash. Denote the expected value of bank assets net of the cost of issuing equity $v_t^d$. Uninsured depositors withdraw their deposits when the bank value $v_t^d$ is less than the depositor's outside option. Denote the probability that an uninsured depositor withdraws his deposits $G$.

$$G(v_t^d) = \begin{cases} 1 & v_t^d \geq d_t \\ 0 & v_t^d > d_t, \end{cases} \tag{7}$$

where $d_t$ denotes the quantity of deposits after the interest rate shock. It includes both insured and uninsured deposits because the bank has the same obligation to pay for insured and uninsured deposits when it is solvent. Taking into account both rate-driven and panic-driven deposit outflows, the amount of uninsured deposits remaining at the bank after they observe the period-$t$ policy rate is $u \times G(v_0^d)$ at period 0 and $[u - \lambda \mathbb{1}(q = q_1)] \times G(v_1^d)$ at period 1.

Insured depositors, on the other hand, are rate insensitive, as we documented in Section 2. We, therefore, assume that insured depositors' switching costs are so large that their outside option is strictly below the return from the bank deposit. Insured depositors are also insensitive to bank defaults as FDIC insures their deposits. So, insured depositors do not withdraw deposits.

Adding up the uninsured and insured depositors whose deposits remain in the banks after they observe the policy rate shock and decide whether to withdraw deposits or not, we get the total deposit supply after the interest rate shock is

$$d = 1 - u + [u - \lambda \mathbb{1}(q = q_1)] \times G(v^d) \tag{8}$$

### Banks

Banks are endowed with equity $e_0$ and matched with 1 unit of deposits at the beginning of period 0. They invest all funding in long-term assets and classify an asset as either HTM or MTM. Denote the quantity of HTM assets $h_0$ and the quantity of MTM assets $m_0$. At the beginning of a period $t$, banks observe the policy rate and the corresponding asset value, and decide whether to liquidate asset holdings to pay for deposit withdrawals.

Banks also decide whether to classify their long-term assets in the HTM or MTM account before observing the policy rate. The market value of long-term assets is decreasing in the long-term interest rate. The MTM return reflects the capital gains or losses resulting from policy rate fluctuations. The unrealized capital loss from MTM assets is deducted from the book equity value. However, when calculating the book equity value, the regulator uses book returns of HTM long-term assets as if the unrealized capital gains or losses would never be realized.

In the benchmark model, banks offer a deposit contract that gives depositors the same payoff as their outside option, holding cash. In the full model, we relax this assumption and introduce Cournot competition among a finite number of banks. Both the deposit rate and rate-driven deposit outflow are endogenous.

We use the model to study how the equity ratio determines the bank's classification of long-term assets and its fragility to bank runs. Capital regulation, equity issuance costs, and HTM Accounting play important roles in our analysis.

### Capital Regulation, Equity Issuance Costs, and HTM Accounting

Capital regulation measures bank equity using the book value. When the book equity value is below the required capital level, banks must issue additional equity. Denote the required capital level $\rho$ per unit of deposit and the level of book equity $e_t$. The amount of equity that the bank needs to issue to meet the capital requirement is

$$\Delta e_t = \{\rho - e_t\}^+. \tag{9}$$

Denote the equity issuance cost $\Phi(\Delta e_t) \geq \Delta e_t$. We assume that issuing equity is costly for banks when $\Phi(\Delta e_t)$ is strictly greater than $\Delta e_t$.

**Assumption 2** *Issuing additional equity is costly for banks. The cost of issuing additional equity is linear.* $\Phi(\Delta e_t) = (\kappa + 1)\Delta e_t,$ *for* $t = 0, 1,$ *where* $\kappa > 0$.

Fluctuations in the book value of equity increase expected equity issuance costs. This is because the deadweight loss from issuing equity, $\kappa\{\rho - e_t\}^+$, is a convex function in book equity $e_t$.

The cost of equity issuance to satisfy capital requirements depends on whether banks classify long-term assets as MTM or HTM. Banks only need to deduct unrealized capital losses from MTM assets from their book equity, not those from HTM assets. The cost of issuing equity to satisfy capital requirements thus depends on the classification of assets, or, the changes in the market value of MTM assets.

Since HTM assets do not incur banks additional equity issuance costs as the market value of the long-term assets fluctuates, why don't banks classify all long-term-assets as HTM? This is because HTM assets become illiquid as banks are not supposed to sell HTM assets. If they liquidate any HTM assets, all HTM assets in the same portfolio will be labeled as MTM.

**Assumption 3** *If banks liquidate any HTM assets, all HTM assets are marked-to-market.*

Assumption 3 is a regulatory requirement (Storch (2023) and Malone et al. (2023)) for the trading of HTM assets. If HTM assets are ever liquidated, all HTM assets of the same asset class in the same cohort are deemed tradeable securities. Banks cannot then justify HTM labels on those assets. The assumption implies that the HTM assets are illiquid. Banks may face a trade-off between liquidity and equity issuance costs when they classify long-term assets as HTM.

Table 1 outlines the timeline of events for each period. In each period, a solvent bank first decides how to classify their long-term assets as HTM and MTM. An interest rate shock is publicly announced. Depositors decide whether to withdraw deposits after observing the realized interest rate. Banks then decide whether to liquidate MTM assets or HTM assets and to issue equity to fulfill the demand for liquidity from deposit withdrawal.

| | |
|---|---|
| $t.1$ | Banks classify long-term assets as HTM or MTM. |
| $t.2$ | Long-term interest rate shock is realized. |
| $t.3$ | Depositors decide whether to withdraw deposits. |
| $t.4$ | Banks decide whether to liquidate assets and issue equity. |

Table 1: Timeline for a period $t$.

# 4 Equilibrium

We first describe how the equity issuance cost is related to the asset classification, then characterize equilibrium in period 1, and then how the incentives to classify long-term assets in HTM account in period 0 depends on bank equity capital.

## 4.1 Asset Classification and Equity Issuance

The bank chooses the classification of long-term assets at each period before the interest rate is realized. At period 0, banks could freely choose between HTM and MTM. At period 1, bank could freely choose to put MTM back to HTM, but whenever the bank chooses to withdraw money from the HTM account, all remaining long-term assets must be marked-to-market.

At the beginning of period 0, the balance sheet for banks follows

$$1 + e_0 = h_0 + m_0$$

After the interest rate increases, the MTM asset value decreases from 1 to $q_0$. The book equity value after the period-0 interest rate shock becomes

$$e_0 - (1 - q_0)\, m_0 + \Delta e_0 \tag{10}$$

where $\Delta e_0$ is the period-0 equity issuance. To satisfy the capital requirement, banks need to issue

$$\Delta e_0 = \{\rho - e_0 + (1 - q_0)\, m_0\}^+ \tag{11}$$

**Lemma 1** *All newly issued equity at period 0 is invested in the MTM assets.*

By purchasing MTM long-term assets using newly issued equity, banks reduce their MTM asset holdings at the beginning of the period. This strategy minimizes capital losses in the MTM account and lowers the cost of issuing equity.

At the end of period 0, the HTM long-term asset holding stays constant $h_1 = h_0 = h$. MTM long-term asset holding follows $m_1 = m_0 + \frac{\Delta e_0}{q_0}$. Since the bank has one unit of deposit, the required capital holding is $\rho$. Therefore, the book equity at period 1 before the interest rate shock is

$$e_1 = \max\{\rho, e_0 - (1 - q_0) m_0\} \tag{12}$$

The initial equity level $e_0$ determines whether the capital requirement is binding at the beginning of period 1. If $e_0 > \rho + (1 - q_0) m_0$, the capital requirement is non-binding at the end of period 0. The bank's book equity remains above the minimum requirement even after accounting for unrealized capital losses in period 0, $(1-q_0)m_0$. If $e_0 < \rho+(1-q_0)m_0$, the capital requirement is binding at the end of period 0. Banks enter period 1 with $e_1 = \rho$ units of capital.

**Lemma 2** *Banks do not reclassify long-term assets at the beginning of period 1 before the interest rate shock is realized.*

Lemma 2 suggests that banks are disincentivized from transferring assets between MTM and HTM accounts at the beginning of period 1. They avoid transferring assets from MTM to HTM; instead, they reduce their MTM holdings at the beginning of period 0. Similarly, transferring assets from HTM to MTM is undesirable because it would cause all remaining assets to be marked to market, resulting in greater capital losses if the interest rate further increases at period 1.

When the interest rate remains put at period 1, $q = q_0$, banks do not face further rate-driven deposit outflow and, therefore, they do not need to issue more equity.

When the interest rate further increases in period 1, the market value of long-term assets decreases from $q_0$ to $q_1$. $\lambda$ units of uninsured depositors withdraw their funds from the banking system. This withdrawal can trigger banks to liquidate HTM assets, causing book equity losses on both MTM and HTM assets, necessitating new equity issuance. Lemma 3 summarizes these results.

**Lemma 3** *The equity issuance at period 1 when $q = q_1$ follows*

$$\Delta e_1 = \begin{cases} [\rho - e_1 + (q_0 - q_1)\, m_1]^+ , & \text{if } 1 - d_1 \le q_1 m_1 \\ [\rho - e_1 + (q_0 - q_1)\, m_1 + (1 - q_1)h]^+ , & \text{if } 1 - d_1 > q_1 m_1, \end{cases} \tag{13}$$

where the deposit quantity after the period-1 interest rate shock is denoted as $d_1$. $1 - d_1$ is the amount of deposit withdrawal, conditional on the conjecture that depositors do not withdraw deposits at period 0.Whether banks need to issue new equity hinges on whether the bank must liquidate HTM long-term assets. If the MTM long-term assets are sufficient to satisfy liquidity demands, $1 - d_1 \le q_1 m_1$, banks incur only unrealized capital losses from MTM assets. If liquidity demands exceed the value of MTM assets, $1 - d_1 > q_1 m_1$, all long-term assets must be marked to market, leading to significant new equity issuance costs to fulfill capital requirements.

## 4.2 Equilibrium at Period 1

When the policy rate in period 1 stays the same as in period 0, $q = q_0$, there are no exogenous deposit outflows in period 1. The bank will not issue new equity. The value of deposits at period 1 then follows

$$v^d(q_0) = q_0(m_1 + h). \tag{14}$$

When the policy rate further increases at period 1, $q = q_1 < q_0$, some uninsured depositors who withdraw their money from the banking system. If the MTM long-term assets are enough to satisfy the exogenous liquidity demand ($q_1 m_1 > \lambda$), the value of deposits after the deposit withdrawal $d_1$ becomes

$$v^d(q_1) = (q_1 m_1 - (1 - d_1) + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \tag{15}$$

If banks must liquidate long-term assets in the HTM account to meet their liquidity needs, all HTM assets must be marked-to-market. The value of deposits after the deposit withdrawal $d_1$ then becomes

$$v^d(q_1) = (q_1 m_1 - (1 - d_1) + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ \tag{16}$$

The additional cost $\kappa(1-q_1)h$ is caused by banks liquidating HTM assets and, consequently, being forced to mark all HTM assets to market.

#### 4.2.1 Interest Rate Risks and Uninsured Depositor Run

When the interest rate further increases at period 1 ($q = q_1$), the interest rate increase could lead to runs of uninsured depositors. All uninsured depositors run if they perceive the value of deposits is lower than the required return of deposits, that is, one. Proposition 1 characterizes how the interest rate risk causes uninsured depositors to run on the bank.

**Proposition 1 (Interest Rate Risk and Uninsured Depositor Run)** *All uninsured depositors run when only insured depositors remain at the bank, $d_1 = 1 - u$. There is no run in equilibrium when there is only exogenous rate-driven deposit outflow, $d_1 = 1 - \lambda$.*

- *Scenario 1: when the value of MTM assets is sufficiently high, $q_1 m_1 > u$, there are two equilibrium regions depending on the value of deposits without liquidation of HTM long-term assets.*
  - *There is a unique no-run equilibrium if the value of deposits is higher than $d_1$, $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ > 1$.*
  - *There is a unique run equilibrium if if the value of deposits is lower than $d_1$, $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ < 1$.*

- *Scenario 2: when the value of MTM assets is of intermediate level,* $u > q_1 m_1 > \lambda$*, there are three equilibrium regions depending on the value of deposits with and without liquidation of HTM long-term assets.*
  - *There is a unique no-run equilibrium if the value of deposits with liquidation of HTM assets is higher than* $d_1$*,* $(q_1m_1+q_1h)-\kappa\left\{\rho - e_1 + m_1(q_0 - q_1) + (1-q_1)h\right\}^+ > 1$.
  - *There is a unique run equilibrium if the value of deposits without liquidation of HTM assets is lower than* $d_1$*,* $(q_1m_1 + q_1h) - \kappa\left\{\rho - e_1 + m_1(q_0 - q_1)\right\}^+ < 1$.
  - *There exists a no-run equilibrium and a run equilibrium if* $(q_1m_1 + q_1h) - \kappa\left\{\rho - e_1 + m_1(q_0 - q_1) + (1-q_1)h\right\}^+ < 1$ *and* $(q_1m_1+q_1h)-\kappa\left\{\rho - e_1 + m_1(q_0 - q_1)\right\}^+ > 1$.
- *Scenario 3: when the value of MTM assets is low,* $u > \lambda > q_1m_1$*, there are two equilibrium regions depending on value of deposits with liquidation of HTM long-term assets.*
  - *There is a unique no-run equilibrium if the value of deposits is higher than* $d_1$*,* $(q_1m_1 + q_1h) - \kappa\left\{\rho - e_1 + m_1(q_0 - q_1) + (1-q_1)h\right\}^+ > 1$.
  - *There is a unique run equilibrium if if the value of deposits is lower than* $d_1$*,* $(q_1m_1 + q_1h) - \kappa\left\{\rho - e_1 + m_1(q_0 - q_1) + (1-q_1)h\right\}^+ < 1$.

Proposition 1 implies that multiple equilibria exist only when the value of deposits with(out) liquidation of HTM long-term assets is lower (higher) than $d_1$, that is, the promised return of depositors' outside option.

### 4.3 Equilibrium at Period 0

In this section, we study the banks' classification decisions of long-term assets at period 0, in particular, how banks' equity ratio affects the classification of long-term assets in HTM or MTM account.

To study the dynamic trade-off of HTM long-term assets at period 0, we assume that depositors are optimistic about the bank for the rest of the paper. They only expect a bank run when a run is the only possible equilibrium.

**Assumption 4** *Depositors are optimistic. They believe that other uninsured depositors choose not to run on the bank when multiple equilibria could exist.*

Proposition 1 then implies a no-run equilibrium when the value of deposits without liquidation of HTM long-term assets is greater than $d_1$ in Scenarios 1 and 2, or when the value of deposits with liquidation of HTM long-term assets is greater than $d_1$ in Scenario 3.

Assumption 5 guarantees that the value of deposits at period 0 is greater than 1 even if all the long-term assets are marked-to-market.

**Assumption 5**

$$q_0(1+e_0) - \kappa\left[\rho - e_0 + (1-q_0)\right] > 1$$

Assumptions 4 and 5 altogether guarantee that there would be no bank run for all banks if the policy rate is the same across periods 0 and 1.

Denote a banker's value over deposits $V^d(q)$,

$$V^d(q) = \begin{cases} v^d(q) & \text{if } v^d(q) \geq d \\ 0 & \text{if } v^d(q) < d, \end{cases} \tag{17}$$

Bankers do not care about the value of deposits in the run equilibrium.

At period 0, banks choose their long-term asset positions in the HTM account to maximize

$$-(\kappa+1)\left\{\rho - e_0 + (1-q_0)m_0\right\}^+ + pV^d(q_1) + (1-p)V^d(q_0) \tag{18}$$

where the short-term discount factor is normalized to 1, and $p$ denotes banks' subjective belief about future interest rate increases. The first element in Equation (18) represents the equity issuance cost at period 0, while the last two elements reflect the expected present value of the period-1 value of deposits, if it is a no-run equilibrium.

We now turn to our main finding which examines the impact of the equity ratio on the classification of long-term assets as HTM or MTM. Banks face a dynamic trade-off between holding MTM long-term assets and HTM ones: while MTM can result in capital loss and equity issuance cost in the current period, it may also reduce the probability of a bank run in period 1, thereby enhancing future value of deposits. This dynamic trade-off exists if and only if the capital requirement at the end of period 0 is binding. Therefore, our analysis first focuses on the case where $e_1 = \rho$. In this case, banks accumulate liquidity at period 0 when the resulting capital loss and equity issuance cost is less than the benefit of avoiding bank runs at period 1.

$$-(\kappa+p)\left[\rho - e_0 + (1-q_0)m_0\right] + pV^d(q_1) \geq 0, \tag{19}$$

where the first term represents the opportunity cost from issuing equity capital at period 0, and the last term indicates the value of deposits at period 1 when the interest rate further increases, which is positive only if value of deposits is higher than promised return of depositors' outside option.

**Lemma 4** *Assume the equity issuance cost is small enough,* $\kappa < \frac{q_1(1-q_0)}{q_0-q_1}$.

- *If* $\overline{h} < 0$*, there is a unique run equilibrium when the policy rate further increases at period 1, and therefore,* $h = 1 + e_0$.
- *If* $0 < \overline{h} < \widetilde{h}$*, it is a no-run equilibrium when the policy rate further increases at period 1 for* $h < \overline{h}$*, while a run equilibrium for* $h > \overline{h}$*. Banks choose* $h \in \{1 + e_0, \overline{h}\}$.
- *If* $\overline{h} > \widetilde{h}$ *and* $\underline{h} > \widetilde{h}$*, it is a no-run equilibrium when the policy rate further increases at period 1 for* $h < \underline{h}$*, while a run equilibrium for* $h > \underline{h}$*. Banks choose* $h \in \{1+e_0, \underline{h}\}$.
- *If* $\overline{h} > \widetilde{h}$ *and* $\underline{h} < \widetilde{h}$*, it is a no-run equilibrium when the policy rate further increases at period 1 for* $h < \widetilde{h}$*, while a run equilibrium for* $h > \widetilde{h}$*. Banks choose* $h \in \{1+e_0, \widetilde{h}\}$.

$\widetilde{h}$*,* $\overline{h}$*, and* $\underline{h}$ *are defined as* $1+\rho-\frac{\lambda q_0}{q_1}$, $\frac{-1-\kappa(1+\rho)(q_0-q_1)+q_1(1+\rho)}{q_1(1-q_0)-\kappa(q_0-q_1)}$*, and* $\frac{-1-\kappa(1+\rho)(q_0-q_1)+q_1(1+\rho)}{q_1(1-q_0)-\kappa(q_0-q_1)+\kappa q_0(1-q_1)}$*, respectively.*

When banks initially hold $\widetilde{h}$ units of HTM assets, $q_1 m_1 = \lambda$. Therefore, there would be no liquidation of HTM long-term assets when the policy rate increases at period 1 for $h \leq \widetilde{h}$, while all the HTM assets are marked-to-market for $h > \widetilde{h}$. In the first scenario in Lemma 4, $\overline{h} < 0$ implies that the value of deposits without liquidation of HTM long-term assets is lower than the promised return of depositors' outside option $(1 \times d_1)$ at period 1 when $q = q_1$. Therefore, there is a unique run equilibrium when the policy rate further increases at period 1. Banks anticipate unavoidable runs and prefer to hold all their assets in the HTM account at period 0, that is, $h = 1 + e_0$.

In the second scenario in Lemma 4, for $h < \overline{h}$, the value of deposits without liquidation of HTM long-term assets is higher than $d_1$ at period 1 when $q = q_1$. For $\overline{h} < h < \widetilde{h}$ and $h > \widetilde{h}$, the value of deposits is lower than $d_1$ at period 1 when $q = q_1$. Banks will hold just enough MTM long-term assets $(1 + e_0 - \overline{h})$ at period 0 if it is optimal to be in the no-run equilibrium at period 1. If the bank holds MTM long-term assets less than $1+e_0-\overline{h}$, it will face bank run and lose value of deposits at period 1. Conversely, holding MTM long-term assets greater than $1 + e_0 - \overline{h}$ results in higher capital loss and equity issuance costs today. Therefore, if it is optimal to lie in the no-run equilibrium, banks choose $h = \overline{h}$. Conversely, if it is optimal to default when the policy rate further increases at period 1, banks choose $h = 1 + e_0$. The intuition in the last two scenarios is the same.

For the rest of the paper, we focus on the last scenario in Lemma 4 where $\overline{h} > \widetilde{h}$ and $\underline{h} < \widetilde{h}$. Our results are robust in the other three scenarios. By choosing $h = \widetilde{h}$, banks pay equity issuance cost

$$(\kappa + p)\left[\rho - e_0 + (1 - q_0)m_0\right]|_{m_0 = 1 + e_0 - \widetilde{h}} \tag{20}$$

In addition, by choosing $h = \widetilde{h}$, banks gain future value of deposit

$$pV^d(q_1) = p\left[(q_1 m_1 - \lambda + q_1 h) - \kappa m_1(q_0 - q_1)\right]|_{q_1 m_1 = \lambda} \tag{21}$$

**Assumption 6**

$$-(\kappa + p)(1 - q_0)\frac{\lambda q_0}{q_1} + p\left[q_1(1 + \rho) - \lambda q_0 - \kappa\lambda\frac{q_0 - q_1}{q_1}\right] < 0$$

Assumption 6 implies that for banks with an initial equity level at the lower bound $e_0 = \rho$, the marginal benefit of holding liquidity buffer is negative. This technical assumption ensures that Equations (19), (20), and (21) together identify a unique threshold for the bank's initial equity holding at date 0, $\overline{e}(\lambda, q_1, p)$. Banks will choose to mark-to-market a sufficient portion of long-term assets, $h = \widetilde{h}$, only if their equity exceeds this threshold, $e_0 > \overline{e}(\lambda, q_1, p)$.

When $e_0 > \rho + (1 - q_0)\left(1 + e_0 - \widetilde{h}\right)$, the capital requirement at the beginning of period 1 would be non-binding even when banks hold enough liquidity for the possible high interest rate state in period 1. In this case, $\Delta e_0 = 0$. Banks will optimally choose $h = \widetilde{h}$.

Therefore, we establish the conditions under which banks choose period-0 classification that keeps them solvent in period 1, even if the long-term interest rate rises and market value of asset falls to $q_1$.

**Proposition 2** *The classification of long-term assets at period* 0 *relies on banks' initial equity:*

- *When* $e_0 \geq \rho + (1 - q_0)\left(1 + e_0 - \widetilde{h}\right)$, $h = \widetilde{h}$, $m_0 = 1 + e_0 - \widetilde{h}$, $\Delta e_0 = 0$. *In this case, it is a no-run equilibrium in period 1.*
- *When* $\overline{e} \leq e_0 < \rho + (1 - q_0)\left(1 + e_0 - \widetilde{h}\right)$, $h = \widetilde{h}$, $m_0 = 1 + e_0 - \widetilde{h}$, $\Delta e_0 = \rho - e_0 + (1 - q_0)m_0$. *In this case, it is a no-run equilibrium in period 1.*
- *When* $\rho \leq e_0 < \overline{e}$, $h = 1 + e_0$, $m_0 = 0$, $\Delta e_0 = 0$. *In this case, it is a run equilibrium in period 1.*

Proposition 2 implies that if banks' initial equity level is greater than $\overline{e}$, they are willing to incur the capital loss in the MTM account in exchange for future returns by holding lower HTM share. Conversely, if banks' initial equity level is limited and the marginal benefit of holding MTM is negative, they will choose to hold all their long-term assets in the HTM account to maximize their current value. Those banks with equity below $\bar{e}$ put all long-term assets in the HTM account in the hope of a future low-interest-rate environment. This is consistent with the empirical evidence in Section 2, where we find that banks with higher equity ratios are more likely to reduce their HTM share during periods of monetary tightening.

As previously noted, $p$ denotes banks' subjective expectations regarding future interest rate risks. The following proposition illustrates how banks' optimism about the future influences the likelihood of a bank run.

**Proposition 3** *When banks are more optimistic, expecting a lower probability $p$, that a further rate increase at period 1 is unlikely, threshold equity level $\bar{e}(\lambda, q_1, p)$ increases.*

As optimism about the future increases (i.e., $p$ decreases), more banks allocate the majority of their long-term assets to the HTM account. In the extreme case where $p = 0$, banks assign zero probability to a positive future interest rate shock. As a result, the cutoff $\bar{e}$ approaches infinity, causing all banks to hold the majority of their long-term assets in the HTM account, with only the minimum necessary in MTM to meet period-0 liquidity demands.

**Proposition 4** $\bar{e}(\lambda, q_1, p)$ *increases when*

- *period-1 liquidity withdrawal $\lambda$ increases;*
- *or asset value of long-term asset $q_1$ decreases.*

Proposition 4 outlines the factors influencing banks' motivation to engage in accounting manipulation. A higher $\bar{e}$ indicates an increase in the likelihood of accounting manipulation. When the period-1 liquidity withdrawal $\lambda$ is higher, the marginal benefit of holding MTM assets falls, thereby increasing $\bar{e}$. Moreover, an increase in period-1 interest rate reduces the market value of long-term assets $q_1$, reducing the benefits of holding MTM assets and thus heightening $\bar{e}$.

As implied from Proposition 1, with more uninsured depositor, that is, a higher $u$, the region that exists multiple equilibria will be be larger. In addition, the uninsured deposit ratio would also affect $\bar{e}(\lambda, q_1, p)$ once we assume that the uninsured deposit leads to more deposit withdrawal $\lambda$. We provide evidence in Section 2 and will provide micro-foundation of how uninsured deposit ratio leads to higher rate-driven deposit outflow in our full model.

## 5 Optimal Capital Issuance and Cap on HTM Share

In this section, we examine optimal regulations on bank equity issuance and held-to-maturity share caps, with a focus on the externality arising from banks' underestimation of interest rate risk. Incorporating banks' market power, the full model allows for a deeper analysis of optimal regulation, accounting for limited liability and banks' risk-taking incentives.

### 5.1 Underestimation of Interest Rate Risk

What is the optimal policy under these constraints if regulators can set both a cap on HTM assets and a required equity issuance? To answer this question, we write down regulators' optimization problem. Suppose the regulator selects a HTM cap $\widehat{h}$ and an equity issuance $\Delta e$ at period 0 to maximize the expected value of deposits,

$$\max_{\widehat{h},\Delta e}\{-(\kappa+1)\Delta e + p_R V^d(q_1) + (1-p_R)V^d(q_0)\}, \text{ s.t. } h < \widehat{h}$$

where the first term represents the equity issuance cost. $p_R$ denotes regulators' subjective belief that the long-term interest rate may further increase in period 1.

**Assumption 7** *Regulators are more concerned about rate increases than banks, $p_R > p$.*

We use the difference in risk perception to reflect regulators' concern about bank fragility under rate increases. Proposition 5 captures the optimal capital issuance and HTM share under underestimation of interest rate risks.

**Proposition 5 (Optimal Capital Issuance and HTM Share Cap)** *The optimal capital issuance and HTM cap are*

$$(\widehat{h}^*, \Delta e^*) = \begin{cases} (\geq \widetilde{h}, 0) & \text{if } e_0 > \rho + (1-q_0)\left(1+e_0-\widetilde{h}\right) \\ (\geq \widetilde{h}, \widetilde{e}(e_0)) & \text{if } \overline{e} < e_0 < \rho + (1-q_0)\left(1+e_0-\widetilde{h}\right) \\ (\widetilde{h}, \widetilde{e}(e_0)) & \text{if } \max\{\overline{e}_R, \rho\} < e_0 < \overline{e} \\ (1+e_0, 0) & \text{if } e_0 < \max\{\overline{e}_R, \rho\} \end{cases} \tag{22}$$

*where $\widetilde{e}(e_0) = \rho - e_0 + (1-q_0)(1+e_0-\widetilde{h})$, and $\overline{e}_R$ is the lower bound of bank equity that satisfies inequality (19) under probability $p_R$. The optimal share cap would be $\frac{\widetilde{h}}{1+e_0}$.*

$\overline{e}_R$ represents the threshold above which the bank regulator aims to ensure bank solvency in period 1. It increases when the bank regulator is more optimistic, that is, when $p_R$ is smaller. Proposition 5 suggests that the optimal regulations for equity issuance and HTM share caps depend on the initial equity level. When equity exceeds $\rho+(1-q_0)\left(1+e_0-\widetilde{h}\right)$, banks maintain sufficient book equity above the minimum requirement, negating the need for HTM share caps or new equity issuance. When $\overline{e} \leq e_0 < \rho + (1-q_0)\left(1+e_0-\widetilde{h}\right)$, banks voluntarily hold sufficient liquidity and issue $\widetilde{e}(e_0)$, eliminating the need for a HTM share cap. When $\max\{\overline{e}_R, \rho\} \leq e_0 < \overline{e}$, banks hold just enough liquidity for period-0 deposit outflows, risking a bank run in period 1 when the policy rate is high. To prevent this, the regulator imposes an HTM share cap below 1 and issue $\widetilde{e}(e_0)$ to ensure sufficient liquidity. When $e_0 < \max\{\overline{e}_R, \rho\}$, a bank run in period 1 is unavoidable, thus the optimal HTM share cap is set at 1, with no need for new equity issuance.

Figure 3 illustrates the optimal policies for equity issuance $\Delta e^*$ and and the HTM share cap $\widehat{h}^*$. Unlike in the decentralized equilibrium, the regulator mandates higher equity issuance and enforces an HTM share cap below 1, but only for mid-sized banks with initial equity levels in the range of $\max\{\overline{e}_R, \rho\} \leq e_0 < \overline{e}$. The bank run threshold decreases from $\overline{e}$ in the decentralized equilibrium to $\max\{\overline{e}_R, \rho\}$ in the regulator's problem.

As long as the regulator sets an HTM share cap below 1 for mid-sized banks, these banks will voluntarily issue $\widetilde{e}(e_0)$ to offset capital losses from MTM assets. Conversely, if the regulator only mandates new equity issuance, banks will ensure sufficient liquidity at the start of period 0. Thus, either equity issuance or an HTM share cap can effectively prevent unintended bank runs. Proposition 6 summarizes this finding.

**Proposition 6** *Either mandated equity issuance or HTM share cap is effective in preventing unintended bank runs.*

# 6 Full Model

In this section, we extend the two-period model by incorporating imperfect bank competition, building on recent literature on bank runs, including Drechsler et al. (2023) and DeMarzo et al. (2024). This extension examines how bank asset classification is influenced by positive profits and risk-taking behavior under limited liability. Additionally, the framework provides a micro-foundation for the positive relationship between uninsured deposits and rate-driven deposit outflows, which in turn shapes banks' incentives to classify long-term assets as held-to-maturity.

## 6.1 Additional Model Ingredients

Time lasts forever and is indexed by $t = 0, 1, 2, \cdots$. The economy is populated with $N$ banks, a unit measure of depositors, and a competitive money market mutual funds

(MMMF) sector. Banks are identical. Each depositor is endowed with a unit of wealth. Some depositors are insured. Others are not.

### Interest Rates and Discount Factors

Denote the long-term policy interest rate at period $t$ as $r_t$. We assume that there are consecutive interest rate shocks in periods 0 and 1. Denote the realized policy rate at period 0 as $r_0$. The realized policy rate at period 1

$$r_1 = \begin{cases} r_0 & \text{w.p. } 1-p, \\ r_h & \text{w.p. } p. \end{cases} \tag{23}$$

With the probability of $p$, banks expect that the policy rate increases to $r_h$; otherwise, banks expect that it remains at $r_0$. To simplify our analysis, we assume that there are no further interest rate shocks afterward.

$$r_t = r_1, \text{ for all } t \geq 2. \tag{24}$$

The interest rate shocks at periods 0 and 1 are persistent.

Bankers and depositors discount future returns at the market rate $r_t$. We calculate the book value of HTM assets using a constant discount rate $r$. $r$ is the book return of long-term assets. It stays constant over time. The market value of a bank does not directly depend on whether long-term assets are classified as HTM or MTM, as future returns are all discounted using the market rate.

At period 0, the real policy rate increases to $r_0$. At period 1, the real policy rate may increase further to $r_h$. That is, we assume that $r_h > r_0 > r$. The assumed order of interest rates is summarized in Assumption 8.

**Assumption 8** *Interest rates and discount factors satisfy the following orders:*

$$r_h > r_0 > r, \textit{ for all } t. \tag{25}$$

### Depositors

There are $1-u$ insured depositors and $u$ uninsured depositors. Each of them is endowed with a unit of wealth. We index depositors by $i \in [0,1]$. All of them are matched with one of the $N$ banks at the beginning of period 0. Insured and uninsured depositors are distributed evenly across banks. So the total deposit quantity is initially 1, each bank has $1/N$ units of deposits, and a $u$ fraction of their deposits are uninsured.

At the beginning of each period, a policy rate shock may arrive and is observed by depositors. Depositors then decide whether to withdraw their deposits or not. Insured depositors' outside option is holding cash or depositing money in the checking account, which promises a zero net return. An uninsured depositor $i$ can access money mutual funds at some switching costs. Net of the depositor's accessing cost, the outside option promises an idiosyncratic return, $r_{it}$ at period $t$.

$$r_{it} = \tilde{\beta}_i r_t - F, \tag{26}$$

where $\tilde{\beta}_i$ is an i.i.d. draw from a uniform distribution $U[0,1]$, and $F > 0$ is a fixed switching cost. $\tilde{\beta}_i$ is constant over time. The return $r_{it}$ is a depositor's private information. So, the deposit rate cannot be contingent on it. An uninsured depositor $i$ remains in the bank when the idiosyncratic return is below the deposit rate $r_{it} < r_t^d$ when the bank is solvent and can fulfill the promised deposit rate.

Uninsured depositors may also withdraw when they expect that the bank will be insolvent. Denote the expected market value of the bank at period $t$ $V_t$. We call the ratio of the bank value per deposit, $v_t = \frac{V_t}{d_{t-1}}$, its solvency ratio. Denote the probability that an uninsured depositor withdraws his deposits at period $t$ $G$. It depends on the solvency ratio, $G$ is a function of $v_t$. We assume that it is a step function around an insolvency threshold $\underline{v}$,

$$G(v) = \begin{cases} 1 & v > \underline{v} \\ 0 & v < \underline{v} \end{cases} \tag{27}$$

It is natural to assume that the threshold is 0, $\underline{v} = 0$, but other values of $\underline{v}$ do not change our analyses qualitatively. This is the second reason that an uninsured depositor may withdraw his deposit.

In addition to the interest rate-driven and panic-driven outflows, at the end of periods $t \geq 0$ the bank experiences exogenous deposit outflows at a rate $\delta$. This means deposits have an average maturity $1/\delta$. These outflows capture the natural decay of a bank's deposit franchise without further investment in their depositor base. Overall, an uninsured depositor remains at period $t$ with probability $(1-\delta)^t \times \text{Prob}(r_t^d \geq r_{it}) \times G(v_t)$. As before, we assume insured depositors are rate insentitive. Therefore, an insured depositor remains at period $t$ with probability $(1-\delta)^t$.

Adding up the uninsured and insured depositors that remain at the banking sector at the end of period $t$, we get that the total deposit supply at the end of period $t$ is

$$d_t = (1-\delta)^t \left[1 - u + u \times \text{Prob}(r_t^d \geq r_{it}) \times G(v_t)\right] \tag{28}$$

### Banks

Banks engage in Cournot competition. Initially, the bank $n$ have equity $e_{n0}$ and $d_{n0} = 1/N$ unit of deposit, which are invested in long-term assets in MTM v.s. HTM account, that is, $m_{n0}$ and $h_{n0}$. At the beginning of period $t$, bank $n$ observes the policy rate $r_t$, and decides on its deposit quantity $d'_{nt}$ and whether to liquidate its asset holdings to meet deposit withdrawals $d_{nt} - d'_{nt}$. The items $x = h, m, d, e$ on banks' balance sheets before the interest rate shock at period $t$ is denoted as $x_{nt}$, and those after the interest rate shock is denoted as $x'_{nt}$.

Banks also decide whether to classify their long-term assets in the HTM or MTM account before observing the policy rate. The future returns of MTM long-term assets are discounted at the market rate, $1/(1 + r_t)$. However, when calculating the book equity value, the future returns of of HTM long-term assets are discount at the predetermined rate $r$ as if the unrealized capital gains or losses would never be realized.

The bank $n$ faces a capital requirement $e'_{nt} \geq \rho(1-\delta)^t d_{n0}$. All other items on the balance sheet face exogenous outflows at rate $\delta$ at the end of each period. This ensures that banks' assets match their liabilities. Since there are no further interest rate shocks at periods $t \geq 2$, item $x = h, m, d, e$ on bank $n$'s balance sheet shrinks exogenously, $x_{nt} = (1 - \delta)^t x_{n1}$. A bank pays a fixed operating cost in each period. It shrinks at the same rate as the scale of its balance sheet. The cost at period $t$ is $c(1 - \delta)^{t-1}$.

## 6.2 Equilibrium Characterization

Throughout the full model, we will focus on the symmetric equilibrium.

**Definition 1 (Symmetric Equilibrium)** *A symmetric equilibrium is ${d'_{nt}}^* = d'_t/N$ such that the bank market value is maximized at ${d'_{nt}}^* = d'_t/N$, given other banks' deposit choice ${d'_{-nt}}^* = d'_t/N$ and its own portfolio holding $h'_{nt} = h'_{-nt} = h'_t/N$, $m'_{nt} = m'_{-nt} = m'_t/N$, $e'_{nt} = e'_{-nt} = e'_t/N$.*

In the symmetric equilibrium, the total value of all banks is given by $NV({d'_{nt}}^*, \Delta e_{nt}) = V(N{d'_{nt}}^*, N\Delta e_{nt}) = V(d_t'^*, \Delta e_t)$ at the optimal deposit rate. Our analysis will focus on this total bank value from this point onward. For simplicity, we now denote $V(d'_t, \Delta e_t)$ as $V(d'_t)$.

We will leave all other detailed analyses that are similar to the two-period model in the Appendix.

### 6.3 Uninsured Deposits and Rate-driven Deposit Outflows

In this section, we show the positive correlation between uninsured depositor ratio and the amount of rate-driven deposit outflows when the policy rate increases.

**Proposition 7 (Uninsured Deposit and Rate-driven Outflow)** *In the no-run equilibrium, the equilibrium deposit rate is* $r^d = \frac{Nr - \frac{1-u}{u} r - F}{N+1}$*, the deposit rate beta is positive, and the deposit growth beta is negative.*

$$\frac{dr^d}{dr} > 0 \, , \, \frac{d \log d'}{dr} < 0. \tag{29}$$

*Both the deposit rate and the deposit quantity become more sensitive to the policy rate when the uninsured deposit ratio* $u$ *is high,*

$$\frac{d}{du}\left(\frac{dr^d}{dr}\right) > 0 \, , \, \frac{d}{du}\left(\left|\frac{d \log(d')}{dr}\right|\right) \geq 0. \tag{30}$$

Proposition 7 is consistent with the empirical findings on the deposit rate and growth betas in Section 2.4. Banks with higher uninsured deposit ratios expect escalated deposit outflows when the policy rate increases. In response to the rate-sensitive deposit outflow, these banks offer higher deposit rates to retain depositors. This implies that banks with higher uninsured deposits have lower effective market power.

### 6.4 Optimal Regulation under Limited Liability

Given the limited liability, banks may take excessive risks by holding too many HTM long-term assets. To address this, consider a scenario where the regulator is also concerned with depositors' welfare. In this case, the regulator would choose a uniform HTM cap $\widehat{h}$ and an equity issuance $\Delta e$ at period 0 to maximize the combined expected value of banks and depositors, excluding FDIC transfers.

$$\max_{\widehat{h}, \Delta e} \left\{ (1 - p\frac{1-\delta}{1+r_0})\overline{V}(d'_0) + p\mathrm{PV}(V(d'_1)|_{r_1 = r_h}) - (\kappa+1)\Delta e + \sum_{t=1}^{\infty} \frac{(\delta + r^d_{t-1}) d'_{t-1} \mathbb{1}(V(d'_{t-1}) > 0)}{\Pi_{s=0}^{t}(1+r_s)} \right\},$$
$$\text{s.t.} \quad h \leq \widehat{h}$$

where the first three term captures the bank market value net equity issuance cost, and the last term captures the expected value of depositors, which is positive if and only if banks are solvent. $\overline{V}(d'_0)$ denotes the market value of banks if the policy rate remains at $r = r_0$.

For the regulator, the marginal benefit of imposing a HTM share cap is given by

$$\begin{aligned}&-(\kappa+p\frac{1-\delta}{1+r_0})q_0\left[\rho-e_0+(1-q_0)(\lambda_0^*+\lambda_1^*)\right]\\&+\mathrm{PV}(V(d_1')|_{r_1=r_h})+\frac{p}{1+r_0}\frac{(r_1^d+\delta)d_1'}{r_h+\delta},\end{aligned}\tag{31}$$

which is positive when $e_0>\overline{e}_D$. $q_0\lambda_0^*$ and $q_1\lambda_1^*$ captures the rate-driven deposit outflows at periods 0 and 1. The primary distinction between Equations (19) and (31) lies in the final term of Equation (31), which reflects the expected value for depositors if the interest rate increases to $r_h$ in period 1. Given that the marginal benefit of imposing an HTM share cap is higher, it follows that $\overline{e}_D<\overline{e}$.

**Proposition 8 (Optimal Capital Issuance and HTM Share Cap)** *The optimal capital level and HTM cap are*

$$(\widehat{h}^*,\Delta e^*)=\begin{cases}(\geq 1+\rho-q_0(\lambda_0^*+\lambda_1^*),0) & e_0\geq\rho+(1-q_0)(\lambda_0^*+\lambda_1^*)\\(\geq 1+\rho-q_0(\lambda_0^*+\lambda_1^*),\widetilde{e}(e_0)) & \overline{e}\leq e_0<\rho+(1-q_0)(\lambda_0^*+\lambda_1^*)\\(1+\rho-q_0(\lambda_0^*+\lambda_1^*),\widetilde{e}(e_0)) & \max\{\overline{e}_D,\underline{e}\}\leq e_0<\overline{e}\\(1+e_0,0) & \underline{e}<e_0<\max\{\overline{e}_D,\underline{e}\}\end{cases}$$

*where* $\widetilde{e}(e_0)=q_0\left[\rho-e_0+(1-q_0)(\lambda_0^*+\lambda_1^*)\right]$*, and* $\overline{e}_D$ *represents the equity level at which Equation (31) is equal to zero. The optimal HTM share cap would be* $\frac{1+\rho-q_0(\lambda_0^*+\lambda_1^*)}{1+e_0}$.

Proposition 8 suggests that a regulator concerned with depositors' welfare would require higher equity issuance and impose an HTM share cap below 1 specifically for mid-sized banks with initial equity levels within the range $\max\{\overline{e}_D,\underline{e}\}\leq e_0<\overline{e}$. Additionally, either of these regulatory tools effectively prevents unintended bank runs. Figure 4 visualizes these outcomes.

## 7 Conclusion

In this paper, we study the role of held-to-maturity vs marked-to-market accounting for bank vulnerability to interest rate risks and optimal design of HTM accounting rule, in conjuncture with the capital requirement. Empirically, using bank-level data from Call Report, we find that banks with lower equity ratios and higher uninsured deposit ratios tend to increase HTM asset shares more in response to increase in policy rate. Disciplined by these findings, we then introduce HTM versus MTM accounting, uninsured deposit, capital requirement and costly equity issuance to a banking model with imperfect competition. In such a framework, banks face a trade-off between classifying long-term assets into HTM account to satisfy the capital requirement, without incurring costly equity issuance, when interest rates increase today, against the increased run risks in the future once interest rate increases further.

With this trade-off, our model predicts that banks with low regulatory capital ( high uninsured deposit share) have higher marginal benefits (lower marginal cost) of classifying assets into HTM account, and tend to have higher HTM asset share when the policy rate increases. In particular, when banks underestimate the future probability of interest rate increases and have limited liability to depositors once default, we should that banks tend to hold higher share of long-term assets than the level desired by policymakers. Our theory suggests policymakers should design a cap on held-to-maturity long-term assets or mandate more equity capital issuance, which may reduce the run risks of banks with a moderate amount of capital. Our empirical evidence using the U.S. Call Reports supports the key predictions of our theory.

| Variables | All | | Low UD Ratio | | High UD Ratio | |
|---|---|---|---|---|---|---|
| | Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. |
| Uninsured Deposit (UD) Ratio | 0.325 | 0.152 | 0.209 | 0.063 | 0.442 | 0.123 |
| Uninsured Deposit to Asset Ratio | 0.274 | 0.127 | 0.177 | 0.055 | 0.371 | 0.103 |
| Deposit Rate | 0.680% | 0.005 | 0.713% | 0.005 | 0.647% | 0.005 |
| Domestic Deposit Rate | 0.679% | 0.005 | 0.713% | 0.005 | 0.645% | 0.005 |
| ln(Total Deposit) | 19.1 | 1.42 | 18.6 | 1.07 | 19.7 | 1.52 |
| Loan/Deposit | 0.718 | 0.201 | 0.723 | 0.191 | 0.713 | 0.210 |
| (Loan+HTM)/Deposit | 0.751 | 0.199 | 0.757 | 0.191 | 0.744 | 0.207 |
| Securities/Assets | 23.3% | 0.154 | 23.0% | 0.148 | 23.5% | 0.161 |
| HTM/Assets | 2.67% | 0.076 | 2.79% | 0.077 | 2.55% | 0.075 |
| AFS/Assets | 20.6% | 0.153 | 20.2% | 0.148 | 21.0% | 0.157 |
| HTM/Securities | 12.1% | 0.266 | 13.0% | 0.285 | 11.1% | 0.245 |
| Herfindahl-Hirschman Index (HHI) | 0.157 | 0.125 | 0.167 | 0.122 | 0.146 | 0.127 |
| ln(Asset) | 19.3 | 1.42 | 18.8 | 1.08 | 19.8 | 1.52 |
| Equity Ratio | 11.1% | 0.045 | 11.2% | 0.036 | 11.0% | 0.053 |
| | | | | | | |
| Obs. of Community Banks | 219,680 | | 111,862 | | 107,818 | |
| Obs. of Regional Banks | 3,681 | | 353 | | 3,328 | |
| Obs. of National Banks | 1,189 | | 60 | | 1,129 | |
| | | | | | | |
| Obs. of National Member Banks | 42,626 | | 19,045 | | 23,581 | |
| Obs. of State Member Banks | 33,576 | | 15,228 | | 18,348 | |
| Obs. of State Nonmember Banks | 148,320 | | 77,993 | | 70,327 | |
| | | | | | | |
| Obs. (Bank×Quarter) | 224,550 | | 112,275 | | 112,275 | |

Table 2: Summary Statistics (A)

***Notes***: The table provides summary statistics for the entire sample, as well as sub-samples categorized by high and low uninsured deposit ratios. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Data is from Call Reports and FDIC. There are 28 observations that belong to federal stock saving bank, federal mutual savings bank, federal stock S&L association, or state stock savings bank.

| Variables | All | | Low Equity Ratio | | High Equity Ratio | |
|---|---|---|---|---|---|---|
| | Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. |
| Uninsured Deposit (UD) Ratio | 0.325 | 0.152 | 0.335 | 0.156 | 0.315 | 0.148 |
| Uninsured Deposit to Asset Ratio | 0.274 | 0.127 | 0.289 | 0.133 | 0.258 | 0.119 |
| Deposit Rate | 0.680% | 0.005 | 0.694% | 0.005 | 0.666% | 0.005 |
| Domestic Deposit Rate | 0.679% | 0.005 | 0.693% | 0.005 | 0.665% | 0.005 |
| ln(Total Deposit) | 19.1 | 1.42 | 19.2 | 1.33 | 19.0 | 1.50 |
| Loan/Deposit | 0.718 | 0.201 | 0.713 | 0.192 | 0.723 | 0.209 |
| (Loan+HTM)/Deposit | 0.751 | 0.199 | 0.740 | 0.190 | 0.761 | 0.208 |
| Securities/Assets | 23.3% | 0.154 | 22.5% | 0.148 | 24.0% | 0.160 |
| HTM/Assets | 2.67% | 0.076 | 2.28% | 0.065 | 3.05% | 0.085 |
| AFS/Assets | 20.6% | 0.153 | 20.2% | 0.147 | 21.0% | 0.159 |
| HTM/Securities | 12.1% | 0.266 | 11.1% | 0.252 | 13.0% | 0.278 |
| Herfindahl-Hirschman Index (HHI) | 0.157 | 0.125 | 0.148 | 0.118 | 0.165 | 0.130 |
| ln(Asset) | 19.3 | 1.42 | 19.4 | 1.35 | 19.2 | 1.48 |
| Equity Ratio | 11.1% | 0.045 | 8.80% | 0.013 | 13.4% | 0.053 |
| | | | | | | |
| Obs. of Community Banks | 219,680 | | 110,376 | | 109,304 | |
| Obs. of Regional Banks | 3,681 | | 1,393 | | 2,288 | |
| Obs. of National Banks | 1,189 | | 506 | | 683 | |
| | | | | | | |
| Obs. of National Member Banks | 42,626 | | 20,480 | | 22,146 | |
| Obs. of State Member Banks | 33,576 | | 16,606 | | 16,970 | |
| Obs. of State Nonmember Banks | 148,320 | | 75,180 | | 73,140 | |
| | | | | | | |
| Obs. (Bank×Quarter) | 224,550 | | 112,275 | | 112,275 | |

Table 3: Summary Statistics (B)

***Notes***: The table provides summary statistics for the entire sample, as well as sub-samples categorized by high and low equity ratios. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Data is from Call Reports and FDIC. There are 28 observations that belong to federal stock saving bank, federal mutual savings bank, federal stock S&L association, or state stock savings bank.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.016*** | 0.011 | -0.072*** | -0.002*** |
| | [0.003] | [0.008] | [0.019] | [0.001] |
| $er_{it-1}$ | 0.156*** | 0.226** | -0.286 | -0.010 |
| | [0.056] | [0.115] | [0.220] | [0.008] |
| $\Delta FF_t * er_{it-1}$ | 0.192** | 0.426*** | -0.921*** | -0.042*** |
| | [0.085] | [0.151] | [0.207] | [0.008] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.033 | 0.012 | 0.015 | 0.018 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table 4: Equity Ratio and Sensitivity of Security to Fed Funds Rate

***Notes***: This table estimates the effect of equity ratio on the security (or HTM share) sensitivities towards Fed funds rate growth. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t * er_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.014*** | 0.014* | -0.070*** | -0.003*** |
| | [0.003] | [0.009] | [0.019] | [0.001] |
| $ud_{it-1}$ | 0.046*** | 0.021 | 0.167** | 0.004* |
| | [0.013] | [0.035] | [0.068] | [0.002] |
| $er_{it-1}$ | 0.161*** | 0.206* | -0.164 | -0.006 |
| | [0.055] | [0.115] | [0.224] | [0.008] |
| $\Delta FF_t * ud_{it-1}$ | -0.019 | -0.043 | -0.053 | 0.003 |
| | [0.012] | [0.031] | [0.067] | [0.002] |
| $\Delta FF_t * er_{it-1}$ | 0.247** | 0.607** | -1.179*** | -0.052*** |
| | [0.112] | [0.248] | [0.257] | [0.010] |
| $ud_{it-1} * er_{it-1}$ | 0.073 | 0.546 | -2.184*** | -0.084*** |
| | [0.271] | [0.358] | [0.519] | [0.018] |
| $\Delta FF_t * er_{it-1} * ud_{it-1}$ | -0.252 | -0.851 | 1.265** | 0.045** |
| | [0.180] | [0.569] | [0.540] | [0.023] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.033 | 0.012 | 0.015 | 0.019 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table 5: Equity Ratio, Uninsured Deposit, and Sensitivity of Security to Fed Funds Rate

***Notes***: This table estimates the effect of equity ratio and uninsured deposit on the security (or HTM share) sensitivities (towards Fed funds rate growth). In particular, we are interested in analyzing how the effect of equity ratio on the sensitivity of HTM share in groups of high/low uninsured deposit groups. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio and uninsured deposit affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. $ud_{it-1}$ is the uninsured deposit ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t$, $\Delta FF_t * er_{it-1}$, $\Delta FF_t * ud_{it-1}$, and $\Delta FF_t * er_{it-1} * ud_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.009*** | 0.024** | -0.168*** | -0.005*** |
| | [0.003] | [0.010] | [0.023] | [0.001] |
| $er_{it-1}$ | 0.144** | 0.230 | -0.181 | -0.001 |
| | [0.068] | [0.144] | [0.232] | [0.008] |
| $\mathbb{1}(er_{it-1} > \tau)$ | -0.001 | -0.005 | 0.021* | 0.000 |
| | [0.002] | [0.005] | [0.012] | [0.000] |
| $\Delta FF_t * er_{it-1}$ | 0.246*** | 0.766*** | -3.511*** | -0.127*** |
| | [0.068] | [0.195] | [0.577] | [0.020] |
| $\Delta FF_t * \mathbb{1}(er_{it-1} > \tau_1)$ | 0.011** | -0.021 | 0.162*** | 0.005*** |
| | [0.005] | [0.013] | [0.035] | [0.001] |
| $\Delta FF_t * er_{it-1} * \mathbb{1}(er_{it-1} > \tau)$ | -0.423*** | -0.876** | 6.579*** | 0.209*** |
| | [0.144] | [0.432] | [1.152] | [0.040] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.034 | 0.012 | 0.015 | 0.019 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table 6: Non-linear Effect of Equity Ratio on the Sensitivity of Security to Fed Funds Rate

***Notes***: This table estimates the non-linear effect of equity ratio on the security (or HTM share) sensitivities (towards Fed funds rate growth). In particular, we are interested in analyzing how the effect of equity ratio on the sensitivity of HTM share in groups of high/low equity ratio groups. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio and uninsured deposit affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. $\mathbb{1}(er_{it-1} > \tau)$ is an indicator that equity ratio is above its median. We are interested in the coefficient on $\Delta FF_t * er_{it-1} * \mathbb{1}(er_{it-1} > \tau)$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| Variables | Deposit Rate Beta | | Deposit Quantity Beta | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | One Quarter | Four Quarter | One Quarter | Four Quarter |
| Average Uninsured Deposit Ratio | 0.295*** | 0.361*** | -0.035*** | -0.035*** |
| | [0.015] | [0.035] | [0.004] | [0.005] |
| Constant | 0.134*** | 0.309*** | -0.011*** | -0.028*** |
| | [0.005] | [0.012] | [0.001] | [0.002] |
| Observations | 20 | 20 | 20 | 20 |
| R-squared | 0.955 | 0.853 | 0.831 | 0.695 |

Table 7: Correlation between Uninsured Deposit Ratio and Bank-specific Betas

***Notes***: This table presents deposit rate (or deposit growth) sensitivities towards Fed funds rate growth against bank-level uninsured deposit ratio. We refer the deposit rate (or deposit growth) sensitivities towards Fed funds rate growth as the bank-specific beta. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Bank-specific betas are calculated by regressing the change in a bank's interest expense rate (or log of deposit quantity) on the contemporaneous (and three previous quarterly) changes in the Fed funds rate and summing the coefficients. Bank-specific betas are winsorized at 0.5% and 99.5% level to eliminate outliers. We then divide the sample into 20 equal-sized bins according to their uninsured deposit ratios, and calculate the average uninsured deposit ratio and average bank-specific betas in each bin. Lastly, average bank specific betas are regressed on the average uninsured deposit ratio. Columns (1) and (2) show the correlation between uninsured deposit ratio and deposit rate beta, while column (2) uses cumulative deposit rate sensitivity of four quarter as dependent variable. Columns (3) and (4) show the correlation between uninsured deposit ratio and deposit quantity beta, while column (4) uses cumulative deposit quantity sensitivity of four quarter as dependent variable. Data is from Call Reports. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ Deposit Rate<br>Variables Demeaned | (2)<br>Δ Deposit Rate<br>Variables Demeaned | (3)<br>Δ ln(Deposit)<br>Variables Demeaned | (4)<br>Δ ln(Deposit)<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | 0.384*** | 0.384*** | -0.033*** | -0.033*** |
| | [0.003] | [0.004] | [0.001] | [0.001] |
| $\mathbb{1}(ud_{it-1} > \tau_1)$ | 0.002 | 0.002 | -0.009*** | -0.009*** |
| | [0.001] | [0.001] | [0.001] | [0.001] |
| $HHI_{it-1}$ | | -0.043 | | 0.027 |
| | | [0.037] | | [0.033] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1} > \tau_1)$ | 0.100*** | 0.097*** | -0.004*** | -0.003*** |
| | [0.004] | [0.004] | [0.001] | [0.001] |
| $\Delta FF_t * HHI_{it-1}$ | | -0.128*** | | 0.018*** |
| | | [0.016] | | [0.003] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.308 | 0.309 | 0.077 | 0.077 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table 8: Uninsured Deposit Ratio and Deposit Betas

***Notes:*** This table estimates the effect of uninsured deposit ratio on deposit betas. We refer the deposit rate (or deposit growth) sensitivities towards Fed funds rate growth as the deposit betas. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) and (2) show how uninsured deposit ratio affects the deposit rate beta, while columns (3) and (4) show how uninsured deposit ratio affects the deposit quantity beta. Columns (3) and (4) additionally control bank-level HHI ($HHI_{it-1}$) and its interaction between Fed funds rate growth $\Delta FF_t$. $\mathbb{1}(ud_{it-1} > \tau_1)$ is an indicator that uninsured deposit ratio is above its median. We are interested in the coefficient on $\Delta FF_t * \mathbb{1}(ud_{it-1} > \tau_1)$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ Deposit Rate | (2)<br>Δ Deposit Rate | (3)<br>Δ ln(Deposit) | (4)<br>Δ ln(Deposit) |
|---|---|---|---|---|
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 1st quantile) | 0.345*** | 0.348*** | -0.030*** | -0.030*** |
| | [0.015] | [0.015] | [0.004] | [0.003] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 2nd quantile) | 0.304*** | 0.306*** | -0.028*** | -0.028*** |
| | [0.009] | [0.010] | [0.002] | [0.002] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 3rd quantile) | 0.314*** | 0.316*** | -0.031*** | -0.032*** |
| | [0.008] | [0.008] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 4th quantile) | 0.341*** | 0.343*** | -0.034*** | -0.034*** |
| | [0.008] | [0.008] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 5th quantile) | 0.358*** | 0.359*** | -0.029*** | -0.029*** |
| | [0.007] | [0.007] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 6th quantile) | 0.369*** | 0.370*** | -0.034*** | -0.034*** |
| | [0.007] | [0.007] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 7th quantile) | 0.399*** | 0.399*** | -0.031*** | -0.032*** |
| | [0.006] | [0.006] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 8th quantile) | 0.427*** | 0.427*** | -0.034*** | -0.034*** |
| | [0.006] | [0.006] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 9th quantile) | 0.446*** | 0.445*** | -0.036*** | -0.036*** |
| | [0.006] | [0.006] | [0.001] | [0.001] |
| $\Delta FF_t * \mathbb{1}(ud_{it-1}$ in the 10th quantile) | 0.491*** | 0.487*** | -0.041*** | -0.041*** |
| | [0.007] | [0.006] | [0.002] | [0.002] |
| $HHI_{it-1}$ | | -0.033 | | 0.029 |
| | | [0.036] | | [0.033] |
| $\Delta FF_t * HHI_{it-1}$ | | -0.094*** | | 0.014*** |
| | | [0.016] | | [0.003] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.310 | 0.311 | 0.076 | 0.076 |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table 9: Deposit Beta and Uninsured Deposit Ratio by Quantiles

***Notes***: This table presents deposit rate (or deposit growth) sensitivities towards Fed funds rate growth against quantiles of uninsured deposit ratio. We refer the deposit rate (or deposit growth) sensitivities towards Fed funds rate growth as the deposit beta. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) and (2) show the correlation between different quantiles of uninsured deposit ratio and deposit rate beta, while column (2) additionally controls for bank-level HHI ($HHI_{it-1}$) and its interaction between Fed funds rate growth $\Delta FF_t$. Columns (3) and (4) show the correlation between different quantiles of uninsured deposit ratio and deposit quantity beta, while column (4) additionally controls for bank-level HHI and its interaction between Fed funds rate growth. Data is from Call Reports. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

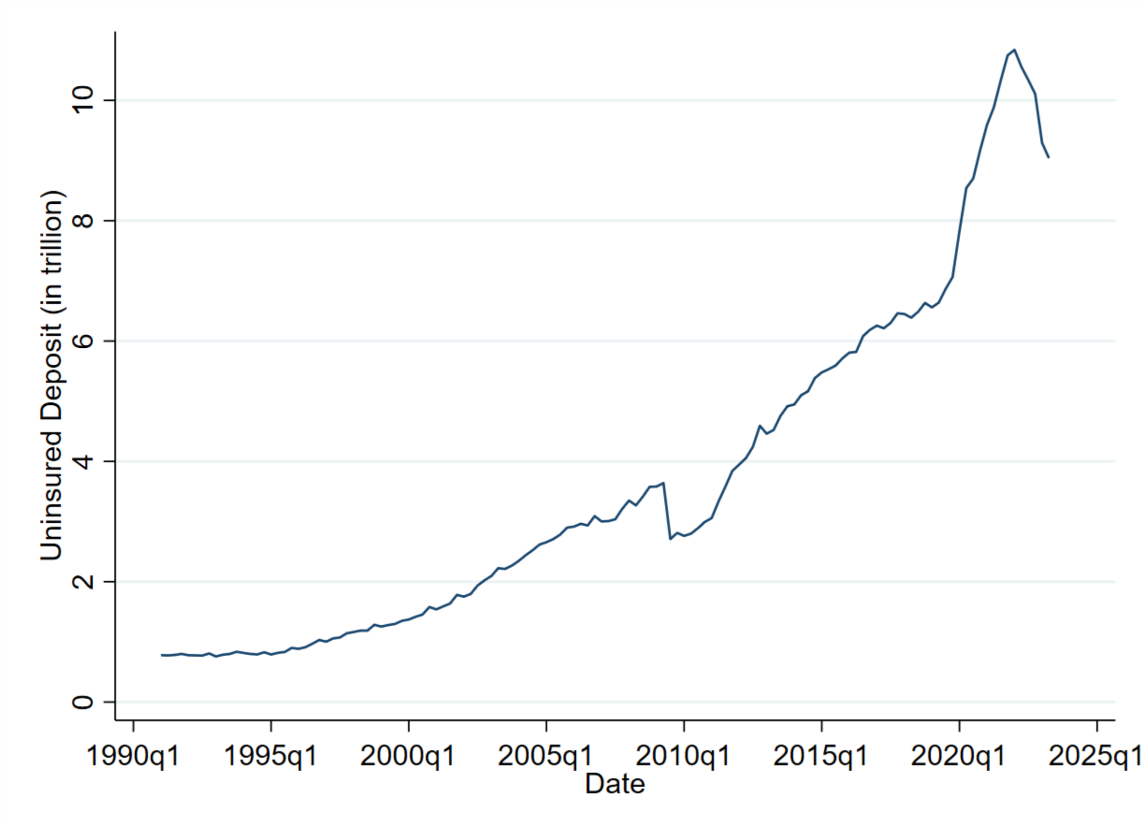
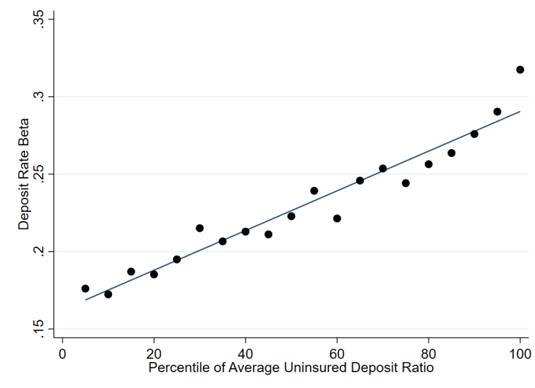
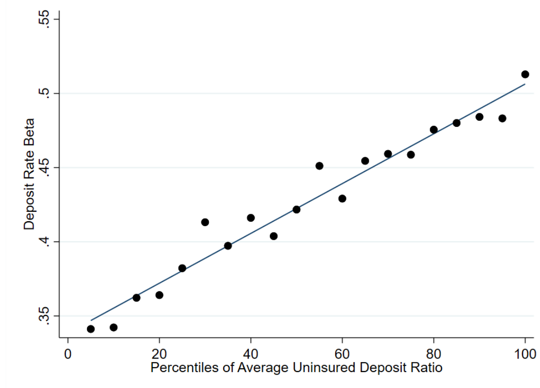



Figure 1: Trends of Uninsured Deposit

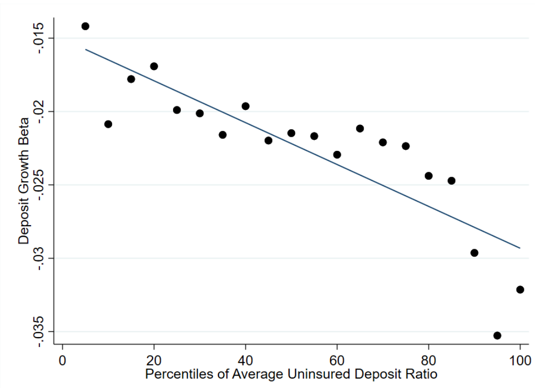
***Notes:*** This plot presents the trend of total uninsured deposits in the U.S. Notice that there is a sharp drop in 2009 because of the regulatory change. Source: Call Report.



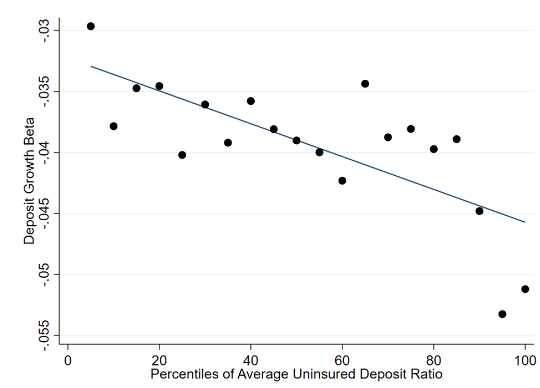

(a) Deposit Rate Beta (One Quarter)




(b) Deposit Rate Beta (Cumulative)



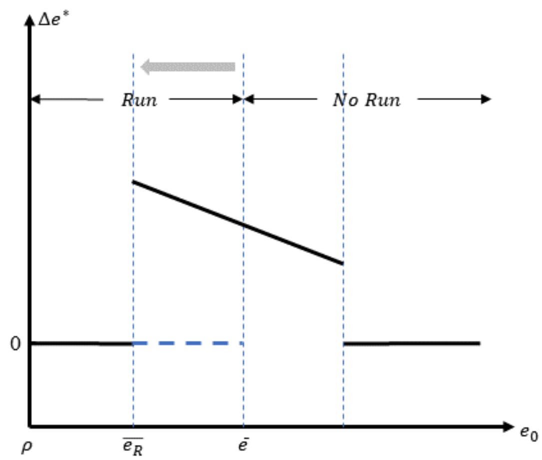

(c) Deposit Growth Beta (One Quarter)



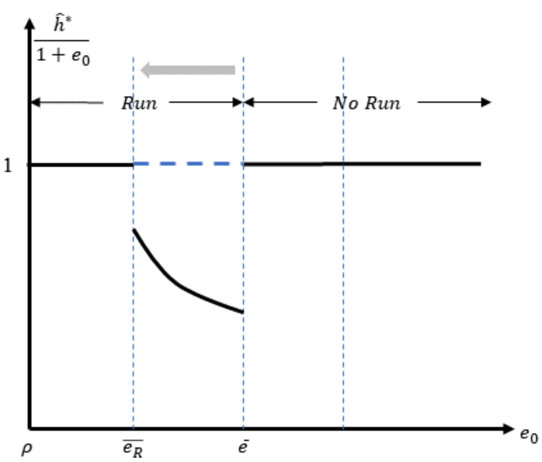

(d) Deposit Growth Beta (Cumulative)

Figure 2: Deposit Rate and Growth Beta

***Notes***: This figure presents deposit rate (or deposit growth) sensitivities towards Fed funds rate growth against percentiles of uninsured deposit ratio. We refer the deposit rate (or deposit growth) sensitivities towards Fed funds rate growth as the bank-specific beta. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Bank-specific betas are calculated by regressing the change in a bank's interest expense rate (or log of deposit quantity) on the contemporaneous (and three previous quarterly) changes in the Fed funds rate and summing the coefficients. Bank-specific betas are winsorized at 0.5% and 99.5% level to eliminate outliers. We then divide the sample into 20 equal-sized bins according to their uninsured deposit ratios, and calculate the average uninsured deposit ratio and average bank-specific betas in each bin. Panels (a) and (b) show the deposit rate betas against percentiles of average uninsured deposit ratio, while panel (b) uses cumulative deposit rate sensitivity of four quarter on Y axis. Panels (c) and (d) show the deposit quantity betas against percentiles of average uninsured deposit ratio, while panel (d) uses cumulative deposit quantity sensitivity of four quarter on Y axis. Data is from Call Reports.

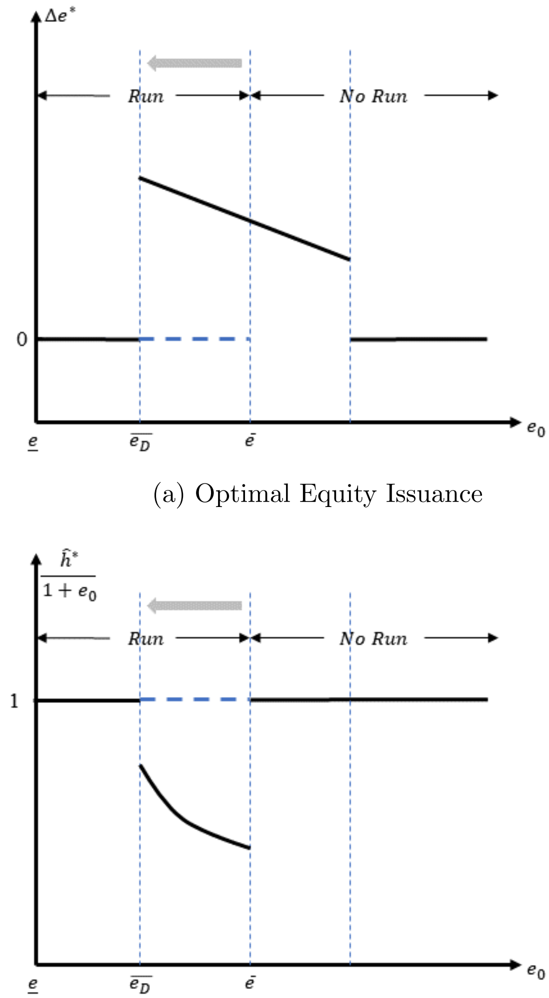



(a) Optimal Equity Issuance




(b) Optimal HTM Share Cap

Figure 3: Optimal Capital Issuance and HTM Share Cap with Underestimation of Interest Rate Risk




(a) Optimal Equity Issuance



(b) Optimal HTM Share Cap

Figure 4: Optimal Capital Issuance and HTM Share Cap under Limited Liability

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# Appendices

## A Data Description and Sources

- Deposit rate: Interest expense on deposits divided by total deposits. The ratio is winsorized at 0.5% and 99.5% level. Data is from Call Reports.
- Domestic Deposit rate: Interest expense on domestic deposits divided by domestic deposits. The ratio is winsorized at 0.5% and 99.5% level. Data is from Call Reports.
- Uninsured deposit ratio: Uninsured deposits divided by total deposits. Uninsured deposits are defined as deposits greater than $100k$ until 2009 and greater than $250k$ after that. The ratio is winsorized at 0.5% and 99.5% level. Uninsured deposit is from RCON2710 series before 2006Q2, and RCONF051+RCONF047 after 2006Q2. RCONF051 includes amount of deposit accounts (excluding retirement accounts) of more than 250000, while RCONF051 includes amount of deposit accounts in retirement accounts of more than 250000. Data is from Call Reports.
- Uninsured deposit to asset ratio: Uninsured deposits divided by total assets. The ratio is winsorized at 0.5% and 99.5% level. Data is from Call Reports.
- Bank size: Community bank with bank assets less than 10 billion, national bank with bank assets more than 100 billion, and regional bank with bank assets in between. Data is from Call Reports.
- Bank Type is directly obtained from FDIC, which mainly includes national member bank, state member bank, and state nonmember bank.
- Loans: Quarterly average of loans from Call Reports.
- Deposits: Total deposit size. Data is from Call Reports.
- Assets: Total asset size. Data is from Call Reports.
- Securities HTM: Securities held to maturity at amortized cost. Data is from Call Reports.
- Securities AFS: Securities available for sale at fair value. Data is from Call Reports.
- Herfindahl-Hirschman Index: We construct county-level HHI based on branch-level deposit size, and then average it into bank-level HHI using deposits as weights. Data is from FDIC.

- Equity ratio: Total equity/total assets. Data is from Call Reports.

# B Other Tables

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.016*** | 0.011 | -0.073*** | -0.002*** |
| | [0.003] | [0.008] | [0.019] | [0.001] |
| $\frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.077** | 0.115 | -0.261* | -0.006 |
| | [0.038] | [0.081] | [0.146] | [0.005] |
| $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.201*** | 0.446*** | -0.725*** | -0.037*** |
| | [0.056] | [0.149] | [0.153] | [0.006] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.033 | 0.012 | 0.015 | 0.018 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table B.1: Equity to Deposit Ratio and Sensitivity of Security to Fed Funds Rate

***Notes***: This table estimates the effect of equity to deposit ratio on the security (or HTM share) sensitivities towards Fed funds rate growth. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity to deposit ratio affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $\frac{Equity_{it-1}}{Deposit_{it-1}}$ is the equity to deposit ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.015*** | 0.014* | -0.071*** | -0.003*** |
| | [0.003] | [0.008] | [0.019] | [0.001] |
| $ud_{it-1}$ | 0.044*** | 0.015 | 0.170** | 0.005* |
| | [0.013] | [0.034] | [0.068] | [0.002] |
| $\frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.082** | 0.109 | -0.201 | -0.004 |
| | [0.038] | [0.081] | [0.147] | [0.005] |
| $\Delta FF_t * ud_{it-1}$ | -0.018 | -0.038 | -0.049 | 0.003 |
| | [0.011] | [0.030] | [0.067] | [0.002] |
| $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.217*** | 0.542** | -0.741*** | -0.037*** |
| | [0.065] | [0.212] | [0.165] | [0.007] |
| $ud_{it-1} * \frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.066 | 0.510** | -1.465*** | -0.063*** |
| | [0.135] | [0.227] | [0.390] | [0.013] |
| $\Delta FF_t * ud_{it-1} * \frac{Equity_{it-1}}{Deposit_{it-1}}$ | -0.132 | -0.898 | 0.389 | 0.012 |
| | [0.142] | [0.699] | [0.448] | [0.020] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.034 | 0.012 | 0.015 | 0.019 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table B.2: Equity to Deposit Ratio, Uninsured Deposit, and Sensitivity of Security to Fed Funds Rate

***Notes***: This table estimates the effect of equity to deposit ratio and uninsured deposit on the security (or HTM share) sensitivities (towards Fed funds rate growth). In particular, we are interested in analyzing how the effect of equity to deposit ratio on the sensitivity of HTM share in groups of high/low uninsured deposit groups. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity to deposit ratio and uninsured deposit affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $\frac{Equity_{it-1}}{Deposit_{it-1}}$ is the equity to deposit ratio for individual bank $i$ at time $t-1$. $ud_{it-1}$ is the uninsured deposit ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t$, $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}}$, $\Delta FF_t * ud_{it-1}$, and $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}} * ud_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.010*** | 0.018* | -0.172*** | -0.005*** |
| | [0.003] | [0.010] | [0.023] | [0.001] |
| $\frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.094** | 0.164* | -0.102 | 0.000 |
| | [0.047] | [0.097] | [0.154] | [0.006] |
| $\mathbb{1}(\frac{Equity_{it-1}}{Deposit_{it-1}} > \tau)$ | -0.004** | -0.011** | 0.001 | -0.000 |
| | [0.002] | [0.005] | [0.011] | [0.000] |
| $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}}$ | 0.226*** | 0.631*** | -2.687*** | -0.100*** |
| | [0.050] | [0.177] | [0.451] | [0.016] |
| $\Delta FF_t * \mathbb{1}(\frac{Equity_{it-1}}{Deposit_{it-1}} > \tau)$ | 0.007 | -0.022 | 0.177*** | 0.006*** |
| | [0.005] | [0.015] | [0.037] | [0.001] |
| $\Delta FF_t * \frac{Equity_{it-1}}{Deposit_{it-1}} * \mathbb{1}(\frac{Equity_{it-1}}{Deposit_{it-1}} > \tau)$ | -0.259** | -0.358 | 5.023*** | 0.150*** |
| | [0.115] | [0.385] | [0.900] | [0.032] |
| Observations | 220,196 | 220,196 | 220,196 | 220,196 |
| R-squared | 0.034 | 0.012 | 0.015 | 0.019 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table B.3: Equity Ratio, Uninsured Deposit, and Sensitivity of Security to Fed Funds Rate

***Notes***: This table estimates the non-linear effect of equity to deposit ratio on the security (or HTM share) sensitivities (towards Fed funds rate growth). In particular, we are interested in analyzing how the effect of equity to deposit ratio on the sensitivity of HTM share in groups of high/low equity to deposit ratio groups. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity to deposit ratio and uninsured deposit affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $\frac{Equity_{it-1}}{Deposit_{it-1}}$ is the equity to deposit ratio for individual bank $i$ at time $t-1$. $\mathbb{1}(\frac{Equity_{it-1}}{Deposit_{it-1}} > \tau)$ is an indicator that equity to deposit ratio is above its median. We are interested in the coefficient on $\Delta FF_t * er_{it-1} * \mathbb{1}(\frac{Equity_{it-1}}{Deposit_{it-1}} > \tau)$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.026** | -0.005 | -0.065 | 0.000 |
| | [0.010] | [0.040] | [0.085] | [0.002] |
| $er_{it-1}$ | 0.165** | 0.230 | -0.116 | -0.007 |
| | [0.068] | [0.147] | [0.287] | [0.010] |
| $\Delta FF_t * er_{it-1}$ | 0.032 | 0.366 | -4.718*** | -0.135*** |
| | [0.379] | [0.641] | [1.163] | [0.035] |
| Observations | 208,809 | 208,809 | 208,809 | 208,809 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table B.4: Equity Ratio and Sensitivity of Security to Fed Funds Rate (News Shock)

***Notes***: This table estimates the effect of equity ratio on the security (or HTM share) sensitivities towards Fed funds rate growth. The changes in the fed funds rate is instrumented by the news shock from Nakamura and Steinsson (2018). The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t * er_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | 0.033 | -0.027 | 0.532*** | 0.007* |
| | [0.027] | [0.070] | [0.133] | [0.004] |
| $er_{it-1}$ | 0.238*** | 0.194 | 0.638** | 0.003 |
| | [0.079] | [0.179] | [0.285] | [0.011] |
| $\Delta FF_t * er_{it-1}$ | 0.494 | 0.570 | -0.482 | -0.139** |
| | [0.332] | [0.779] | [1.691] | [0.057] |
| Observations | 208,809 | 208,809 | 208,809 | 208,809 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table B.5: Equity Ratio and Sensitivity of Security to Fed Funds Rate (High Frequency Shock)

***Notes***: This table estimates the effect of equity ratio on the security (or HTM share) sensitivities towards Fed funds rate growth. The changes in the fed funds rate is instrumented by the high frequency shock from Nakamura and Steinsson (2018). The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t * er_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.039*** | -0.029** | -0.096*** | -0.002* |
| | [0.004] | [0.014] | [0.032] | [0.001] |
| $er_{it-1}$ | 0.240*** | 0.537*** | -0.627** | -0.025** |
| | [0.077] | [0.166] | [0.305] | [0.011] |
| $\Delta FF_t * er_{it-1}$ | 0.098 | 0.348** | -1.083*** | -0.047*** |
| | [0.081] | [0.158] | [0.224] | [0.009] |
| Observations | 141,060 | 141,060 | 141,060 | 141,060 |
| R-squared | 0.043 | 0.025 | 0.026 | 0.030 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table B.6: Equity Ratio and Sensitivity of Security to Fed Funds Rate (Subsample: sign($\Delta FF_t$)=sign($\Delta FF_{t-1}$))

***Notes***: This table estimates the effect of equity ratio on the security (or HTM share) sensitivities towards Fed funds rate growth. The table includes the sub-sample in periods where the change of Fed funds rate is persistent. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t * er_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

| VARIABLES | (1)<br>Δ ln(Securities)<br>Variables Demeaned | (2)<br>Δ ln(Securities AFS)<br>Variables Demeaned | (3)<br>Δ ln(Securities HTM)<br>Variables Demeaned | (4)<br>Δ HTM Share<br>Variables Demeaned |
|---|---|---|---|---|
| $\Delta FF_t$ | -0.228*** | -0.144 | -0.200 | -0.006 |
| | [0.065] | [0.222] | [0.462] | [0.013] |
| $er_{it-1}$ | 0.031 | 0.078 | 0.513 | -0.017 |
| | [0.129] | [0.473] | [0.694] | [0.029] |
| $\Delta FF_t * er_{it-1}$ | -0.700 | 1.701 | 2.602 | -0.322 |
| | [1.304] | [5.211] | [6.748] | [0.289] |
| Observations | 74,789 | 74,789 | 74,789 | 74,789 |
| R-squared | 0.074 | 0.047 | 0.052 | 0.056 |
| Bank Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Quarter Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Size Fixed Effect | Yes | Yes | Yes | Yes |
| Bank Type Fixed Effect | Yes | Yes | Yes | Yes |

Table B.7: Equity Ratio and Sensitivity of Security to Fed Funds Rate (Subsample: sign($\Delta FF_t$)≠sign($\Delta FF_{t-1}$))

***Notes***: This table estimates the effect of equity ratio on the security (or HTM share) sensitivities towards Fed funds rate growth. The table includes the sub-sample in periods where the change of Fed funds rate is not persistent. The data is at the bank-quarter level and covers 2010Q1 to 2023Q2. Columns (1) - (4) show how equity ratio affects the sensitivity of log(AFS+1), log(HTM+1), log(securities), and HTM/Securities, respectively. $er_{it-1}$ is the equity ratio for individual bank $i$ at time $t-1$. We are interested in the coefficient on $\Delta FF_t * er_{it-1}$. The data is from the Call Reports and FDIC. Fixed effects are denoted at the bottom of the table. Standard errors are clustered by bank. *, **, *** stands for significance at 10%, 5%, 1% level, respectively.

# C Proofs

**Proof for Lemma 1.** Suppose banks need $\widetilde{m}$ units of MTM long-term assets at period 1 for potential liquidity needs. If no additional equity is issued at the end of period 0, banks do not need to allocate addition revenue between HTM and MTM accounts. Thus, we focus on the scenario where the equity issuance cost is positive and the capital requirement is binding at the end of period 0.

If the injected equity $\Delta e$ at the end of period 0 is invested in the MTM assets, banks choose $m_0$ to satisfy

$$\widetilde{m} = \frac{\rho - e_0 + (1 - q_0)m_0}{q_0} + m_0, \tag{C1}$$

which is equivalent to $m_0 = q_0\widetilde{m} + e_0 - \rho$. Therefore, the equity issuance cost at period 0 would be $(\rho - e_0 + (1 - q_0)(q_0\widetilde{m} + e_0 - \rho))\kappa$.

If the injected equity $\Delta e$ at the end of period 0 is invested in the HTM assets, banks choose $m_0$ to satisfy

$$\widetilde{m} = m_0. \tag{C2}$$

The equity issuance cost at period 0 would be $(\rho - e_0 + (1 - q_0)\widetilde{m})\kappa$.

Since $\rho - e_0 + (1 - q_0)\widetilde{m} > 0$, we have $q_0\widetilde{m} + e_0 - \rho < \widetilde{m}$. That is, the equity issuance cost at period 0 will be lower if the injected equity is invested in the MTM long-term assets. Thus, all the injected equity at period 0 will be invested in the MTM long-term assets. ■

**Proof for Lemma 2.** Banks will not transfer assets from the HTM to MTM account before the interest rate shock occurs at the start of period 1, as doing so would require all remaining assets to be marked to market, incurring an unintended $(1 - q_0)h$ capital loss.

Suppose banks require $\widetilde{m}$ units of MTM long-term assets in period 1 for potential liquidity needs. Currently, banks hold $m_1 > \widetilde{m}$ units of MTM assets. They could transfer $m_1 - \widetilde{m}$ units of MTM assets back to the HTM account. Holding $m_1$ units of MTM long-term assets would incur an equity issuance cost of $\rho - e_0 + (1 - q_0)(q_0 m_1 + e_0 - \rho)$ at the end of period 0. To minimize costs, banks would instead prefer to enter period 1 with only $\widetilde{m}$ units of MTM assets, reducing their equity issuance cost to $\rho - e_0 + (1 - q_0)(q_0\widetilde{m} + e_0 - \rho)$. Reclassifying long-term assets from MTM to HTM at period 1 is weakly dominated by holding less but sufficient MTM long-term assets initially. ■

**Proof for Lemma 3.** In this lemma, we show the equity issuance cost when $q = q_1$ at period 1. When the market value of MTM long-term assets $q_1 m_1$ is greater than the liquidity withdrawal $1 - d_1$, the book equity of the bank after deposit withdrawal in period

1 is

$$
\begin{aligned}
& q_1(m_1 - \frac{1-d_1}{q_1}) + h - d_1 + \Delta e_1 \\
=& q_1(m_1 - \frac{1-d_1}{q_1}) + h - d_1 + \Delta e_1 + (e_1 - q_0 m_1 - h + 1) \\
=& e_1 - (q_0 - q_1)m_1 + \Delta e_1 \\
\geq & \rho,
\end{aligned}
\tag{C3}
$$

where the first row the sum of the market value of remaining MTM long-term assets after the deposit withdrawal $q_1(m_1 - \frac{1-d_1}{q_1})$, the book value of HTM long-term assets $h$, and the new equity issuance $\Delta e_1$, minus the deposit $d_1$. The second row additionally plus a zero term $e_1 - q_0 m_1 - h + 1$. Therefore, the new equity issuance in this scenario is

$$
\Delta e_1 = \{\rho - e_1 + (q_0 - q_1)\, m_1\}^+ \tag{C4}
$$

Interestingly, the equity issuance cost does not depend on the deposit outflow, but only the initial holdings of MTM long-term assets.

When the market value of MTM long-term assets $q_1 m_1$ is less than the liquidity withdrawal $1 - d_1$, the book equity of the bank after deposit withdrawal in period 1 is

$$
\begin{aligned}
& q_1(h + m_1 - \frac{1-d_1}{q_1}) - d_1 + \Delta e_1 \\
=& q_1(h + m_1 - \frac{1-d_1}{q_1}) - d_1 + \Delta e_1 + (e_1 - q_0 m_1 - h + 1) \\
=& e_1 - (q_0 - q_1)m_1 - (1 - q_1)h + \Delta e_1 \\
\geq & \rho
\end{aligned}
\tag{C5}
$$

In this scenario, all the long-term assets are forced to be marked-to-market. Therefore, the first row of Equation (C5) is the sum of the market value of remaining MTM long-term assets after the deposit withdrawal $q_1(h + m_1 - \frac{1-d_1}{q_1})$ and the new equity issuance $\Delta e_1$, minus the deposit $d_1$. The new equity issuance then follows

$$
\Delta e_1 = \{\rho - e_1 + (q_0 - q_1)\, m_1 + (1 - q_1)h\}^+ \tag{C6}
$$

■

**Proof for Proposition 1.** When all the uninsured depositors run, only insured depositors remain in the bank, that is, $d_1 = 1 - u$. When there is only exogenous deposit outflow, parts of uninsured depositors withdraw their money from the banking system, that is, $d_1 = 1 - \lambda$.

**Case 1** **($q_1 m_1 > u > \lambda$.)** *In this case, the market value of MTM long-term assets is sufficiently high that it is enough to meet the liquidity needs even if all the uninsured depositors run. There will a no-run equilibrium if the value of deposits is greater than the promised value of depositors' outside option, conditioning on only exogenous deposit withdrawal $\lambda$:*

$$v^d(q_1) = (q_1 m_1 - \lambda + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \geq 1 - \lambda, \tag{C7}$$

*which is equivalent to $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \geq 1$.*

*There will be a run-equilibrium if the value of deposits is less than the promised value of depositors' outside option, conditioning on all the uninsured depositors run:*

$$v^d(q_1) = (q_1 m_1 - u + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ < 1 - u, \tag{C8}$$

*which is equivalent to $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ < 1$.*

*The sets implied by Equations (C7) and (C8) have no intersection, ensuring the uniqueness of both the no-run equilibrium and the run equilibrium.*

**Case 2** **($u > q_1 m_1 > \lambda$.)** *In this case, the market value of MTM long-term assets is sufficient to meet liquidity needs under exogenous deposit outflows $\lambda$, but insufficient if all uninsured depositors run. A no-run equilibrium exists if the value of deposits exceeds the promised return of depositors' outside option, conditioning on only exogenous deposit withdrawal $\lambda$:*

$$v^d(q_1) = (q_1 m_1 - \lambda + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \geq 1 - \lambda, \tag{C9}$$

*which is equivalent to $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \geq 1$.*

*There will be a run-equilibrium if the value of deposits is less than the promised value of depositors' outside option, conditioning on all the uninsured depositors run:*

$$v^d(q_1) = (q_1 m_1 - u + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ < 1 - u, \tag{C10}$$

*which is equivalent to $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ < 1$. In this case, there will be multiple equilibria when Equations (C9) and (C10) are both satisfied. When $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ < 1$, there will be a unique run equilibrium. When $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ > 1$, there will be a unique no-run equilibrium.*

**Case 3** **($u > \lambda > q_1 m_1$.)** *In this case, the market value of MTM long-term assets is low that it is not enough to meet the liquidity needs even when there is only exogenous deposit outflows $\lambda$. There will a no-run equilibrium if the value of deposits is greater than* *the promised value of depositors' outside option, conditioning on only exogenous deposit withdrawal $\lambda$:*

$$v^d(q_1) = (q_1 m_1 - \lambda + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ \geq 1 - \lambda, \qquad \text{(C11)}$$

*which is equivalent to* $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ \geq 1$.

*There will be a run-equilibrium if the value of deposits is less than the promised value of depositors' outside option, conditioning on all the uninsured depositors run:*

$$v^d(q_1) = (q_1 m_1 - u + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ < 1 - u, \qquad \text{(C12)}$$

*which is equivalent to* $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ < 1$.

*The sets implied by Equations (C11) and (C12) have no intersection, ensuring the uniqueness of both the no-run equilibrium and the run equilibrium.*

Considering these three cases, we establish Proposition 1. ■

**Proof for Lemma 4.** In this lemma, we have assumed that depositors are optimistic, that is, the no-run equilibrium is selected whenever there are multiple equilibria. Therefore, there would be a no-run equilibrium whenever $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \geq 1$ in Case 1 and Case 2 of Proposition 1 ($h < \widetilde{h}$), and a run equilibrium whenever $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ < 1$ in Case 3 of Proposition 1 ($h > \widetilde{h}$).

Assume the capital requirement is binding at the end of period 0, that is, $e_1 = \rho$. $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1)\}^+ \geq 1$ is equivalent to

$$[q_1(1 - q_0) - \kappa(q_0 - q_1)]\, h < -1 - \kappa(1 + \rho)(q_0 - q_1) + q_1(1 + \rho) \qquad \text{(C13)}$$

Under Assumption of $q_1(1 - q_0) - \kappa(q_0 - q_1) > 0$, we have $h < \frac{-1-\kappa(1+\rho)(q_0-q_1)+q_1(1+\rho)}{q_1(1-q_0)-\kappa(q_0-q_1)} \equiv \overline{h}$.

On the other hand, $(q_1 m_1 + q_1 h) - \kappa \{\rho - e_1 + m_1(q_0 - q_1) + (1 - q_1)h\}^+ < 1$ is equivalent to

$$[q_1(1 - q_0) - \kappa(q_0 - q_1) + \kappa q_0(1 - q_1)]\, h < -1 - \kappa(1 + \rho)(q_0 - q_1) + q_1(1 + \rho) \qquad \text{(C14)}$$

the left-hand-side of which is positive as long as $q_1(1 - q_0) - \kappa(q_0 - q_1) > 0$. Equation (C14) implies $h < \frac{-1-\kappa(1+\rho)(q_0-q_1)+q_1(1+\rho)}{q_1(1-q_0)-\kappa(q_0-q_1)+\kappa q_0(1-q_1)} \equiv \underline{h}$.

**Case 1** ($\overline{h} < 0$). *In this case, even if all long-term assets are placed in the MTM account, the value of deposits remains below the promised return of depositors' outside option, leading to a unique run equilibrium when the policy rate increases in period 1. Anticipating this inevitable run, banks at period 0 opt to classify all their assets in the HTM account, i.e.,* $h = 1 + e_0$.

**Case 2** ($0 < \overline{h} < \widetilde{h}$.) *In this case, for any $h < \overline{h}$, the market value of MTM long-term assets is enough to meet the liquidity needs and it is a no-run equilibrium, that is, $(q_1 m_1 + q_1 h) - \kappa m_1(q_0 - q_1) \geq 1$. For $\overline{h} < h < \widetilde{h}$, the market value of MTM long-term assets is enough to meet the liquidity needs but it is a run equilibrium, that is, $(q_1 m_1 + q_1 h) - \kappa m_1(q_0 - q_1) < 1$. For $h > \widetilde{h}$, the market value of MTM long-term assets is not enough to meet the liquidity needs and it is definitely a run equilibrium because*

$$(q_1 m_1 + q_1 h) - \kappa \left[m_1(q_0 - q_1) + (1 - q_1)h\right] < (q_1 m_1 + q_1 h) - \kappa m_1(q_0 - q_1) < 0 \quad \text{(C15)}$$

*Therefore, it would be a no-run equilibrium when the policy rate further increases at period 1 for $h < \overline{h}$, while a run equilibrium for $h > \overline{h}$.*

*Given this, banks will hold $h = 1 + e_0$ at the beginning of period 0 if a run equilibrium occurs when the policy rate increases further in period 1. Finally, we demonstrate that if a no-run equilibrium is expected with a further policy rate increase, banks will hold just enough liquidity, $h = \overline{h}$.*

*If banks choose $h > \overline{h}$, a run equilibrium would arise following the rate increase in period 1, leading banks to prefer holding all their assets in the HTM account ($h = 1 + e_0$). Conversely, if banks select $h \leq \overline{h}$, the marginal benefit of holding fewer HTM assets becomes*

$$-(\kappa + p) + p\left(\frac{q_1}{q_0} - q_1 - \kappa\frac{q_0 - q_1}{q_0}\right), \quad \text{(C16)}$$

*which is definitely negative as $q_1 < q_0$. Therefore, banks will hold precisely $h = \overline{h}$. In summary, $h =\in \{1 + e_0, \overline{h}\}$*

**Case 3** ($\overline{h} > \widetilde{h}$ *and* $\underline{h} > \widetilde{h}$.) *In this case, for any $h < \widetilde{h}$, the market value of MTM long-term assets is enough to meet the liquidity needs and it is a no-run equilibrium, that is, $(q_1 m_1 + q_1 h) - \kappa m_1(q_0 - q_1) \geq 1$. For $\widetilde{h} < h < \underline{h}$, the market value of MTM long-term assets is not enough to meet the liquidity needs but it is still a no-run equilibrium, that is, $(q_1 m_1 + q_1 h) - \kappa\left[m_1(q_0 - q_1) + (1 - q_1)h\right] \geq 1$. For $h > \underline{h}$, the market value of MTM long-term assets is not enough to meet the liquidity needs and it would be a run equilibrium, that is, $(q_1 m_1 + q_1 h) - \kappa\left[m_1(q_0 - q_1) + (1 - q_1)h\right] < 1$.*

*Therefore, it would be a no-run equilibrium when the policy rate further increases at period 1 for $h < \underline{h}$, while a run equilibrium for $h > \underline{h}$. Similar to Case 2, bank will choose the asset classification $h \in \{1 + e_0, \underline{h}\}$.*

**Case 4** ($\overline{h} > \widetilde{h}$ *and* $\underline{h} < \widetilde{h}$.) *In this case, for any $h < \widetilde{h}$, the market value of MTM long-term assets is enough to meet the liquidity needs and it is a no-run equilibrium, that is, $(q_1 m_1 + q_1 h) - \kappa m_1(q_0 - q_1) \geq 1$. For $h > \widetilde{h}$, the market value of MTM long-term assets is not enough to meet the liquidity needs and it would be a run equilibrium, that is,*

$(q_1 m_1 + q_1 h) - \kappa [m_1(q_0 - q_1) + (1 - q_1)h] < 1$.

*Therefore, it would be a no-run equilibrium when the policy rate further increases at period 1 for $h < \widetilde{h}$, while a run equilibrium for $h > \widetilde{h}$. Similar to previous cases, bank will choose the asset classification $h \in \{1 + e_0, \widetilde{h}\}$.* ■

**Proof for Proposition 2.** When the capital constraint is binding at the end of period 0, that is, $e_1 = \rho$, the period-0 equity issuance cost is positive. We thus have the dynamic trade-off: holding more HTM save the equity issuance cost today but raise the probability of a bank run tomorrow.

In the fourth case in Lemma 4, banks choose $h \in \{1 + e_0, \widetilde{h}\}$. By choosing $h = \widetilde{h}$, bank pay equity issuance cost

$$\begin{aligned} &(\kappa + p) [\rho - e_0 + (1 - q_0) m_0] \,|_{m_0 = 1 + e_0 - \widetilde{h}} \\ =&(\kappa + p) \left[ \rho - q_0 e_0 + (1 - q_0)(-\rho + \frac{\lambda q_0}{q_1}) \right] \end{aligned} \tag{C17}$$

In addition, by choosing $h = \widetilde{h}$, banks gain future value of deposit

$$\begin{aligned} &pV^d(q_1) = p [(q_1 m_1 - \lambda + q_1 h) - \kappa m_1 (q_0 - q_1)] \,|_{q_1 m_1 = \lambda} \\ =&p \left[ q_1 (1 + \rho) - \lambda q_0 - \kappa \lambda \frac{q_0 - q_1}{q_1} \right] \end{aligned} \tag{C18}$$

Therefore, banks will choose $h = \widetilde{h}$ if and only if

$$-(\kappa + p) \left[ \rho - q_0 e_0 + (1 - q_0)(-\rho + \frac{\lambda q_0}{q_1}) \right] + p \left[ q_1 (1 + \rho) - \lambda q_0 - \kappa \lambda \frac{q_0 - q_1}{q_1} \right] > 0 \tag{C19}$$

Denote the left-hand-side term in Equation (C19) as $LHS$. $LHS$ is an increasing function of $e_0$

$$\frac{\partial LHS}{\partial e_0} = (\kappa + p) q_0 > 0. \tag{C20}$$

Under Assumption 6, $LHS$ is negative when $e_0 = \rho$. When $e_0$ converges to $\infty$, $LHS$ is positive. Equation (C19), therefore, identifies a unique threshold $\bar{e}$, above which bank choose mark-to-market a sufficient portion of their long-term assets, $h = \widetilde{h}$. In this scenario, banks hold MTM assets $m_0 = 1 + e_0 - \widetilde{h}$ and issue period-0 equity $\Delta e_0 = \rho - e_0 + (1 - q_0) m_0$. When $e_0 < \bar{e}$, $h = 1 + e_0$. In this scenario, banks hold zero MTM assets initially and do not need to issue extra equity at the end of period 0.

The last scenario is that the capital constraint at the end of period 0 is still non-binding even if banks hold enough liquidity $h = \widetilde{h}$. Choosing $h = \widetilde{h}$ at period 0 reduces the probability of bank runs at period 1 at no cost. In this scenario, banks choose to put $h = \widetilde{h}$ long-term assets in the HTM account, and $m_0 = 1 + e_0 - \widetilde{h}$ in the MTM account. There is no equity issuance cost at period 0, $\Delta e_0 = 0$. This scenario holds when $e_0 > \rho + (1 - q_0)(1 + e_0 - \widetilde{h})$. ■

**Proofs for Proposition 3 and 4.** $\bar{e} = \bar{e}(\lambda, q_1, p)$ is a function of exogenous liquidity withdrawal $\lambda$, asset value at period 1 $q_1$, and subjective belief about period-1 interest rate risk $p$.

$LHS$ is an increasing function of $p$ at $e_0 = \bar{e}$ since

$$\frac{\partial LHS}{\partial p} = \left[q_1(1+\rho) - \lambda q_0 - \kappa\lambda \frac{q_0 - q_1}{q_1}\right] - \left[\rho - q_0 e_0 + (1 - q_0)(-\rho + \frac{\lambda q_0}{q_1})\right], \tag{C21}$$

which is positive at $e_0 = \bar{e}$. Therefore, $\bar{e}$ is a decreasing function of $p$.

$LHS$ is a decreasing function of $\lambda$ since

$$\frac{\partial LHS}{\partial \lambda} = -pq_0, \tag{C22}$$

which is negative. Therefore, $\bar{e}$ is an increasing function of $\lambda$.

$LHS$ is a increasing function of $q_1$ since

$$\frac{\partial LHS}{\partial q_1} = (\kappa + p)\frac{\lambda q_0}{q_1^2} + p(1+\rho) + \kappa\lambda \frac{q_0}{q_1^2}, \tag{C23}$$

which is positive. Therefore, $\bar{e}$ is a decreasing function of $q_1$. ■

**Proof for Proposition 5.** Regulator maximizes the expected value of deposits

$$\max_{\widehat{h}, \Delta e} \{-(\kappa + 1)\Delta e + p_R V^d(q_1) + (1 - p_R)V^d(q_0)\} \text{ s.t. } h < \widehat{h} \tag{C24}$$

In the regulator's problem, banks choose their initial HTM long-term asset holdings $h$ subject to the regulator's HTM upper cap $\widehat{h}$. Regulator can also mandate equity issuance at the end of period 0 $\Delta e$.

Following Proposition 2, if the regulator, instead ot bank themselves, can directly choose HTM long-term asset holdings $h$ in the equilibrium, they would choose

$$(h, \Delta e) = \begin{cases} (\widetilde{h}, 0) & e_0 > \rho + (1 - q_0)(1 + e_0 - \widetilde{h}) \\ (\widetilde{h}, \widetilde{e}(e_0)) & \max\{\bar{e}_R, \rho\} < e_0 < \rho + (1 - q_0)(1 + e_0 - \widetilde{h}) \\ (1 + e_0, 0) & \rho < e_0 < \max\{\bar{e}_R, \rho\} \end{cases} \tag{C25}$$

where $\widetilde{e}(e_0)$ is denoted as $\rho - e_0 + (1-q_0)(1+e_0) - \widetilde{h}$. $\overline{e}_R$ is defined by

$$-(\kappa+p_R)\left[\rho - q_0\overline{e}_R + (1-q_0)(-\rho + \frac{\lambda q_0}{q_1})\right] + p_R\left[q_1(1+\rho) - \lambda q_0 - \kappa\lambda\frac{q_0-q_1}{q_1}\right] = 0 \quad \text{(C26)}$$

Since $p < p_R$, we have $\overline{e} > \max \overline{e}_R, \rho$. Given that the regulator can only impose an upper bound on banks' HTM long-term asset holdings, they would not constrain banks with $e_0 > \underline{e}$ and $\rho < e_0 < \max \overline{e}_R, \rho$, as these banks are already making optimal decisions. For banks with $\max \overline{e}_R, \rho < e_0 < \overline{e}$, they voluntarily choose $h = 1 + e_0$, as shown in Proposition 2, while the optimal HTM asset holding is $h = \widetilde{h}$. To achieve optimality, the regulator sets $\widehat{h} = \widetilde{h}$ in this range. In other regions, the regulator sets an HTM cap higher than banks' own HTM decisions. ■

**Proof for Proposition 7.** We neglect the time index when it causes no confusion. To maximize bank $n$'s market value by choosing the deposit size $d'_n$ is equivalent to maximize:

$$\left[r - r^d(d'_n, d'_{-n})\right] d'_n \quad \text{(C27)}$$

Combining Equations (28) and (C27), the optimality is achieved in the symmetric equilibrium when:

$$r^d = \frac{Nr - \frac{1-u}{u}r - F}{N+1}$$

Notice that the deposit rate in this case is positive only when $u > \frac{r}{(N+1)r - F}$. Therefore, we obtain:

$$r^d = \begin{cases} \frac{Nr - \frac{1-u}{u}r - F}{N+1} & u > \frac{r}{(N+1)r-F} \\ 0 & u \leq \frac{r}{(N+1)r-F} \end{cases} \quad \text{(C28)}$$

The total deposit demand in the no-run equilibrium at period $t$ then follows

$$\frac{d'_t}{(1-\delta)^t} = \begin{cases} \frac{N}{N+1}\left(1 + u\frac{F}{r_t}\right) & u > \frac{r_t}{(N+1)r_t-F} \\ 1 - u + u\frac{F}{r_t} & u \leq \frac{r_t}{(N+1)r_t-F} \end{cases} \quad \text{(C29)}$$

We focus our analysis in a more realistic region where $r^d > 0$. Therefore, we obtain:

$$\frac{dr^d}{dr} = \frac{N - \frac{1-u}{u}}{N+1} > 0$$

The positive deposit rate beta follows that the deposit rate is positive. The effect of uninsured deposit ratio on the deposit rate beta follows

$$\frac{d^2 r^d}{drdu} = \frac{1}{(N+1)u^2} > 0$$

Moreover, the deposit growth beta follows

$$\begin{aligned}\frac{dlog(d')}{dr} = \frac{dd'}{dr}\frac{1}{d'} &= -\frac{N}{N+1}\frac{uF}{r^2}\frac{r}{(1-u)r + u(F + r^d)} \\ &= -\frac{N}{N+1}\frac{uF}{r}\frac{1}{(1-u)r + u(F + \frac{(N-\frac{1-u}{u})r - F}{N+1})} \\ &= -\frac{1}{r}\frac{uF}{uF + r} = \frac{1}{r}(\frac{r}{r+uF} - 1) < 0\end{aligned}$$

The above equation implies that when the policy rate increases, there would be deposit outflow. The effect of uninsured deposit ratio on the deposit growth beta follows

$$\frac{d^2 log(d')}{drdu} = -\frac{F}{(r+uF)^2} < 0$$

This proposition implies that the deposit rate beta is positive, but the deposit growth beta is negative. ■

# D Detailed Characterization of the Full Model

In this section, we first describe how the asset classification is related to the equity issuance, then characterize equilibrium in period 1, and then how the incentives to classify long-term assets in HTM account in period 0 depends on bank capital.

## D.1 Asset Classification and Equity Issuance

The bank chooses the classification of long-term assets at each period before the interest rate is realized. At period 0, banks could freely choose between HTM and MTM. At period $t \geq 1$, bank could freely choose to put MTM back to HTM, but whenever the bank chooses to withdraw money from the HTM account, all remaining long-term assets must be market-to-market.

The overall items $x = h, m, d, e$ on banks' balance sheets before the interest rate shock at period $t$ is denoted as $x_t = \sum_{n=1}^{N} x_{nt}$, and those after the interest rate shock is denoted as $x'_t = \sum_{n=1}^{N} x'_{nt}$. At the beginning of period 0, the book equity level for banks

$$e_0 = q_B m_0 + q_B h_0 - d_0$$

where $q_B$ denotes the book value of the long-term assets, given by

$$q_B = \sum_{t=1}^{\infty} \frac{\delta(1-\delta)^{t-1}}{(1+r)^t} + \sum_{t=1}^{\infty} \frac{r(1-\delta)^{t-1}}{(1+r)^t} = \frac{r+\delta}{r+\delta} = 1 \tag{D1}$$

where, in the first equality of Equation (D1), the first term corresponds to the exogenous withdrawals in periods $t \geq 0$, and the second term captures interest payments on the remaining long-term assets in each period.

Assumption 9 guarantees that all banks do not need to issue new equity if the policy rate remains at $r_0$. Under this assumption, all banks will hold enough MTM long-term assets to meet the liquidity demand at period 0.

**Assumption 9** $e_0 \geq \rho + \frac{1-q_0}{q_0}\left[1 - \frac{N}{N+1}(1 + u\frac{F}{r_0})\right] \equiv \underline{e}$

After the interest rate increases to $r_0$, depositors withdraw some money from banks. Banks sell parts of their MTM long-term assets to meet the liquidity outflow, that is, $d'_0 < d_0$, $m'_0 < m_0$, and $h'_0 = h_0$. The book equity value after the depositors' withdrawal decision becomes

$$e'_0 = q_0 m'_0 + h'_0 - d'_0 + \Delta e_0 = e_0 - (1-q_0)\, m_0 + \Delta e_0 \geq \rho \tag{D2}$$

where $\Delta e_0$ is the period-0 equity issuance, and $q_0$ denotes the market price of the MTM long-term assets at period 0, given by

$$q_0 = \sum_{t=1}^{\infty} \frac{\delta(1-\delta)^{t-1}}{(1+r_0)^t} + \sum_{t=1}^{\infty} \frac{r(1-\delta)^{t-1}}{(1+r_0)^t} = \frac{r+\delta}{r_0+\delta} \tag{D3}$$

Since the interest rate increases to $r_0$ at period 0, the market price of MTM long-term assets $q_0$ is less than 1. Equation (D2) implies that the unrealized capital losses from ex-ante MTM long-term asset holdings should be deducted from the book equity. To satisfy the capital requirement, banks need to issue

$$\Delta e_0 = \{\rho - e_0 + (1-q_0)\, m_0\}^+ \tag{D4}$$

We assume a linear cost function of issuing equity $\Phi(\Delta e_t) = (\kappa+1)\Delta e_t$.

**Lemma 5** *All the injected equity at period 0 will be invested in the MTM long-term assets.*

Lemma 5 demonstrates that by investing newly issued equity in MTM long-term assets at the end of period 0, banks can reduce their MTM asset holdings at the start of the same period. This strategy minimizes capital losses in the MTM account and lowers the cost of equity issuance.

At end of period 0, the overall HTM long-term asset holding becomes $h_1 = (1-\delta)h'_0$, MTM long-term assets follows $m_1 = (1-\delta)(m'_0 + \frac{\Delta e_0}{q_0})$, deposit $d_1 = (1-\delta)d'_0$. Therefore, the book equity at period 1 before the interest rate shock is given by $e_1 = (1-\delta)e'_0$.

**Lemma 6** *There is no reclassification between the MTM and HTM account at period 1.*

Lemma 6 suggests that banks are disincentivized from transferring assets between MTM and HTM accounts. Specifically, banks will avoid transferring assets from MTM to HTM; instead, they prefer to reduce their MTM holdings at the beginning of period 0. Similarly, transferring assets from HTM to MTM is undesirable because it would require all remaining assets to be marked to market, potentially resulting in significant capital losses if interest rates increase to $R_h$.

When the interest rate remains at $r_1 = r_0$ at period 1, there would be no endogenous deposit outflow. Therefore, $x'_1 = x_1$, where $X = h, m, d, e$. There would be no equity issuance at period 1.

When the interest rate rises to $r_1 = r_h$, some depositors will optimally choose to withdraw their funds from the banking system. This withdrawal triggers potential capital losses on both MTM and HTM long-term assets, necessitating new equity issuance. Lemma 7 summarizes these outcomes.

**Lemma 7** *The equity issuance at period 1 when $r_1 = r_h$ follows*

$$\Delta e_1 = \begin{cases} [\rho(1-\delta) - e_1 + (q_0 - q_1)\, m_1]^+, & \text{if } d_1 - d'_1 \le q_1 m_1 \\ [\rho(1-\delta) - e_1 + (q_0 - q_1)\, m_1 + (1-q_1)h_1]^+, & \text{if } d_1 - d'_1 > q_1 m_1 \end{cases} \tag{D5}$$

*where $q_1 = \frac{r+\delta}{r_h+\delta}$ denotes the market price of MTM long-term assets when $r_1 = r_h$.*

Lemma 7 suggests that the necessity of new equity issuance hinges on whether the bank must liquidate HTM long-term assets. If the MTM long-term assets are sufficient to satisfy liquidity demands (i.e., $d_1 - d'_1 \le q_1 m_1$), the bank incurs only unrealized capital losses from these assets. However, if liquidity demands exceed the value of MTM assets ($d_1 - d'_1 > q_1 m_1$), all long-term assets must be marked to market, leading to significant new equity issuance costs to fulfill capital requirements.

### D.2 Equilibrium at Period 1

Denote a bank $n$'s deposit quantity at the end of period 1 $d'_{n1}$ and any other bank's deposit quantity $d'_{-n1}$. When the policy rate doesn't change $r_1 = r_0$, there are no further endogenous deposit outflows in period 1, as depositors' outside option is also unchanged. The optimal deposit for bank $n$ is ${d'_{n1}}^* = d_{n1}$. The bank will not issue new equity.

When the policy rate further increases, $r_1 = r_h > r_0$, the bank $n$ chooses its deposit demand and new equity issuance to maximize the following objective given the predetermined balance sheet items $x_{n1}$, $X = h, m, e$.

$$F(d'_{n1}, \Delta e_{n1}; h_{n1}, m_{n1}, e_{n1}) = q_1(h'_{n1} + m'_{n1}) + \Delta e_{n1} - q_d d'_{n1} - q_c c - \Phi(\Delta e_{n1}) \tag{D6}$$

where $q_d$ and $q_c$ denote the present value of deposit and operating cost for banks. $\Phi(\Delta e_{n1}) = (\kappa + 1)\Delta e_{n1}$ measures the equity issuance cost. Bank value $V(d'_{n1}, \Delta e_{n1})$ then becomes:

$$V(d'_{n1}, \Delta e_{n1}) = \max\{F(d'_{n1}, \Delta e_{n1}; h_{n1}, m_{n1}, e_{n1}), 0\} \tag{D7}$$

Similarly, the present values of deposits and operation costs are

$$q_d = \frac{r^d(d'_{n1}, d'_{-n1}) + \delta}{r_h + \delta}, \;\; q_c = \frac{1}{r_h + \delta}, \tag{D8}$$

where $r^d(d'_{n1}, d'_{-n1})$ denotes the demand curve for deposits implied by Equation (28), with total deposit demand $d'_1 = d'_{n1} + (N-1)d'_{-n1}$. For convenience, the deposit rate at period $t$ is denoted as $r^d_t$ in the rest of the analysis.

Equation (D6) implies that the marginal benefit of retaining depositor is $r_h - r^d_1 - d'_{n1}\frac{\partial r^d_1}{\partial d'_{n1}}$. On the margin, the bank purchases long-term assets whose return is $r_h$, and the marginal cost of retaining a depositor is $r^d_1 + d'_{n1}\frac{\partial r^d_1}{\partial d'_{n1}}$. Therefore, the objective function $F(d'_{n1}, \Delta e_{n1}; h_{n1}, m_{n1}, e_{n1})$ is concave in $d'_{n1}$, linear in $\Delta e_{n1}$, and has a kink at $d'_{n1} = d_{n1} - q_1 m_1$. When the bank $n$'s deposits moves from $\{d_{n1} - q_1 m_1\}^-$ to $\{d_{n1} - q_1 m_1\}^+$, and the objective function jumps.

We focus on the symmetric equilibrium throughout the full model, where banks hold the same deposit quantities.

**Definition 2 (Symmetric Equilibrium)** *A symmetric equilibrium is ${d'_{nt}}^* = d'_t/N$ such that the bank market value is maximized at ${d'_{nt}}^* = d'_t/N$, given other banks' deposit choice ${d'_{-nt}}^* = d'_t/N$ and its own portfolio holding $h'_{nt} = h'_{-nt} = h'_t/N$, $m'_{nt} = m'_{-nt} = m'_t/N$, $e'_{nt} = e'_{-nt} = e'_t/N$.*

In the symmetric equilibrium, the total value of all banks is given by $NV({d'_{nt}}^*, \Delta e_{nt}) =$

$V(Nd'^*_{nt}, N\Delta e_{nt}) = V(d'^*_t, \Delta e_t)$ at the optimal deposit rate. Our analysis will focus on this total bank value from this point onward. For simplicity, we now denote $V(d'_t, \Delta e_t)$ as $V(d'_t)$.

### D.2.1 Interest Rate Risks and Uninsured Depositor Run

When the interest rate further increases at period 1 to $r_h$, the interest rate increase could lead to runs of uninsured depositors.

**Assumption 10** $u > \frac{r_0}{(N+1)r_0 - F}$.

Assumption 10 confines the analysis to a realistic range where the deposit rate in the no-run equilibrium is positive, $r_1^d > 0$. This condition is more likely to hold when there are enough uninsured depositors.

We assume that a bank defaults at period 1 when all long-term assets in HTM account are marked to market ($d_1 - d'_1 > q_1 m_1$) for traceability. Assumption 11 summarizes the condition.

**Assumption 11** *The operating cost $C$ is large enough so that banks default when all HTM assets are reclassified as MTM.*

$$\frac{Nc}{1-\delta} > \frac{uN}{r_h}\left(\frac{F + \frac{1}{u}r_h}{N+1}\right)^2 + (r_h+\delta)e'_0 - \kappa(r_h+\delta)\left[\rho - e'_0 + (1-q_1)h'_0 + (q_0 - q_1)(m'_0 + \frac{\Delta e_{n0}}{q_0})\right] \tag{D9}$$

When banks' MTM long-term assets are enough to satisfy liquidity demand $d_1 - d'_1 \leq q_1 m_1$, the total bank value becomes

$$V(d'_t) = \max\left\{\frac{1}{r_h+\delta}\left[(r_h - r_1^d)d'_1 + (r_h+\delta)e'_1 - Nc\right] - (1-q_1)h_1 - (\kappa+1)\Delta e_1, 0\right\}$$

Denote $q_0\lambda_0 = 1 - d'_0$, which measures deposit outflow at period 0. The initial equity level determines whether the capital requirement is binding at period 1. Specifically, if $e_0 > \rho + (1-q_0)m_0 + (q_0 - q_1)(m_0 - \lambda_0)$, the capital requirement at period 1 is non-binding. In this case, the bank's book equity remains above the minimum requirement even after accounting for unrealized capital losses in period 0, $(1-q_0)m_0$, and those in period 1, $(q_0 - q_1)(m_0 - \lambda_0)$. If $\rho + (1-q_0)m_0 < e_0 < \rho + (1-q_0)m_0 + (q_0-q_1)(m_0 - \lambda_0)$, the capital requirement at period 0 is non-binding and the capital requirement at period 1 is binding. When $e_0 < \rho + (1-q_0)m_0$, the capital requirement at period 0 is binding. Banks enter period 1 with $e_1 = \rho(1-\delta)$.

Assumption 12 guarantees the bank solvency when banks' MTM long-term assets are enough to satisfy liquidity demand and capital requirements are binding at the beginning of period 1.

**Assumption 12**

$$\frac{Nc}{1-\delta} < \frac{uN}{r_h}\left(\frac{F+\frac{1}{u}r_h}{N+1}\right)^2 + (r_h+\delta)\rho - (r_h+\delta)(1-q_1)h_1 - \kappa(r_h+\delta)\left[(q_0-q_1)(m_0' + \frac{\Delta e_{n0}}{q_0})\right]$$

where $m_0' + \frac{\Delta e_{n0}}{q_0} = m_0 - \lambda_0 + \frac{\rho - e_0 - (q_0-1)m_0}{q_0} = -\lambda_0 + \frac{\rho - e_0 + m_0}{q_0}$.

**Proposition 9 (Interest Rate Risk and Uninsured Depositor Run)** *All uninsured depositors run when only insured depositors remain at the bank,* $\underline{d_1'} = (1-u)(1-\delta)$. *When there is only rate-driven deposit outflow,* ${d_1'}^* = (1-\delta)\frac{N}{N+1}\left(1+u\frac{F}{r_h}\right)$.

- *When the value of MTM assets is sufficiently high,* $q_1 m_1 > d_1 - \underline{d_1'} > d_1 - {d_1'}^*$, *there are two equilibrium regions depending on bank values when all uninsured depositors run and no uninsured depositors run on the bank.*
  - *When the bank value is still positive even if all uninsured depositors run,* $V_1\left(\underline{d_1'}\right) > 0$, *there is a unique no-run equilibrium and the equilibrium deposit quantity is* $d_1 = {d_1'}^*$.
  - *When bank value can be positive or negative depending on whether the uninsured depositors run or not,* $V_1\left(\underline{d_1'}\right) < 0 < V_1\left({d_1'}^*\right)$, *there exist a run equilibrium and a no-run equilibrium. The equilibrium deposit quantity* $d_1 = {d_1'}^*$ *in the no-run equilibrium and* $d_1 = \underline{d_1'}$ *in the run equilibrium.*
- *When the value of MTM assets is of intermediate level,* $d_1 - \underline{d_1'} > q_1 m_1 > d_1 - {d_1'}^*$, *the no-run equilibrium cannot be unique. When all uninsured depositors withdraw their deposits, the bank must default.*
- *When the value of MTM assets is low,* $d_1 - \underline{d_1'} > d_1 - {d_1'}^* > q_1 m_1$, *there is a unique run equilibrium.*

For the rest of the paper, we assume that depositors are optimistic about the bank. They only expect a bank run when a run is the only possible equilibrium. Therefore, Assumption 12 guarantees that a no-run equilibrium as long as banks' MTM long-term assets are enough to meet deposit outflows.

## D.3 Equilibrium at Period 0

In this section, we study the banks' classification decisions at period 0, in particular, how banks' equity ratio affects the classification of long-term assets in HTM or MTM account.

**Assumption 13** *The bank operating cost $c$ is small enough so that banks do not default at period* 0.

Under Assumption 13, total bank value at period 0 $V(d_0')$ is

$$\begin{aligned} V(d_0') = &\frac{r+\delta}{1+r_0}(h_0' + m_0' + \frac{\Delta e_0}{q_0}) - \frac{r_0^d+\delta}{1+r_0}d_0' - \frac{Nc}{1+r_0} \\ &+ (1-p)\mathrm{PV}(V(d_1')|_{r_1=r_0}) + p\mathrm{PV}(V(d_1')|_{r_1=r_h}) - \Phi(\Delta e_0) \end{aligned} \tag{D10}$$

where $r_0^d$ is the deposit rate at period 0, $\mathrm{PV}(V(d_1')|_{r_1=r_h})$ is the present value of period-1 bank value when the policy rate increases to $r_h$, and $\mathrm{PV}(V(d_1')|_{r_1=r_0})$ is the present value of period-1 bank value when the policy rate remains at $r_0$. The first row in Equation (D10) represents the flow profit at period 0, while the second row reflects the expected present value of the period-1 bank value.

Let $\overline{V}(d_0')$ denote the total bank value at period 0 if, contrary to the model assumption, there is no further interest rate shocks at period 1, that is, $p = 0$.

$$\overline{V}(d_0') = \frac{1}{r_0+\delta}\left[(r+\delta)(h_0'+m_0') - (r_0^d+\delta)d_0' - Nc\right] + \Delta e_0$$

We can simplify the total bank value at period 0 to

$$\begin{aligned} V(d_0') &= \overline{V}(d_0') + p\left[\mathrm{PV}(V(d_1')|_{r_1=r_h}) - \mathrm{PV}(V(d_1')|_{r_1=r_0})\right] - \Phi(\Delta e_0) \\ &= (1 - p\frac{1-\delta}{1+r_0})\overline{V}(d_0') + p\mathrm{PV}(V(d_1')|_{r_1=r_h}) - \Phi(\Delta e_0) \end{aligned} \tag{D11}$$

The total bank value at period 0 is a weighted average of $\overline{V}(d_0')$ and the present value of the period-1 bank value when the policy rate is high, $\mathrm{PV}(V(d_1')|_{r_1=r_h})$.

We now turn to our primary finding, examining the impact of the equity ratio on the classification of long-term assets as HTM or MTM. Banks face a trade-off between holding MTM long-term assets and HTM ones: while MTM can result in capital loss and equity issuance cost in the current period, it may also reduce the probability of a bank run in period 1, thereby enhancing future bank value. Consequently, banks accumulate liquidity in period 0 when the resulting capital loss and equity issuance cost is less than the benefit of avoiding bank runs at period 1.

$$(1 - p\frac{1-\delta}{1+r_0})\Delta e_0 - \Phi(\Delta e_0) + p\text{PV}(V(d_1')|_{r_1=r_h}) \geq 0, \tag{D12}$$

where the first term represents the current return from issuing more equity, the second term represents the equity issuance cost due to capital losses from MTM assets, while the second term indicates the present value of period-1 bank value, which is positive only if the bank holds sufficient MTM long-term assets.

**Assumption 14** $\frac{q_0}{q_1}\frac{uN}{N+1}(\frac{F}{r_0} - \frac{F}{r_h}) + e_0 - \rho > \frac{1-q_0}{q_0}\left[1 - \frac{N}{N+1}\left(1 + u\frac{F}{r_0}\right)\right]$.

Assumption 14 guarantees that the injected equity at period 0 is not enough to cover period-1 liquidity outflow.

**Lemma 8** *Assume the capital requirement is binding at the beginning of period 1. If banks want to remain solvent at period 1 even when the interest rate further increases,* $r_1 = r_h$*, they choose to MTM sufficient amount of long-term assets,* $m_0 = q_0(\lambda_0^* + \lambda_1^*) + e_0 - \rho$*. Otherwise, banks choose* $m_0 = \lambda_0^*$*. Here,* ${d_0'}^* = \frac{N}{N+1}\left(1 + u\frac{F}{r_0}\right)$, $\lambda_0^* = \frac{{d_0'}^*}{q_0}$, $\lambda_1^* = \frac{{d_0'}^* - \frac{{d_1'}^*}{1-\delta}}{q_1}$.

In Lemma 4, $q_0\lambda_0^*$ represents the rate-driven outflow at period 0 and $q_1\lambda_1^*$ represents the rate-driven outflow at period 1. Lemma 4 implies that banks will hold just enough liquidity in period 0 if it is optimal to be solvent at period 1. If the bank holds MTM long-term assets less than $q_0(\lambda_0^* + \lambda_1^*) + e_0 - \rho$, it will face a liquidity shortage and will faces bank run in period 1. Conversely, holding MTM long-term assets greater than $q_0(\lambda_0^* + \lambda_1^*) + e_0 - \rho$ results in higher capital loss and equity issuance costs today. Therefore, if it is optimal to hoard liquidity, banks will hold just enough $m_0$ to meet the liquidity demand in period 1.

When $e_0 > \rho + (1 - q_0)(\lambda_0^* + \lambda_1^*)$, the capital requirement at the beginning of period 1 would be non-binding even when banks hold enough liquidity for the possible high interest rate state in period 1. In this case, $\Delta e_0 = 0$. Banks will optimally choose $m_0 = \lambda_0^* + \lambda_1^*$.

When $\rho + (1 - q_0)\lambda_0^* < e_0 < \rho + (1 - q_0)(\lambda_0^* + \lambda_1^*)$, banks should issue $\Delta e_0 = q_0\left[\rho - e_0 + (1 - q_0)(\lambda_0^* + \lambda_1^*)\right]$ when banks initially hold more MTM long-term assets $m_0 = q_0(\lambda_0^* + \lambda_1^*) + e_0 - \rho$, while do not need to issue any issue new equity, $\Delta e_0 = 0$, when banks initially hold less MTM long-term assets $m_0 = \lambda_0^*$. In this case, Equation (D12) becomes:

$$-(\kappa + p\frac{1-\delta}{1+r_0})q_0\left[\rho - e_0 + (1 - q_0)(\lambda_0^* + \lambda_1^*)\right] + \text{PV}(V(d_1')|_{r_1=r_h}) > 0 \tag{D13}$$

**Assumption 15**

$$-(\kappa + p\frac{1-\delta}{1+r_0})(1-q_0)q_0\lambda_1^* + p\frac{N(1-\delta)}{(1+R_0)(r_h+\delta)}$$

$$\times\left[\frac{u}{r_h}\left(\frac{F+\frac{1}{u}r_h}{N+1}\right)^2 + (r_h+\delta)\rho - \frac{c}{1-\delta} - (r_h+\delta)(1-q_1)h_1 - \kappa(r_h+\delta)(q_0-q_1)(m_0' + \frac{\Delta e_0}{q_0})\right] < 0$$

Assumption 15 implies that for banks with an initial equity level at the lower bound $e_0 = \underline{e}$, the marginal benefit of holding liquidity buffer is negative. This technical assumption ensures that Equation (D13) identifies a unique threshold for the bank's initial equity holding at date 0, $\overline{e}(u,p)$. Banks will choose to mark-to-market a sufficient portion of long-term assets only if their equity exceeds this threshold, $e_0 > \overline{e}(u,p)$. Therefore, we establish the conditions under which banks choose period-0 classification that keeps them solvent in period 1, even if the long-term interest rate rises to $r_h$.

**Proposition 10** *The classification of long-term assets at period* 0 *relies on banks' initial equity:*

- *When* $e_0 \geq \rho + (1-q_0)(\lambda_0^* + \lambda_1^*)$, $m_0 = \lambda_0^* + \lambda_1^*$, $h_0 = 1 + e_0 - \lambda_0^* - \lambda_1^*$, $\Delta e_0 = 0$. *In this case, it is a no-run equilibrium in period 1.*
- *When* $\overline{e} \leq e_0 < \rho + (1-q_0)(\lambda_0^* + \lambda_1^*)$, $m_0 = q_0(\lambda_0^* + \lambda_1^*) + e_0 - \rho$, $h_0 = 1 + \rho - q_0(\lambda_0^* + \lambda_1^*)$, $\Delta e_0 = q_0\left[\rho - e_0 + (1-q_0)(\lambda_0^* + \lambda_1^*)\right]$. *In this case, it is a no-run equilibrium in period 1.*
- *When* $\underline{e} \leq e_0 < \overline{e}$, $m_0 = \frac{1-D_0^*}{q_0}$, $h_0 = 1 + e_0 - \frac{1-D_0^*}{q_0}$, $\Delta e_0 = 0$. *In this case, it is a run equilibrium in period 1.*

Proposition 10 implies that if banks' initial equity level is greater than $\overline{e}$, they are willing to incur the capital loss in the MTM account in exchange for future returns by holding lower HTM share. Conversely, if banks' initial equity level is limited and the marginal benefit of holding MTM is negative, they will choose to hold more their long-term assets in the HTM account to maximize their current value. Those banks with equity below $\overline{E}$ put more long-term assets in the HTM account in the hope of a future low-interest-rate environment. This is consistent with the empirical evidence in Section 2, where we find that banks with higher equity ratios are more likely to reduce their HTM share during periods of monetary tightening.

As previously noted, $p$ denotes banks' subjective expectations regarding future interest rate risks. The following proposition illustrates how banks' optimism about the future influences the likelihood of a bank run.

**Proposition 11** *When banks are more optimistic (lower $p$), $\overline{e}(u,p)$ increases.*

As optimism about the future increases (i.e., $p$ decreases), more banks allocate the majority of their long-term assets to the HTM account. In the extreme case where $p = 0$, banks assign zero probability to a positive future interest rate shock. As a result, the cutoff $\overline{e}$ approaches infinity, causing all banks to hold the majority of their long-term assets in the HTM account, with only the minimum necessary in MTM to meet period-0 liquidity demands.

**Proposition 12** $\overline{E}(u,p)$ *increases when the uninsured depositor ratio $u$ increases under the assumption that period-1 increase rate hike $r_h$ is sufficiently large, $r_h > F$ and $(q_0 - q_1)\frac{F}{r_0} > q_0\frac{F}{r_h}$.*

Proposition 12 outlines the factors influencing banks' motivation to engage in accounting manipulation. A higher $\overline{e}$ increases the likelihood of accounting manipulation. An increase in uninsured depositors leads to more deposit outflow and diminishes the deposit franchise value of banks (indexed by higher deposit rate beta), reducing the benefits of holding MTM assets and thus heightening $\overline{e}$.

## D.4 Optimal Regulation Under Underestimation of Interest Rate Risk

What is the optimal policy under these constraints if regulators can set both a cap on HTM assets and a required equity issuance? To answer this question, we write down regulators' optimization problem. Suppose the regulator selects a uniform HTM share cap $\widehat{h}$ and an equity issuance $\Delta e$ at period 0 to maximize the expected value of banks,

$$\max_{\widehat{h},\Delta e}\left\{(1 - p_R\frac{1-\delta}{1+r_0})\overline{V}(d_0') + p_R\text{PV}(V(d_1')|_{r_1=r_h}) - (\kappa+1)\Delta e\right\},\ \text{ s.t. } h < \widehat{h}$$

where the final term represents the equity issuance cost. $p_R$ denotes regulators' subjective perception of future interest rate risk.

**Assumption 16** *Assume that regulators are more concerned about rate increases than banks, $p_R > p$.*

We use the difference in risk perception to reflect regulators' concern about bank fragility under rate increases.

**Proposition 13 (Optimal Capital Issuance and HTM Share Cap)** *The optimal capital issuance and HTM cap are*

$$(\widehat{h}^*, \Delta e^*) = \begin{cases} (\geq 1 + \rho - q_0(\lambda_0^* + \lambda_1^*), 0) & e_0 \geq \rho + (1 - q_0)(\lambda_0^* + \lambda_1^*) \\ (\geq 1 + \rho - q_0(\lambda_0^* + \lambda_1^*), \widetilde{e}(e_0)) & \overline{e} \leq e_0 < \rho + (1 - q_0)(\lambda_0^* + \lambda_1^*) \\ (1 + \rho - q_0(\lambda_0^* + \lambda_1^*), \widetilde{e}(e_0)) & \max\{\overline{e}_R, \underline{e}\} \leq e_0 < \overline{e} \\ (1 + e_0, 0) & \underline{e} < e_0 < \max\{\overline{e}_R, \underline{e}\} \end{cases}$$

*where* $\widetilde{e}(e_0) = q_0 [\rho - e_0 + (1 - q_0)(\lambda_0^* + \lambda_1^*)]$*, and* $\overline{e}_R$ *is the lower bound of bank equity that satisfies inequality (D12) under probability* $p_R$*.*

$\overline{e}_R$ represents the threshold above which the bank regulator aims to ensure bank solvency in period 1. It increases when the bank regulator is more optimistic, that is, when $p_R$ is smaller. Proposition 5 suggests that the optimal regulations for equity issuance and HTM share caps depend on the initial equity level. When equity exceeds $\rho + (1 - q_0)(\lambda_0^* + \lambda_1^*)$, banks maintain sufficient book equity above the minimum requirement, negating the need for HTM share caps or new equity issuance. When $\overline{e} \leq e_0 < \rho + (1 - q_0)(\lambda_0^* + \lambda_1^*)$, banks voluntarily hold sufficient liquidity and issue $\widetilde{e}(e_0)$, eliminating the need for a HTM share cap. When $\max\{\overline{e}_R, \underline{e}\} \leq e_0 < \overline{e}$, banks hold just enough liquidity for period-0 deposit outflows, risking a bank run in period 1 when the policy rate is high. To prevent this, the regulator imposes an HTM share cap below 1 and issue $\widetilde{e}(e_0)$ to ensure sufficient liquidity. When $\widetilde{e}_0 < \max\{\overline{e}_R, \underline{e}\}$, a bank run in period 1 is unavoidable, thus the optimal HTM share cap is set at 1, with no need for new equity issuance.

As long as the regulator sets an HTM share cap below 1 for mid-sized banks, these banks will voluntarily issue $\widetilde{e}(e_0)$ to offset capital losses from MTM assets. Conversely, if the regulator only mandates new equity issuance, banks will ensure sufficient liquidity at the start of period 0. Thus, either equity issuance or an HTM share cap can effectively prevent unintended bank runs.