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The 2023 Banking Turmoil and the Bank Term Funding Program*

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Abstract

We use high-frequency data to examine the effectiveness of the Bank Term Funding Program (BTFP) in supporting the liquidity positions of vulnerable banks during the March 2023 banking turmoil. We uncover three key findings. First, our high-frequency data confirm that banks with high reliance on uninsured deposits and large unrealized losses on securities holdings suffered larger deposit outflows at the onset of the episode. Second, the BTFP played an outsized role in meeting these outflows at banks with larger securities losses, reflecting the at-par valuation of securities collateral at the BTFP (banks at the 90th percentile in securities losses replaced 26 cents of every dollar of outflows with BTFP borrowing, compared to only 7 cents on average). Third, in addition to funding loan growth and deposit outflows, banks used the BTFP to build cash holdings, indicating that the program enabled banks to position themselves against potential future funding needs. Overall, we demonstrate that the BTFP enabled banks to meet funding needs and preserve liquidity during the period of stress.

Keywords: 2023 banking turmoil, deposit outflows, uninsured deposits, securities losses, Bank Term Funding Program (BTFP), emergency liquidity facilities
JEL Classifications: E52, E58, G01, G21

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1 Introduction

A key function of banks is maturity transformation. They borrow short-term deposits and provide long-term credit to firms and households. This function also hedges banks against interest rate risk (Drechsler *et al.* (2021)). Deposits usually bear below-market rates when interest rates rise, thus hedging the interest rate exposure of long-term assets (Hannan and Berger (1991); Neumark and Sharpe (1991); Drechsler *et al.* (2017)). However, hedging only works so long as deposits stay in the bank. If the deposit franchise value becomes larger than the value of the bank's long-term assets when interest rates rise, uninsured depositors may run (Jiang *et al.* (2023), Drechsler *et al.* (2023), Haddad *et al.* (2023)). The failure of the Bank of the Commonwealth in 1973 is an example of interest rate risk that resulted from exposure to long-duration, fixed-rate assets and an unstable funding base (Prescott (2024)). The banking turmoil in March 2023 was the most recent manifestation of this phenomenon.

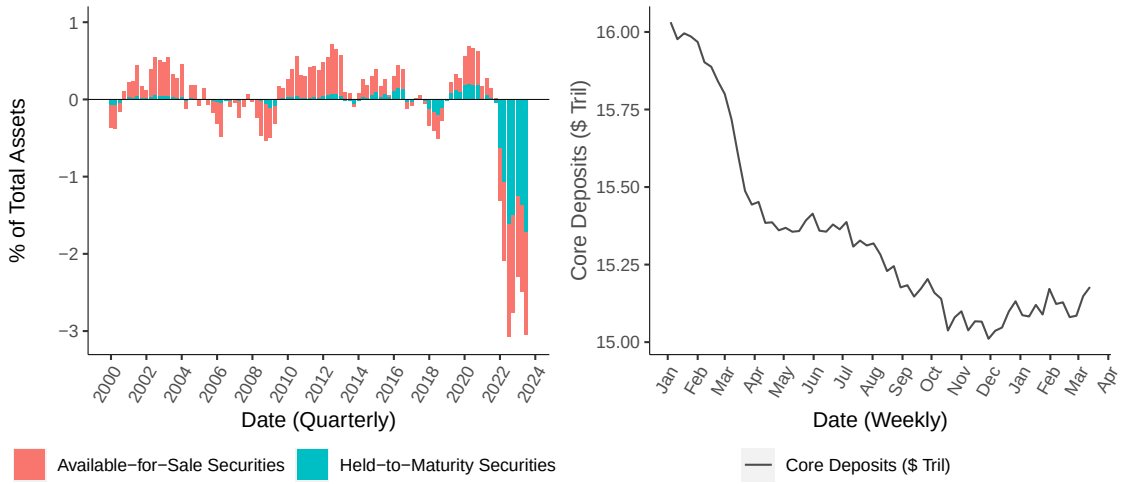
What actions can manage the risk of a run in the presence of interest rate risk? Ex-ante, banks could shorten the maturity of their assets, but this would undo their interest rate hedge. The value of short-term assets does not appreciate enough to offset the decline in the value of the deposit franchise when interest rates fall (Drechsler *et al.* (2023)). Banks could also invest in swaps that pay fixed and receive floating rate. Recent evidence, however, suggests only limited hedging of bank assets using interest rate swap positions (e.g. McPhail *et al.* (2023); Granja *et al.* (2024)).

This paper establishes that an ex-post lender of last resort (LOLR) intervention calibrated to preserve banks' asset values by providing liquidity against the par value of collateral can help contain a run on banks' deposit franchise in the presence of interest rate risk. In particular, we document and discuss the effectiveness of the Bank Term Funding Program (BTFP) introduced in March 2023 as an ex-post intervention to address run risk.

As yields started rising in the spring of 2022, the value of securities held by depository institutions declined and banks started to accumulate significant unrealized losses on their balance sheets (Figure 1, left panel). Following the failures of Silicon Valley Bank (SVB) and Signature Bank in March 2023, concerns mounted over the health of other banks with similar characteristics—those with heavy reliance on uninsured deposits and large losses in their securities portfolios. Broader contagion caused some of those vulnerable banks to face rapid deposit outflows (Figure 1, right panel).

In response to the turmoil, the Federal Reserve Board established the BTFP, with approval by the Secretary of the Treasury, pursuant to section 13(3) of the Federal Reserve Act. The BTFP extended loans for up to one year at a fixed rate of 10 basis points over the one-year overnight-indexed swap (OIS) rate. Importantly, BTFP collateral was valued at par rather than market value. This paper examines banks' experience with deposit outflows during the 2023 banking turmoil and

Figure 1: Unrealized Securities Losses and Deposit Outflows



Note: The left figure shows unrealized securities losses (available-for-sale (AFS) and held-to-maturity (HTM)) for all U.S. commercial banks from 2000Q1 to 2023Q3 as a percent of total assets. The right figure shows the levels of core deposits for U.S. domestically-chartered commercial banks from January 2023 to March 2024. Source: author calculations, Call Reports, H.8.

the effectiveness of the BTFP.

We bring together several confidential, bank-level, high-frequency datasets, including data on banks' assets and liabilities from the Federal Reserve's FR 2644 reporting form and on borrowings from the BTFP and the discount window. The analysis centers around three main questions. First, we examine what risk factors contributed to banks' core deposit outflows during the stress episode. We find that banks with high reliance on uninsured deposits as a source of funding and large marked-to-market losses on securities holdings faced relatively more deposit outflows. These effects of uninsured deposits and security losses were short-lived, however, and dissipated by early May.

Second, we ask how banks managed these core deposit outflows, such as by reducing liquid assets or borrowing wholesale. We find that banks primarily reduced cash holdings or borrowed from non-Fed sources, mainly Federal Home Loan Banks (FHLBs), when core deposit outflows were realized. BTFP borrowings played a relatively modest role in how the *average bank* met funding needs. However, BTFP was an important source of funding for the vulnerable banks, such as those with large securities losses or high reliance on uninsured deposits. In particular, *banks with relatively large security losses* used BTFP borrowings to a greater extent to fund core deposit outflows, and turned to other liquidity sources to a lesser extent than the average bank, including to non-Fed borrowings, large time deposits, cash, and securities. On average, banks covered 7 cents for every dollar of deposit outflows with BTFP borrowings and 32 cents with non-Fed borrowings; in contrast, banks at the 90th percentile in securities losses covered 26 cents for every dollar of core deposit outflows with BTFP borrowings and 28 cents with non-Fed borrowings.

Vulnerable banks' relative preference for BTFP over non-Fed borrowings reflects the advantage of at-par collateral valuation at the BTFP. Furthermore, reliance on BTFP borrowings was especially large among regional banks with total assets between $100 and $250 billion. These banks were more impacted by the turmoil, and used the BTFP to cover almost 50 cents for every dollar of their core deposit outflows. Moreover, vulnerable banks pledged substantially more collateral than they subsequently encumbered with BTFP loans. This collateral pledging was concentrated in mortgage-backed securities (MBS) and collateralized mortgage obligations (CMOs), which suffered disproportionately large fair value declines from January 2022 to March 2023.

Third, to understand how banks used wholesale borrowings from the BTFP and other sources, we investigate the dynamic relationship between banks' wholesale borrowings and deposits, cash, and loans over time. Starting with shifts in the composition of bank liabilities, we find that banks increased non-Fed borrowings immediately in the weeks that core deposits fell, but only used BTFP borrowing after a period of sustained deposit outflows. This result suggests that the BTFP usage may have entailed a fixed cost so banks only used BTFP if a significant enough funding need arose. On the asset side, we find that banks that increased their wholesale borrowings built up their cash buffers, suggesting a precautionary reason for wholesale borrowing. Additionally, banks that borrowed from either the BTFP or non-Fed sources exhibited stronger loan growth both before and after borrowing, indicating that some of the borrowing was used to fund new lending.

Our findings have several important implications. First, BTFP was successful in targeting the more vulnerable banks, whose BTFP borrowing was motivated by both precautionary motives and the need to fund the realized deposit outflows. The precautionary motive behind BTFP borrowings is reflected by our finding that, for a given amount of realized deposit outflows, vulnerable banks with large security losses and high reliance on uninsured deposits borrowed more from the BTFP than other banks. Vulnerable banks also pledged substantially more collateral at the BTFP than they borrowed. Second, the at-par valuation of collateral provided an advantage to banks with larger security losses, given that such banks used more BTFP relative to non-Fed borrowings compared with other banks. The at-par collateral valuation advantage of BTFP was especially important for vulnerable banks, which pledged larger amounts of MBS and CMO collateral—securities with relatively larger fair value losses than Treasury and agency securities, given their negative convexity to rising interest rates—in line with the larger shares of these securities in banks' portfolios. Third, the finding that banks borrowing from either BTFP or non-Fed sources experienced similar trend growth in loan balances suggests that BTFP supported the lending of more vulnerable banks, which were more likely to borrow from the BTFP and to benefit from the at-par collateral advantage. Conceivably in the absence of BTFP borrowing, vulnerable banks may have been forced to execute costlier balance sheet adjustments, which could have impacted lending.

Related literature: Our findings contribute to the literature on the interplay between banks' liquidity and interest rate risk. In theory, the risk of runs on a bank's deposit franchise increases when interest rates are high and banks rely on uninsured deposits. This is because the value of the bank's assets declines relative to the value of the uninsured deposit franchise (e.g., Drechsler *et al.* (2023); Jiang *et al.* (2023); Haddad *et al.* (2023)). Our results highlight the role of banks' marked-to-market losses on securities holdings, which reduced the value of their assets when interest rates increased, and also the role of uninsured deposits in prompting deposit runs. Our results also show that banks with larger losses tapped more into BTFP funding—obtaining funding at the par value of collateral—to restore their asset values and contain deposit runs.

Relatedly, our findings contribute to the literature on LOLR by analyzing the BTFP in two important ways. First, a large theoretical literature discusses the benefits of LOLR interventions during financial crises (Diamond and Dybvig (1983); Freixas *et al.* (2004); Rochet and Vives (2004)). By supplying term funding (Jasova *et al.* (2021)), expanding collateral eligibility requirements (Van Bekkum *et al.* (2018)), or directly purchasing commercial loans from banks (Minoiu *et al.* (2024)), LOLR can help banks support the supply of credit and prevent a crunch when private liquidity freezes. Our finding that BTFP supported banks' loan balances is consistent with this literature. This is largely due to BTFP's one-year fixed-rate funding at 10 basis points spread over the market rate, which resembles the value of the deposit franchise when deposits stay with the bank (e.g., Drechsler *et al.* (2021)).

Second, our finding that banks with large securities losses disproportionately used the BTFP to meet deposit outflows suggests that the par valuation of collateral was a key determinant of the program's ability to encourage utilization and contain deposit runs. By helping such banks avoid realizing losses from potential sales of securities and maximize the amount of liquidity obtained against collateral, the BTFP helped prevent them from becoming undercapitalized, which would have further exacerbated the bank run (Egan *et al.* (2017); Jiang *et al.* (2023)). In other words, the par valuation of collateral helped contain the run, even in the presence of significant interest rate risk. This finding marks an important contribution to the literature on the design and transmission of central bank liquidity provision (Drechsler *et al.* (2016); Carlson and Macchiavelli (2020); Carpinelli and Crosignani (2021); Kotidis *et al.* (2022)).

More generally, our paper relates to the literature on bank runs and panics. Our finding that depositors withdrew because of a bank's higher securities losses is consistent with the standard models of bank runs (e.g., Diamond and Dybvig (1983)) and theories where solvency concerns increase the likelihood of a run (e.g., Diamond and Rajan (2011); Brunnermeier and Pedersen (2009)). However, our paper is more directly related to newer theories in which bank runs could occur even when assets are fully liquid and high-quality (e.g., Drechsler *et al.* (2023), Jiang *et al.*

(2023)). The March 2023 banking crisis represents a case in which the interaction between higher franchise values, uninsured deposits, and market-to-market losses on otherwise *liquid* security holdings prompted runs, which the BTFP helped contain. Our evidence that the run was concentrated on banks with higher shares of uninsured deposits also complements studies of past episodes of depositor behavior during bank runs (e.g., Iyer and Puri (2012); Iyer *et al.* (2016)).

Finally, our analysis complements findings in an emerging literature that studies the 2023 banking turmoil events. For example, Choi *et al.* (2023) study the contagion effects following the run on SVB, while Caglio *et al.* (2023) present evidence on flight to safety from regional banks towards larger banks. Cookson *et al.* (2023) highlight social media as a key spillover mechanism. While Cipriani *et al.* (2024) study the role of fundamentals and public signals on prompting runs in a study contemporaneous with ours, we also focus on banks' balance sheet adjustment strategies in the aftermath of deposit runs, distinguishing between BTFP and other sources of wholesale funding, as well as highlighting the role of par collateral valuation at the BTFP in containing runs.

2 Institutional Background

Silicon Valley Bank (SVB) was a $200 billion bank with a concentrated customer base in the technology industry. On March 8, 2023, SVB announced significant losses in its securities portfolio. Coupled with the bank's concentrated customer base, the announcement led to rapid and substantial deposit outflows. Meanwhile, Signature Bank and Silvergate Bank faced similar liquidity pressures, amid investors' concerns about their cryptocurrency industry exposures. While Silvergate Bank decided to wind down its operations voluntarily, SVB and Signature Bank collapsed on March 10 and March 12, respectively, when it became clear that they had insufficient liquidity to meet deposit outflows.

The speed and magnitude of the deposit runs were unprecedented (Rose, 2023). For example, SVB informed regulators on the morning of March 10 that $100 billion in deposit withdrawals were expected for that day. In contrast, depositors withdrew about $17 billion over the course of eight business days in September 2008 during the run on Washington Mutual, a much larger bank. While SVB and Signature Bank were placed in receivership, concerns over broader contagion led to sizable declines in bank stock prices. The KBW Bank Index and KBW Regional Bank Index fell by as much as 20% and 25% on subsequent days. The declines in bank stock prices led to yet more deposit outflows and eroded confidence in the banking system.

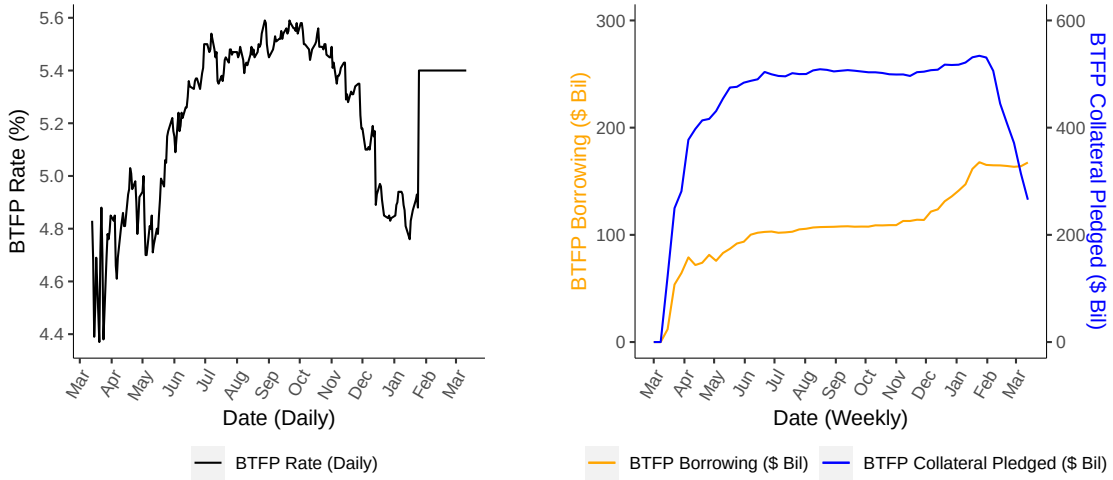
To avert potentially far-reaching consequences of these developments, the Federal Reserve and other agencies took decisive actions to protect depositors and maintain confidence in the banking sector. On March 12, the Federal Reserve announced the establishment of the BTFP. The BTFP allowed depository institutions that were eligible for primary credit at the Federal Reserve's discount

window to borrow for up to one year at a fixed rate of 10 basis points over the one-year overnight-indexed swap (OIS) rate. The longer loan term helped provide a stable source of funding for depository institutions. In addition, BTFP collateral was valued at par, rather than market value. Eligible collateral was limited to open-market operation eligible collateral, and included Treasury securities, agency debt, and agency MBS and CMOs. No haircuts were applied to eligible collateral.

The left panel of Figure 2 shows that the interest rate on BTFP loans increased steadily between March and October before it gradually declined in late 2023, reflecting market expectations for interest rates over the next year. The interest rate applicable to new BTFP loans was adjusted on January 24, 2024, to be no lower than the interest rate on reserve balances (IORB) on the same day the loan was made, partially reflecting the stabilization of market funding conditions.

The right panel of Figure 2 plots the outstanding amount of BTFP borrowing (in orange) and of collateral pledged (in blue) over the program. The outstanding amount of BTFP loans and the collateral pledged at the BTFP increased rapidly in the first few months of the program, before stabilizing during the second half of 2023. Interestingly, depository institutions pledged substantially more collateral than what they used to borrow, which may reflect a precautionary motive to access the BTFP if and when they need to. After January 24, 2024, when the Federal Reserve announced that the BTFP would cease making new loans as scheduled on March 11, the amount of pledged collateral fell while borrowing gradually declined.

Figure 2: BTFP rate and uptake



Note: The left panel of the figure shows BTFP rate (in %). The right panel of the figure shows BTFP borrowing and collateral pledging ($B). The time period is between March 12, 2023 and March 11, 2024.

3 Methodology and Data

3.1 Methodology

Our analysis centers around three questions. First, what risk factors contributed to core deposit outflows during the banking turmoil? Second, how did banks manage these deposit outflows? Third, how did banks use BTFP and other funds to fund loans and accumulate reserve balances?

To address the first question, we run cross-sectional regressions predicting changes in banks' core deposits over four eight-week intervals. We principally focus on changes between March 8 and May 3, because this period covers the onset of the banking turmoil. We also analyze changes between May 3 and June 28, June 28 to August 23, and August 23 to October 18 to study deposit outflows during the period in which banking conditions stabilized. We regress the change in core deposits on bank-specific risk factors measured as of 2022q4. Formally, we estimate the equation:

$$\frac{\Delta\text{Deposits}_{i,t,t'}}{\text{Assets}_{i,t}} = \beta_1 \frac{\text{Uninsured deposits}_{i,22q4}}{\text{Assets}_{i,22q4}} + \beta_2 \frac{\text{HTM Securities Losses}_{i,22q4}}{\text{Assets}_{i,22q4}} + \gamma' X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where i indexes banks, t and t' denote the start and end of the eight-week window under consideration, and uninsured deposits and HTM securities losses (both normalized by a bank's total assets as of 2022q4) are the primary risk factors of interest. We additionally consider specifications interacting the two risk factors to capture the fact that HTM securities losses may predominantly affect the incentives of uninsured depositors to withdraw funds (Jiang *et al.*, 2023). We focus on the HTM security portfolio since banks are restricted in hedging interest rate risk for HTM securities and face greater impediments to selling these assets, given the marked-to-market valuations involved that would result in accounting losses (Granja *et al.*, 2024). However, the findings are broadly similar when considering security losses combined between AFS and HTM portfolios.[1] $X_{i,t}$ is a vector of controls that includes loan growth, $\Delta\text{Loans}_{i,t,t'}/\text{Assets}_{i,t}$, to account for the fact that loan growth can cause deposit growth if funds are initially held in the borrower's deposit account (Glancy *et al.*, 2020; Cooperman *et al.*, 2023). We also include balance sheet items from 2022q4 Call Report filings: liquid asset holdings (the sum of cash, federal funds, reverse repo and securities holdings) as a share of total assets, deposit growth leading into the period of the banking turmoil (i.e. 2022q1 to 2022q4), average funding cost (annualized interest expense as a percent of total liabilities), and FHLB advances as a share of total assets.[2] Finally, we include bank size indicators

[1] Appendix Table B1 presents results from the interaction of uninsured deposits with both HTM and AFS securities losses. It shows that AFS security losses also interact with uninsured deposits, but the effect is smaller.

[2] Controlling for loan growth in this regression could conceptually be problematic if banks reduced loans to meet deposit outflows. However, banks are unlikely to adjust lending at the high frequencies studied in this paper. When banks change lending policies, it tends to affect loan balances over the course of the following years rather than

that equal one if a bank is a community bank (under $10 billion in total assets) or regional bank (between $10 and $250 billion in assets).[3]

Second, we investigate how banks managed core deposit outflows, either by borrowing funds from the BTFP or other sources or by reducing liquid asset holdings. We replace the left-hand side variable of specification (1) with changes in either BTFP borrowing to total assets or changes in other balance sheet items that could be used to meet funding needs (e.g., FHLB advances, securities sales), and test whether banks that had characteristics that made them vulnerable to deposit outflows adjusted more to compensate. Formally, we estimate the regression:

$$\begin{aligned}\frac{\Delta Y_{i,t,t'}}{\text{Assets}_{i,t}} = \beta_1 \frac{\Delta\text{Deposits}_{i,t,t'}}{\text{Assets}_{i,t}} + \beta_2 \frac{\text{HTM Securities Losses}_{i,22q4}}{\text{Assets}_{i,22q4}} \\ + \beta_3 \frac{\text{Uninsured deposits}_{i,22q4}}{\text{Assets}_{i,22q4}} + \gamma' X_{i,t} + \varepsilon_{i,t},\end{aligned} \tag{2}$$

where $\Delta Y_{i,t,t'}/\text{Assets}_{i,t}$ is the change in some balance sheet item over the eight-week interval of interest and $\Delta\text{Deposits}_{i,t,t'}/\text{Assets}_{i,t}$ is the change in core deposits during this time. β_1 estimates how much banks adjust balance sheet item Y in response to a dollar of deposit outflows. In some specifications, we interact deposit outflows with HTM security losses to investigate how the response to deposit outflows differs across banks. Finally, $X_{i,t}$ is a vector of the same variables included as controls in equation (1).[4]

Third, to better understand the dynamics in how banks used wholesale borrowing, we investigate the relationship between banks' borrowing decisions and changes in deposits, cash holdings, and loans over time. Specifically, instead of using a fixed window to estimate the relationship between borrowing and other balance sheet developments, we use local projections to trace out changes in bank balance sheet items at various horizons surrounding borrowing. Specifically, we estimate:

$$\frac{y_{i,t+h} - y_{i,t-1}}{Assets_{i,t-1}} = \beta^h \frac{\Delta BTFP_{i,t}}{Assets_{i,t-1}} + \tau_t^h + \epsilon_{i,t}^h \tag{3}$$

where τ_t^h is a week fixed effect. $\{\beta^h\}$ traces the path of balance sheet variables surrounding increase in BTFP balances relative to other banks that did not change BTFP usage in a particular week. We also estimate a similar specification for non-Fed borrowings. The sample for this analysis includes t ranging from March 15th to July 26th. We investigate leads/lags up to 10 weeks (i.e., $h \in [-10, -9, ..., 10]$), so the estimation data includes balance sheet changes from January 4th to

following weeks (Bassett *et al.*, 2014; Castro *et al.*, 2022).

[3]The omitted category is banks with total assets that exceed $250 billion.

[4]For robustness, we also estimate equation (2) with Excess Loan Growth—defined as $(\Delta\text{Loans}_{i,t,t'} - \Delta\text{Deposits}_{i,t,t'})/\text{Assets}_{i,t}$—as the main independent variable. This measure reflects the additional funding need the bank needs to raise (besides from core deposits) to fund the growth in their loan portfolio.

October 4th.

3.2 Data

Our analysis primarily draws on form FR 2644, which provides detailed data on banks' assets and liabilities at a weekly frequency. To focus attention on institutions participating in conventional banking activities, we restrict the sample to domestically chartered banks, and omit banks in companies principally involved in investment banking or custodian activities.[5] On the asset side, the data provide a detailed classification of different loan types, as well as securities and cash holdings. On the liabilities side, the data include core and large time deposits balances, as well as aggregate wholesale borrowings.[6] Wholesale borrowings include FHLB advances, repos, federal funds, discount window and BTFP borrowing. We isolate Federal Reserve borrowing from other wholesale borrowings by separately obtaining discount window and BTFP borrowings data from internal Federal Reserve records.[7] Outside of the largest banks, which are more active in repo markets, the remaining part of wholesale borrowings is mostly composed of FHLB advances. Finally, we rely on bank Call Reports data as of December 2022 to measure ex-ante vulnerabilities (e.g., uninsured deposit shares and security losses).

3.3 Summary statistics

To gauge the scope of coverage of our sample, Figures A1-A8 of Appendix A compare certain balance sheet characteristics of FR 2644 filers to the universe of banks (Call Reports data). In general, FR 2644 banks have very similar characteristics to the corresponding sample of all commercial banks (core deposits, FHLB advances, unrealized securities loss relative to total assets). The most significant differences are total assets and the share of uninsured deposits (Figures A1 and A8), where our FR 2644 sample banks are, on average, larger and rely more on uninsured deposits than the average commercial bank in the Call Reports universe. Therefore, our sample is relevant to study the regional banks and banks with high reliance on uninsured deposits, which were disproportionately affected by the banking episode in March 2023.

Table 1 provides additional background information for the banks in our sample. It distinguishes between borrowers and non-borrowers from the BTFP to explore differences in balance sheet characteristics for the banks that accessed the program. Three observations stand out. First,

[5] Though credit unions also participated meaningfully in the BTFP, we restrict our attention to banks due to the lack of high frequency credit union data.

[6] "Core" deposits are defined as liquid (non-CD) deposits plus small (under $100,000) time deposits. This definition includes brokered deposits that have been participated out in shares of less than $100,000, so we may underestimate deposit outflows to the extent that banks offset some of the deposit outflows by raising brokered deposits of this type.

[7] These are daily data, which we aggregate at the weekly level following the timing convention in FR 2644 forms (i.e, Wednesday close of business levels).

BTFP borrowers are substantially smaller than non-borrowers. In general, smaller banks are less able to access market-based funding than larger banks, both in normal times and under stress. Second, BTFP borrowers appear to have greater reliance on uninsured deposits as a source of funding and larger unrealized HTM securities losses relative to assets. And third, possibly related to these risk factors, BTFP borrowers appear to have weaker core deposit growth and a greater reliance on FHLB advances in the run-up to banking turmoil.

Table 1: Summary Statistics

	# Institutions	Assets ($B)	Core Deposit Growth (%)	Uninsured Deposit to Assets (%)	Unrealized HTM Securities Losses (%)	FHLB adv to Assets (%)	FHLB member shr (%)
A. *2022 Q4*							
FR2644 Banks	668	20.74	−4.52	28.57	.40	3.01	94
Borrowers	82	6.26	−7.57	32.22	.65	3.62	98
Non-borrowers	586	22.77	−4.09	28.05	.36	2.93	93
B. *2023 Q1*							
FR2644 Banks	668	20.98	−9.55	26.56	.34	3.45	94
Borrowers	82	6.48	−16.13	29.05	.57	3.76	98
Non-borrowers	586	23.00	−8.63	26.21	.31	3.41	93
C. *2023 Q2*							
FR2644 Banks	668	20.87	−9.25	25.19	.38	3.46	94
Borrowers	82	6.41	−8.25	27.54	.63	2.94	98
Non-borrowers	586	22.9	−9.39	24.85	.35	3.53	93
D. *2023 Q3*							
FR2644 Banks	668	21.00	−0.78	25.3	.50	3.24	94
Borrowers	82	6.45	0.90	27.45	.76	2.93	98
Non-borrowers	586	23.07	−1.02	24.99	.46	3.29	93

Notes: The table shows summary statistics for 2022 Q4 Call Report data for banks and the subset of banks included in the FR2644, broken down by their respective BTFP borrower status (as of 5/3/2023). The uninsured deposits share is defined as uninsured deposits relative to total deposits; unrealized securities losses, FHLB advances are relative to total assets.

4 Results

4.1 Which banks experienced core deposit outflows?

In this section, we investigate what risk factors were associated with deposit outflows and, consequently, financing needs that could be addressed by the BTFP. Table 2 regresses changes in core deposits on banks' 2022q4 uninsured deposit volumes and HTM security losses (all measured as a share of total assets). Columns 1-2 investigate changes in the first eight weeks of stress (from March 8th to May 3rd), while columns 3-8 investigate changes over the following 24 weeks (divided in three intervals of less acute stress).

Column 1 shows that uninsured deposits played a significant role in prompting deposit outflows

during the period of most acute stress. The estimates imply that core deposits fell by about 4 cents for every dollar of uninsured deposits at a bank. This effect is sizable: a one standard deviation increase in uninsured deposits as a share of assets (12.8%) results in about a 50 basis point decline in core deposits as a fraction of assets (relative to a sample mean of -1.7%). Securities losses, however, appear to have little effect on deposit outflows: a one standard deviation increase in HTM losses to assets (0.9%) only raises deposit outflows by 2 basis points as a fraction of assets, and the result is not statistically significant.

Uninsured depositors would have a stronger incentive to withdraw if there were concerns about the risk of failure at their bank. To reflect differences in risk, column 2 interacts the uninsured deposit share with securities losses. The findings show that the effects of having high uninsured deposits are predominantly driven by banks with higher securities losses. The estimates imply that deposit outflows for banks with no security losses exhibit a slightly smaller sensitivity to uninsured deposit shares (core deposits at such banks fall by 3 cents per dollar of uninsured deposits.) However, deposit outflows for a bank where securities losses were 2.4 percent of assets (roughly the 90th percentile of the distribution for the sample) are estimated to be nearly twice as sensitive to uninsured deposits as overall sample, with core deposits falling by about 10 cents for every additional dollar of uninsured deposits.

These effects of uninsured deposits and securities losses appear to be predominantly confined to the two months following the bank failures. Columns 3-8 present estimates from the same specification, but predicting changes in deposits over the course of May and June, July and August or September and October. Uninsured deposits and securities losses are no longer predictive of core deposit outflows during these intervals. In unreported regressions, we also conduct similar analysis of the period leading into the runs (January 11 to March 8). Uninsured deposits were weakly associated with deposit outflows during this period, likely reflecting those borrowers being more rate sensitive. In contrast, held-to-maturity securities losses and its interaction with uninsured deposits were not predictive of outflows.

Table 2: Determinants of Core Deposit Outflows

	$\frac{\Delta\text{Deposits}}{\text{Assets}}$							
	March 8 to May 3		May 3 to June 28		June 28 to August 23		August 23 to October 18	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	-0.04**	-0.03**	0.01	0.01	0.00	0.00	0.01^{+}	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$		-0.03**		-0.00		0.01		-0.01
		(0.01)		(0.01)		(0.01)		(0.01)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$	-0.02	0.89*	0.13	0.23	0.23*	-0.07	-0.04	0.26
	(0.13)	(0.37)	(0.11)	(0.32)	(0.11)	(0.33)	(0.11)	(0.31)
$\frac{\Delta\text{Loans}}{\text{Assets}}$	0.27**	0.26**	0.35**	0.35**	0.26**	0.26**	0.22**	0.22**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)
$\frac{\text{Liquid Assets}}{\text{Assets}}$	-0.02**	-0.02**	-0.05**	-0.05**	-0.03**	-0.04**	-0.02**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Avg. Funding Cost	0.60**	0.60**	-0.21	-0.21	0.55**	0.55**	0.26	0.26
	(0.23)	(0.23)	(0.21)	(0.21)	(0.20)	(0.20)	(0.19)	(0.19)
2022 Dep. Growth	0.04**	0.04**	0.00	0.00	-0.01	-0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\frac{\text{FHLB Advances}}{\text{Assets}}$	0.04	0.04	0.01	0.01	-0.03	-0.03	0.00	0.00
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Community Bank	0.88	0.80	-0.24	-0.25	0.95	0.98	1.34*	1.30^{+}
	(0.79)	(0.78)	(0.76)	(0.76)	(0.72)	(0.72)	(0.67)	(0.67)
Regional Bank	1.59^{+}	1.55^{+}	0.53	0.52	1.00	1.02	1.26^{+}	1.24^{+}
	(0.82)	(0.81)	(0.78)	(0.78)	(0.74)	(0.74)	(0.69)	(0.69)
Constant	-1.90*	-2.14*	0.41	0.39	-0.58	-0.51	-1.47^{+}	-1.53*
	(0.91)	(0.91)	(0.85)	(0.86)	(0.82)	(0.83)	(0.77)	(0.77)
R^2_a	0.119	0.127	0.113	0.112	0.068	0.068	0.053	0.053
Observations	668	668	674	674	678	678	674	674

Notes: The table shows results from cross-sectional regressions of changes in banks' core deposits relative to beginning on period total assets ($\Delta Deposits_{i,t,t'}/Assets_{i,t}$) over three eight-week intervals on uninsured deposits, HTM security losses, contemporaneous loan growth ($\Delta Loans_{i,t,t'}/Assets_{i,t}$), liquid asset holdings (the sum of cash, federal funds, reverse repo and securities holdings), average funding cost (annualized interest expense as a percent of total liabilities), deposit growth in 2022, FHLB advances, and bank size indicators (i.e., community banks are ones with assets under $10 billion in assets and regional banks ones with assets between $10 and $ 250 billion in assets) measured as of 2022:Q4. Core deposit and loan growth are winsorized at the 1 and 99 percent levels. All variables except indicators, deposit growth in 2022, and average funding cost are relative to total assets. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

4.2 How did banks manage core deposit outflows?

Wholesale Borrowing from the BTFP and Private Sources: Next, we focus on how banks managed these deposit outflows. Table 3 investigates how banks adjusted non-deposit borrowing from March 8 to May 3 in response to deposit outflows during that interval. Columns 1 and 3 predict changes in BTFP borrowing as a share of total assets, while columns 4 and 6 predict changes in non-Fed borrowing (borrowings besides BTFP and discount window) as a percent of total assets.[8]

The results in column 1 suggest that a one dollar decline in core deposits, on average, resulted in about an 8 cent increase in BTFP borrowing. Risk factors that were associated with deposit outflows also affected BTFP borrowing beyond their effect on actual deposit outflows (column 2). A one standard deviation increase in HTM security losses and uninsured deposit share were associated with increases of BTFP borrowing of 14 basis points and 26 basis points, respectively, as a share of assets. These results are suggestive of BTFP being used both to meet realized outflows, but also to raise precautionary funding when a bank has features that could make it vulnerable to potential future outflows.

Another reason that banks with greater HTM securities losses might access BTFP funding is that such losses make BTFP funding preferable to other alternatives, such as FHLB borrowing. First, high HTM losses may indicate that a bank's asset holdings are less liquid, causing it to increase borrowing rather shedding liquid assets. That is, banks holding cash or AFS securities would be more able to liquidate assets than banks predominantly holding HTM securities.[9] Second, by valuing securities at par, the BTFP increased borrowing capacity more for banks with greater unrealized losses. For both of these reasons, banks with high HTM securities losses might be expected to meet more of their marginal funding needs with BTFP.

To examine the effect of unrealized security losses on banks' marginal borrowing decisions, column 3 interacts deposit outflows with HTM securities losses. This specification allows us to assess how much banks differ in their propensity to fund deposit outflows with BTFP borrowing. The estimates imply that banks with negligible losses on securities only fund about 4 cents of every dollar of deposit outflows with BTFP funding. However, a bank at the 90th percentile of losses (2.4%) would replace about 26 cents of every dollar of deposit outflows with BTFP borrowing.

An important question remains: Is this higher demand for BTFP borrowing reflective of the program's design (including the at-par valuation of collateral) or does it reflect broader demand for wholesale borrowing? To assess this, columns 4, 5 and 6 repeat the same analysis, but for non-Fed

[8] Variation in discount window borrowing was minimal. While discount window borrowing spiked at the onset of the stress, by May 3rd the most seriously strained banks were closed, and borrowing returned to near pre-SVB levels.

[9] Indeed, banks with greater HTM securities losses disproportionately used private borrowing even before the banking stress in March.

borrowing, consisting predominantly of FHLB advances. This borrowing was a more prominent source of funding overall, with banks increasing borrowing by about 26 cents for every dollar of outflows. However, the interaction effect between deposit outflows and HTM losses seen for BTFP funding is missing for non-Fed borrowing. Banks with greater HTM security losses were slightly less likely to meet deposit outflows with non-Fed borrowing, though the difference is not statistically significant. This result indicates that the high utilization of BTFP for banks with greater security losses did not reflect a general increase in the demand for wholesale funding (e.g., to build liquidity buffers in anticipation of outflows), but instead the choice of banks with greater unrealized losses opting to borrow from the BTFP.

Table 3: Wholesale Borrowing

	$\frac{\Delta\text{BTFP Borrowings}}{\text{Assets}}$			$\frac{\Delta\text{Non-Fed Borrowings}}{\text{Assets}}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta\text{Deposits}}{\text{Assets}}$	-0.08**	-0.07**	-0.04	-0.26**	-0.32**	-0.33**
	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$			-0.09**			0.02
			(0.03)			(0.04)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$		0.15^{+}	-0.04		0.05	0.09
		(0.09)	(0.11)		(0.12)	(0.15)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$		0.02**	0.02*		0.00	0.00
		(0.01)	(0.01)		(0.01)	(0.01)
$\frac{\Delta\text{Loans}}{\text{Assets}}$		0.09^{+}	0.10*		0.25**	0.25**
		(0.05)	(0.05)		(0.07)	(0.07)
$\frac{\text{Liquid Assets}}{\text{Assets}}$		0.01	0.01		-0.04**	-0.04**
		(0.01)	(0.01)		(0.01)	(0.01)
Avg. Funding Cost		0.23	0.21		-0.33	-0.32
		(0.15)	(0.15)		(0.22)	(0.22)
2022 Dep. Growth		-0.02*	-0.02*		0.01	0.01
		(0.01)	(0.01)		(0.01)	(0.01)
$\frac{\text{FHLB Advances}}{\text{Assets}}$		0.05*	0.05*		-0.01	-0.01
		(0.02)	(0.02)		(0.03)	(0.03)
Community Bank		0.81	0.70		-2.00**	-1.98**
		(0.52)	(0.52)		(0.73)	(0.74)
Regional Bank		0.82	0.76		-0.93	-0.92
		(0.54)	(0.54)		(0.76)	(0.76)
Constant	0.43**	-1.51*	-1.27*	0.29*	3.13**	3.08**
	(0.09)	(0.60)	(0.61)	(0.12)	(0.85)	(0.86)
R^2_a	0.014	0.055	0.066	0.075	0.146	0.145
Observations	668	668	668	668	668	668

Notes: The table shows results from cross-sectional regressions of changes in banks' BTFP borrowings and non-Fed borrowings (wholesale borrowings that exclude BTFP and discount window) over the interval March 8—May 3 on contemporaneous deposit growth ($\Delta Deposits_{i,t,t'}/Assets_{i,t}$) uninsured deposits, HTM security losses, contemporaneous loan growth ($\Delta Loans_{i,t,t'}/Assets_{i,t}$), liquid asset holdings (the sum of cash, federal funds, reverse repo and securities holdings), average funding cost (annualized interest expense as a percent of total liabilities), deposit growth in 2022, FHLB advances, and bank size indicators (i.e., community banks are ones with assets under $10 billion in assets and regional banks ones with assets between $10 and $ 250 billion in assets) measured as of 2022:Q4. Core deposit and contemporaneous loan growth are winsorized at the 1 and 99 percent levels. All variables except indicators, deposit growth in 2022, and average funding cost are relative to total assets. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Overall, the findings in Table 3 suggest that BTFP borrowing was motivated by both precautionary motives and the need to fund deposit outflows. That banks with HTM losses were more reliant on BTFP to meet deposit outflows suggests that the at-par valuation of collateral supported demand for BTFP loans.

We also see supporting evidence for these interpretations in banks' decisions regarding the pledging of collateral to the BTFP. Table B3 presents similar estimates, but with the dependent variable being the amount collateral pledged to BTFP (as a share of assets). Two findings are notable. First, deposit outflows, HTM losses, and uninsured deposits prompt banks to raise collateral pledged to the BTFP by almost twice as much as they actually borrow.[10] This result provides further evidence of precautionary motives for BTFP usage, as it shows that banks at more risk of outflows posted collateral to ensure the ability to borrow should the need arise. Second, this additional pledging was predominantly accounted for by MBS and CMO securities.[11]

Large Time Deposits and Liquid Assets: How did banks adjust balance sheet items besides wholesale borrowing in the face of core deposit outflows? We now document the other margins of adjustment, namely the raising of large time deposits and the liquidation of other assets.

Figure 3 presents estimates of how much banks turn to various sources based on regressions along the lines of the specification in equation (2). When the dependent variable is an asset (namely, cash or security holdings), we flip the sign, so that we are predicting the extent to which banks reduce holdings of that asset to meet funding needs. Estimates in blue reflect how much a bank with no HTM losses (empirically, corresponding to the median amount of HTM losses since over half of banks only hold AFS securities) use a particular source to meet deposit outflows. Estimates in red reflect the predicted elasticity between a particular funding source and deposit outflows for a bank at the 90th percentile in HTM security losses to assets. Estimates predicting changes in borrowing come from columns 3 and 6 of Table 3, while the estimates underlying the other funding sources are displayed in Table B2.

As previously discussed, BTFP loans played a small role for banks without HTM losses. Banks without HTM losses only increased BTFP borrowing by about 4 cents for each dollar of core deposit outflows. Instead, these banks predominantly reduced cash holdings or borrowed from non-Fed sources; banks without HTM losses reduced cash by about 47 cents, increased non-Fed borrowings by about 33 cents, and increased large-time deposits by about 7 cents for each dollar of core deposit outflows.

[10] The estimates from Table B3, column 1 indicate that one dollar in deposit outflows, HTM losses, or uninsured deposits raise total collateral pledged to BTFP by 12 cents, 26 cents and 5 cents, respectively, whereas in Table 3, column 2 BTFP borrowing was only found to increase by 7 cents, 15 cents, and 2 cents, respectively.

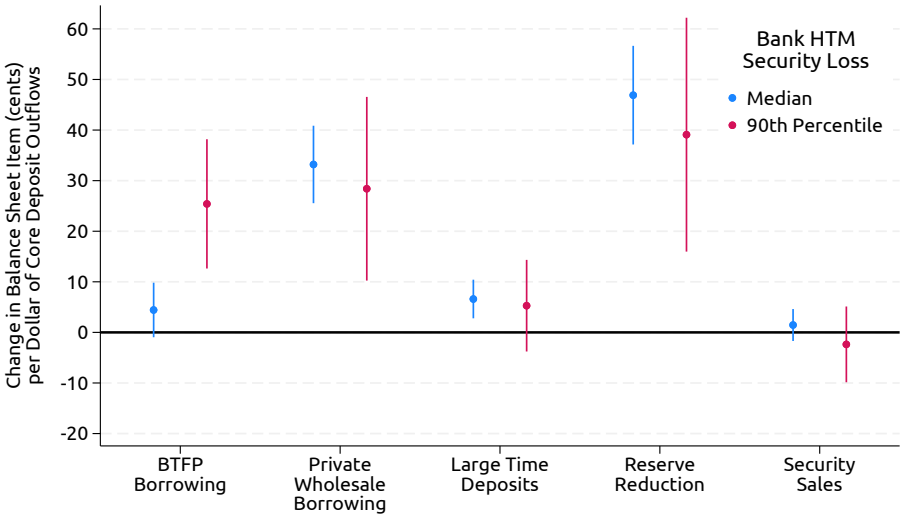
[11] Of the additional collateral pledged in response to deposit outflows, HTM losses, or uninsured deposits, roughly two-thirds are found to be driven by MBS/CMOs.

BTFP loans played a larger role for banks with greater HTM losses. Banks with greater HTM losses used BTFP funding more on the margin to fund deposit outflows (26 cents per dollar of core deposit outflows) and turned slightly less to the other four funding sources (reduced cash by 40 cents, increased non-Fed borrowing by 28 cents, raised large-time deposits by 5 cents, and actually increased security holdings by 4 cents). In short, banks with high HTM losses relied more on BTFP to meet deposit outflows, but funding decisions were otherwise similar to that of the rest of the banking sector.

Figure 4 presents similar estimates, but disaggregates the sample across banks of different sizes. Broad patterns of how banks fund deposit outflows are similar; in the absence of notable HTM security losses, both regional and community banks mostly respond to deposit outflows by raising private borrowing or reducing reserves, with BTFP borrowings having a relatively limited role into the funding mix. However, the shift towards BTFP funding for high-HTM loss banks is mostly driven by regional banks. The estimates imply that a regional bank in the 90th percentile of HTM losses would fund almost half of their deposit outflows by borrowing from the BTFP. Though there is some uncertainty about this exact point estimate due to the smaller subsample and the extrapolation to a relatively high level of HTM-losses, this result provides some useful clarity on which banks utilized BTFP most heavily, namely regional banks with high HTM losses and notable deposit outflows.

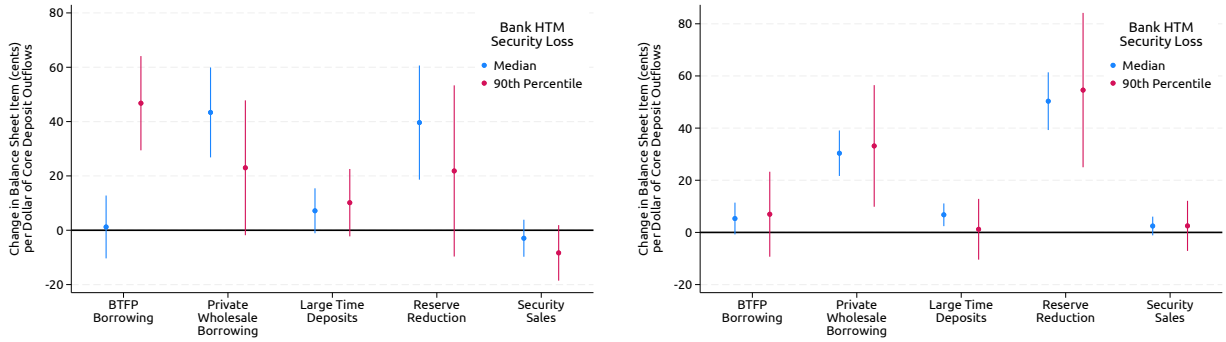
To summarize the results of this section, most banks did not use BTFP funding. Those that did use BTFP borrowing appear to do so for a combination of precautionary reasons (raising funding or posting collateral if they had risk factors linked to deposit outflows) or to replace realized deposit outflows. Though banks typically met such funding needs by raising private borrowing or reducing cash holdings, banks with high HTM security losses relied more heavily on BTFP funding, especially regional banks. While this higher reliance on BTFP for high-HTM-loss banks may reflect numerous factors—for example, precautionary demand for liquidity, less liquid initial asset holdings, or a greater benefit from at-par collateral valuation—the main takeaway is the same: BTFP provided a backstop source of funding that enabled banks to manage funding pressures during the period of most acute stress.

Figure 3: How Banks Fund Core Deposit Outflows: Increase Liabilities and Reduce Assets



Notes: Chart presents estimates of how much various funding sources are used (in cents) to meet a $1 increase in funding needs. Blue dots (lines) present point estimates (95% confidence intervals) for how much a particular source is used for a bank with no HTM losses (the median). Red dots and lines present equivalent estimates for a bank at the 90th percentile in HTM securities losses as a share of assets. The regressions underlying these estimates are in Table B2.

Figure 4: How Banks Fund Deposit Outflows, By Bank Size: Increase Liabilities and Reduce Assets



(a) Regional Banks

(b) Community Banks

Notes: Charts present estimates of how much various funding sources are used (in cents) to meet a $1 increase in funding needs. Left figure shows estimates for regional banks (those with assets between $10 and $100 billion) while the right shows estimates for community banks (those with assets under $10 billion). Blue dots (lines) present point estimates (95% confidence intervals) for how much a particular source is used for a bank with no HTM losses (the median). Red dots and lines present equivalent estimates for a bank at the 90th percentile in HTM securities losses as a share of estimates.

Robustness Deposit flows are not the only development affecting banks' needs for funding. Banks similarly need to manage their balance sheets to accommodate lending opportunities. Interesting, the coefficients on Loan Growth in Tables 3 and B2 demonstrate that loan growth has a roughly symmetric effect on banks' funding decisions: banks increased BTFP borrowing by 10 cents per dollar of loan growth, while reducing cash by 45 cents, increasing private borrowing by 24 cents and increasing large-time deposits by 7 cents. Given this symmetry, we show that the broad patterns shown in Figure 3 also hold when we measure a banks' funding needs by Excess Loan Growth (the difference between loan growth and deposit growth as a share of initial assets). This measure reflects how banks respond to funding needs generated by either loan growth or deposit outflows. Figure B1 and Table B4 show that the main results are robust to this alternative measure.

Deposit Pricing Most of the analysis of this section treated deposit outflows as being outside of banks' immediate control. However, if banks are facing deposit pressures, one potential response is to increase the rates paid on deposits to stem the outflows rather than trying to adjust other parts of the portfolio. Table B5 estimates from the specification in equation (2), but with changes time deposit pricing at various horizons as the dependent variable. There is some evidence of adjustment along the price dimension; one percentage point higher deposit outflows or HTM losses raise 3-month CD rates by about 2 and 7 basis points, respectively. However, there is little effect on CDs at other time horizons. Additionally, these effects are second-order relative to differences in deposit pricing across banks of different sizes, so the implications of these pricing changes for deposit flows are likely modest over such short time intervals.

4.3 Uses of Wholesale Borrowings: Dynamics of Deposits, Cash, and Loans

Finally, we shift our attention from investigating what prompts banks to borrow from BTFP to asking how BTFP funds were used. Instead of investigating changes in bank balance sheets over one specific window, we use local projections to trace out how various balance sheet items change in the period surrounding the increase in borrowing.

The next three figures plot coefficient estimates from regressions similar to that in specification (3), showing how core deposits (Figure 5), cash holdings (Figure 6) and loan balances (Figure 7) evolve in the period surrounding an increase in BTFP usage (left panels) or an increase in non-Fed borrowing (right panels). Both the independent and dependent variables are scaled by assets, so the impulses can be interpreted as the predicted change in the balance sheet item in dollars, per dollar increase in borrowing.

To preview results, we find that banks use BTFP to build up cash holdings (consistent with BTFP helping banks to satisfy precautionary demand for liquidity) and to meet fund needs arising

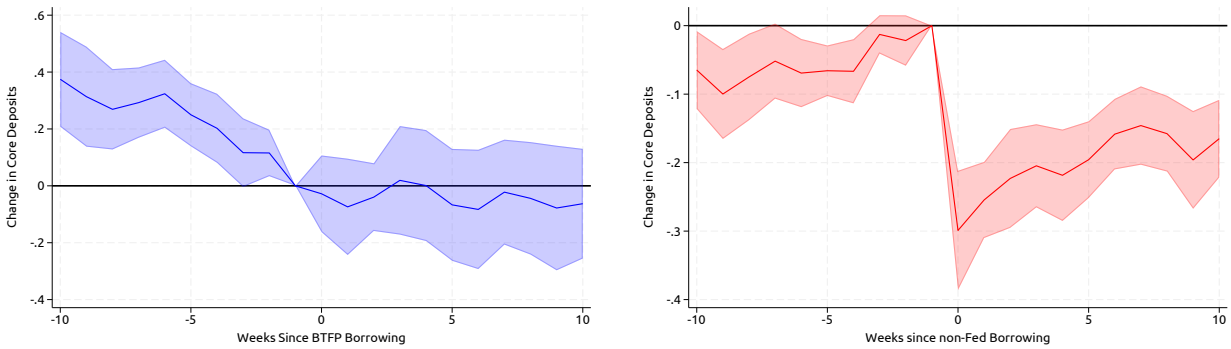
from loan growth and deposit outflows. These results thus provide some additional support for the narrative proposed in Section 4.2, but with more detail on the timing involved.

Dynamics of Core Deposits: Starting with deposit dynamics, Figure 5 shows that banks tend to use BTFP after a sustained period of weak core deposit growth. Banks with one dollar higher borrowing from BTFP on average had about 40 cents more in core deposit outflows over the previous 10 weeks. The week 0 effect gives the change in deposits in the week of actual BTFP usage, which is small and statistically insignificant.

The right panel shows that dynamics for non-Fed borrowings are quite different. Banks borrow from these sources in the actual week that they experience deposit outflows. On average, deposits fall about 30 cents for every dollar of non-Fed borrowing in a given week. There is not a particularly strong trend in core deposits leading into an increase in non-Fed borrowings.

In short, non-Fed borrowings appear to be used to fund deposit outflows in the weeks they occur, whereas BTFP appears to be used after a period of sustained outflows. This outcome is consistent with BTFP having some fixed cost that inhibits use despite features that make it desirable relative to other funding sources—for example, pre-payability or having collateral valued at par. This fixed cost causes banks to wait until funding needs to pass some threshold level of need for it to be worth paying the cost to achieve the favorable source of funding. Non-Fed borrowing, on the other hand, is not subject to these frictions, and thus can be used immediately when deposits decline.

Figure 5: Relationship Between Core Deposits Growth and Borrowing



(a) Change around BTFP Borrowing

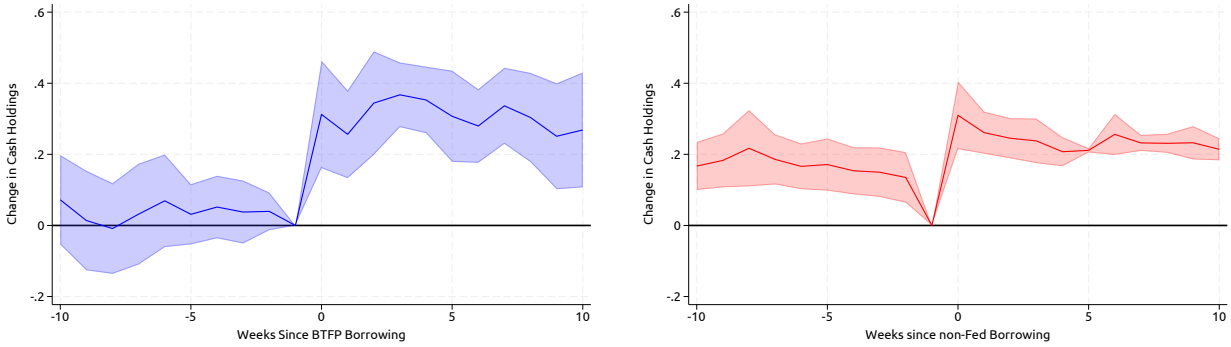
(b) Change around non-Fed Borrowing

Notes: The charts show the dynamic relationship between banks' weekly core deposits and BTFP borrowings (panel a) or non-Fed borrowings (panel b). The coefficients show the relationship between changes in core deposits at various horizons (in dollars) surrounding a$1 increase in borrowings at each bank in the presence of week fixed effects. The week 0 effect gives the change in deposits in the week of actual borrowings.

Dynamics of Cash Holdings: Figure 6 provides similar analysis for cash holdings. One potential use of borrowing is to increase reserves in anticipation of deposit outflows (or replenish reserves

that were used to fund earlier outflows). The figure suggests that some of each type of borrowing is used for this function. In the week of BTFP usage, cash holdings increase by about a third of the amount of BTFP usage and then remains elevated over the next 10 weeks. For non-Fed borrowings, banks on average see a decline in cash the week before borrowing, followed by a larger rebound in the week they borrowed, indicating that borrowing reflects a mixture of replenishing reserves as well as building up reserves to meet future needs.

Figure 6: Relationship Between Cash Holdings and Borrowing



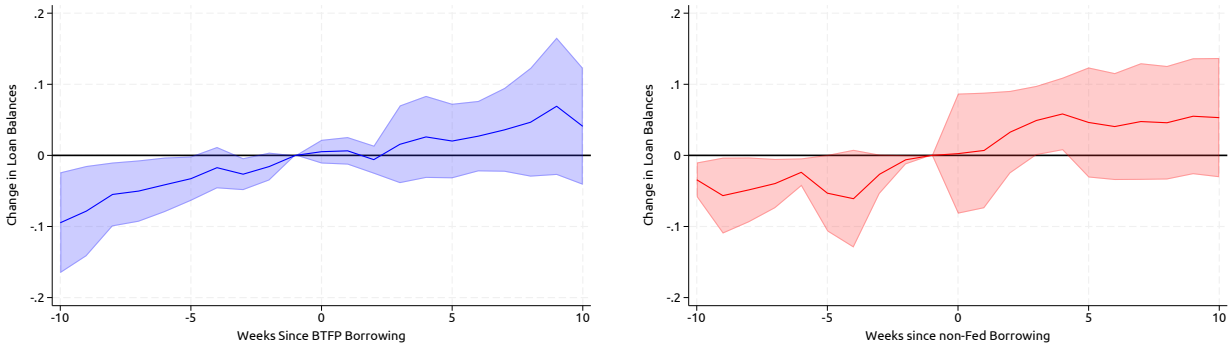
(a) Change around BTFP Borrowing

(b) Change around non-Fed Borrowing

Notes: The charts show the dynamic relationship between banks' weekly cash holdings and BTFP borrowings (panel a) or non-Fed borrowings (panel b). The coefficients show the relationship between changes in cash holdings at various horizons (in dollars) surrounding a $1 increase in borrowings at each bank in the presence of week fixed effects. The week 0 effect gives the change in cash holdings in the week of actual borrowings.

Dynamics of Loan Balances: Figure 7 plots changes in loan balances surrounding a change in borrowings. Overall, the patterns look similar for the two types of borrowings. Banks experience a modest increase in loan balances around the time of borrowing—on the order of 5 cents of loan growth per dollar of borrowing in the couple of months both before and after borrowing—but the estimates are for the most part statistically insignificant. Though banks are likely funding some loans on the margin using BTFP, an increased usage of borrowing may be indicative of funding pressures that would cause banks to restrict credit supply. These offsetting mechanisms would dampen the relationship between BTFP borrowing and loan growth.

Figure 7: Relationship Between Loan Growth and Borrowing



(a) Change around BTFP Borrowing

(b) Change around non-Fed Borrowing

Notes: The charts show the dynamic relationship between banks' weekly loans and BTFP borrowings (panel a) or non-Fed borrowings (panel b). The coefficients show the relationship between changes in loans at various horizons (in dollars) surrounding a $1 increase in borrowings at each bank in the presence of week fixed effects. The week 0 effect gives the change in loans in the week of actual borrowings.

5 Conclusion

This paper examines banks' experience with deposit outflows during the 2023 banking turmoil and the effectiveness of the BTFP. First, we find that banks with high reliance on uninsured deposit funding and large marked-to-market losses on securities holdings faced relatively more deposit outflows. Second, we find that in response to deposit outflows, banks primarily reduced cash holdings and borrowed from non-Fed sources (e.g., FHLB advances). BTFP borrowing played a relatively modest role in how the average bank met funding needs, but was a more important source of funding for banks with relatively larger securities losses or larger reliance on uninsured deposits. These factors were especially prominent for regional banks. Moreover, these risk factors were associated with BTFP borrowing even beyond their effect on realized deposit outflows, suggesting a precautionary motive for BTFP borrowing. In addition, vulnerable banks appeared to prefer BTFP to non-Fed borrowings, and shed less cash to cover funding needs, reflecting the advantage of the at-par collateral valuation at the BTFP. Third, banks increased non-Fed borrowings immediately in the weeks that deposits fell, but only used BTFP borrowing after a period of sustained deposit outflows, suggesting that program usage entailed a fixed cost. Banks borrowing from the BTFP and non-Fed sources displayed similar trend growth in loan balances, possibly suggesting that BTFP supported the loan balances of more vulnerable banks.

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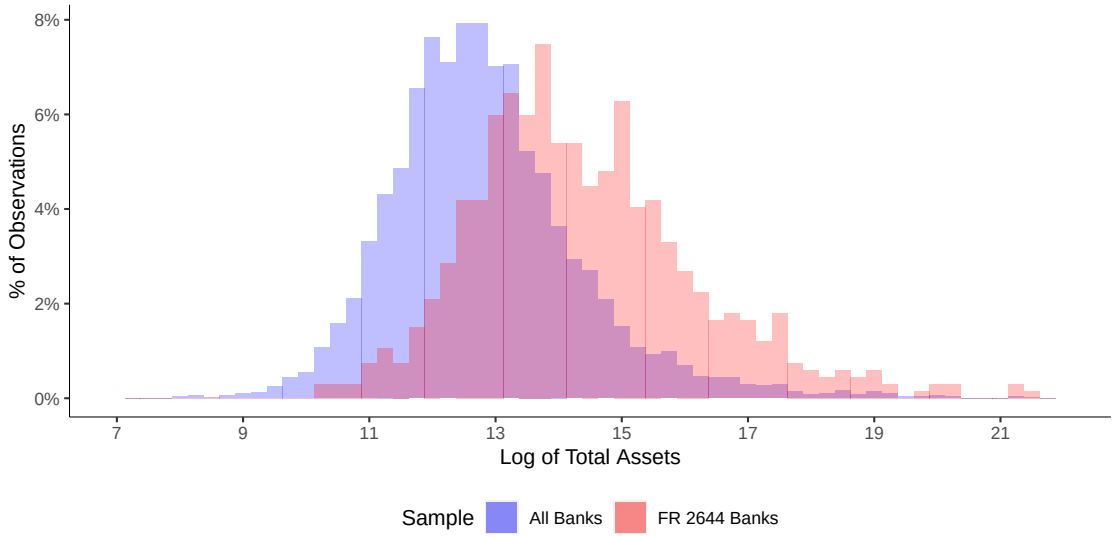
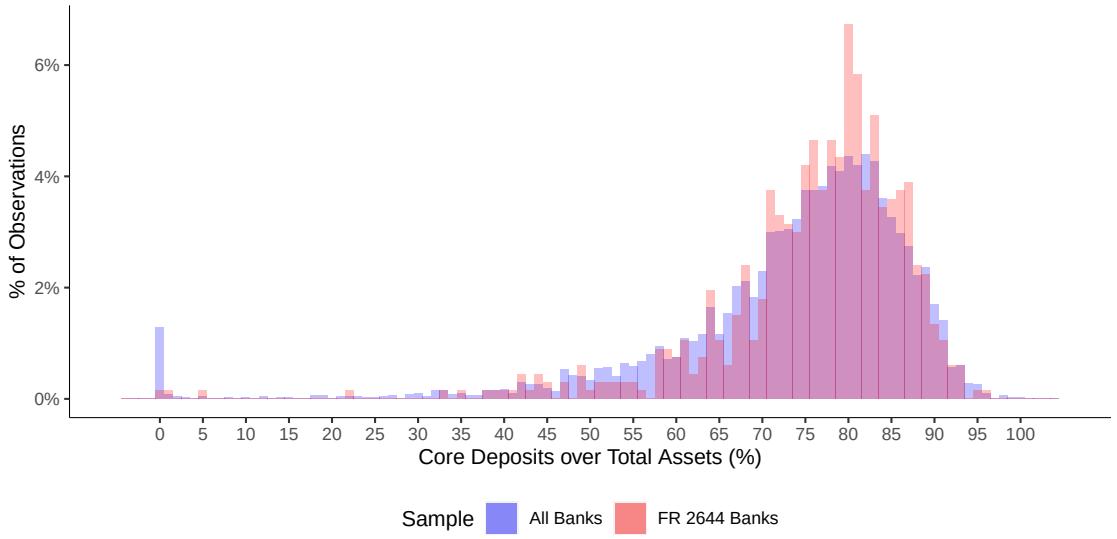
A Appendix

Figure A1: Total Assets



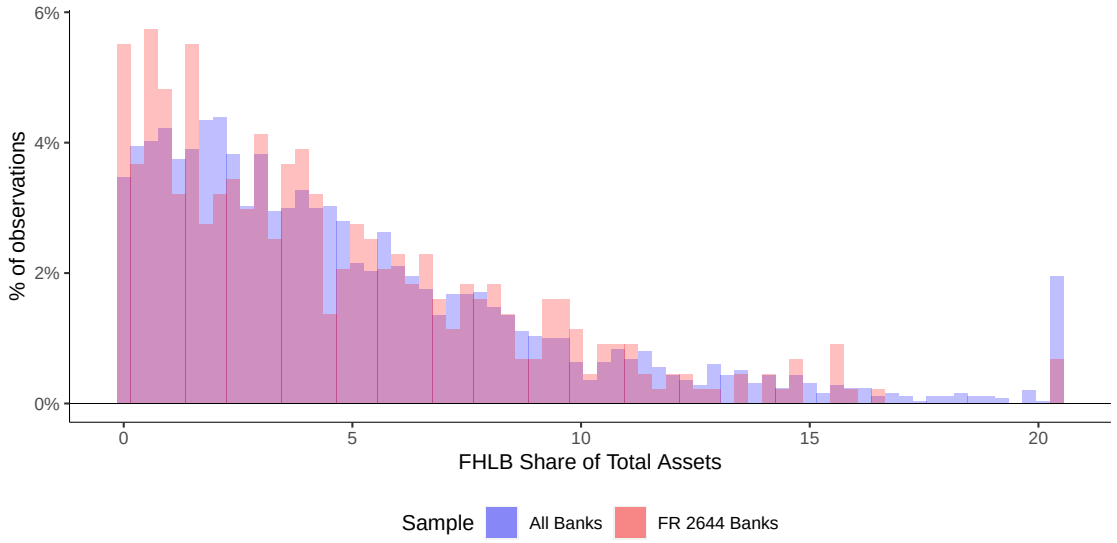
Note: The Figure shows the distribution of total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A2: Core Deposits to Total Assets



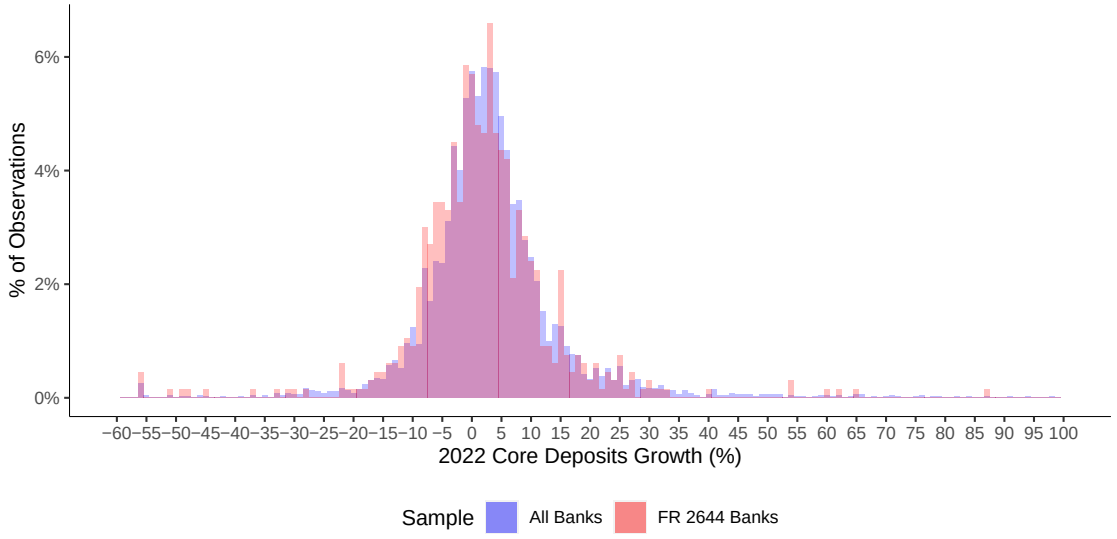
Note: The Figure shows the distribution of core deposits to total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A3: FHLB Advances to Total Assets



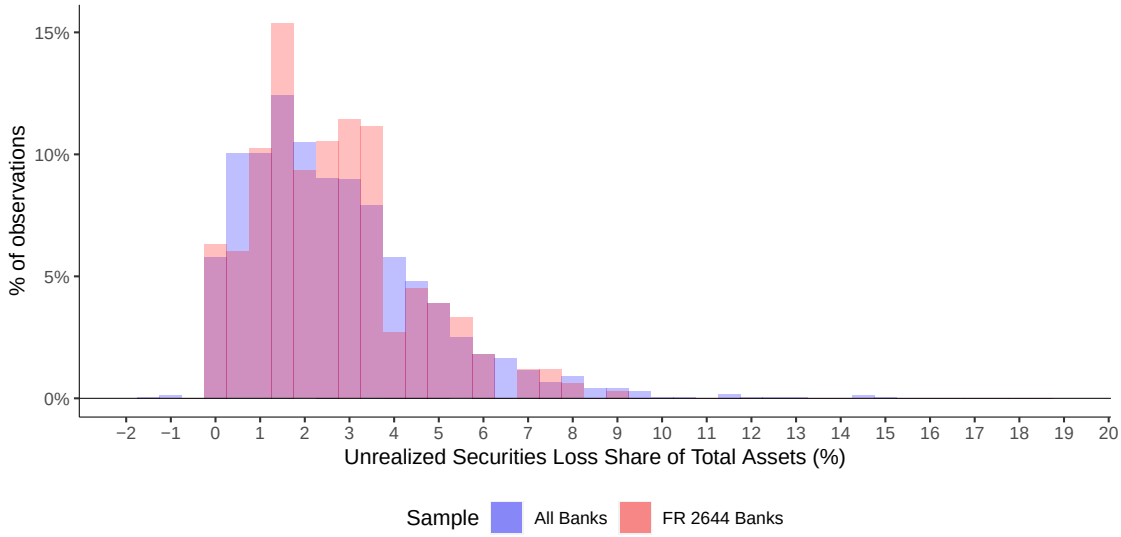
Note: The Figure shows the distribution of FHLB advances to total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A4: Core Deposits Growth



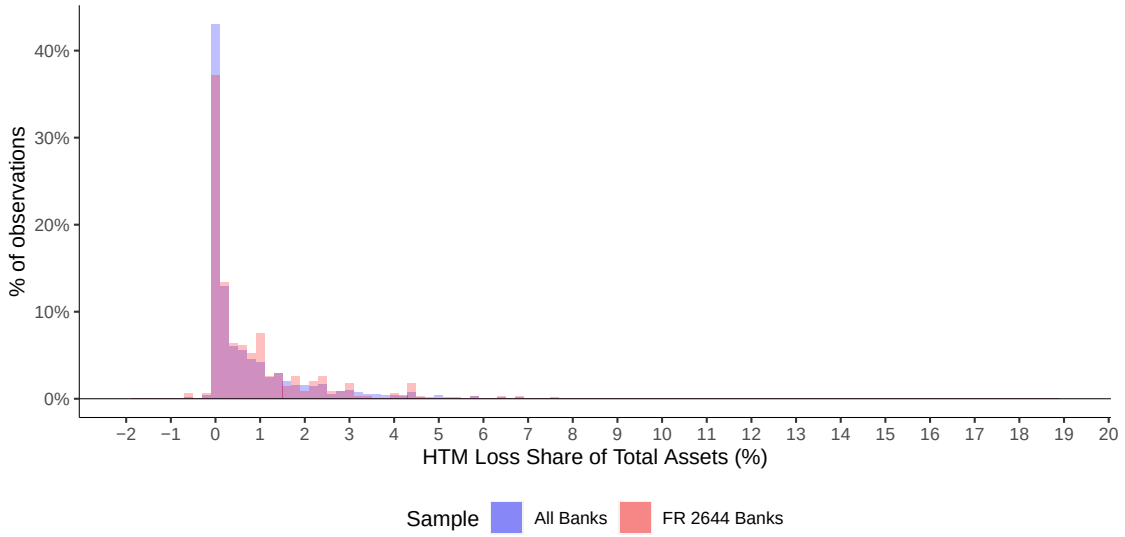
Note: The Figure shows the distribution of core deposits growth in 2022 for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A5: Unrealized Securities Losses to Total Assets



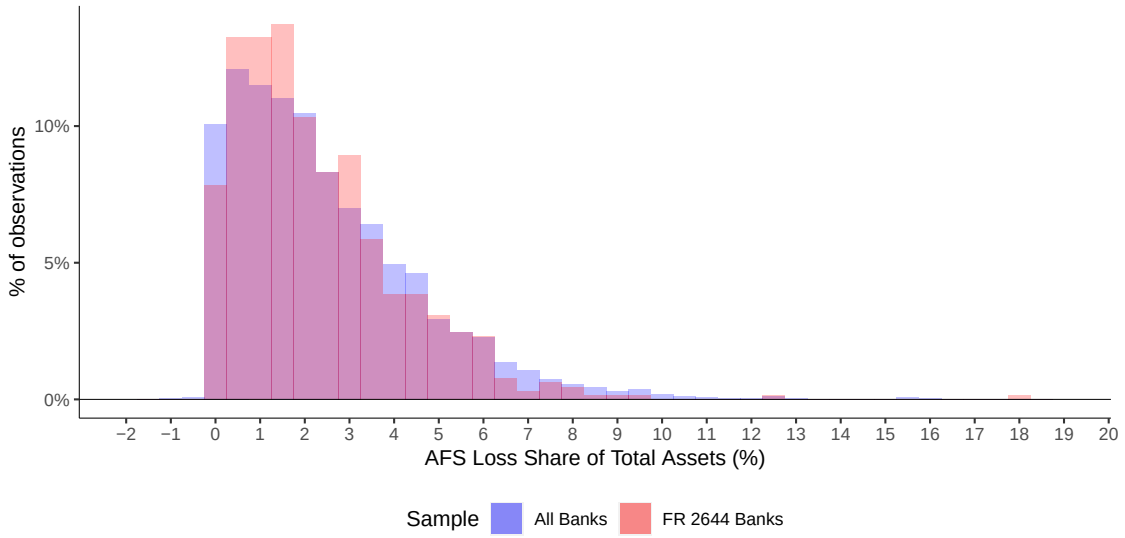
Note: The Figure shows the distribution of unrealized securities losses to total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A6: HTM Unrealized Securities Losses to Total Assets



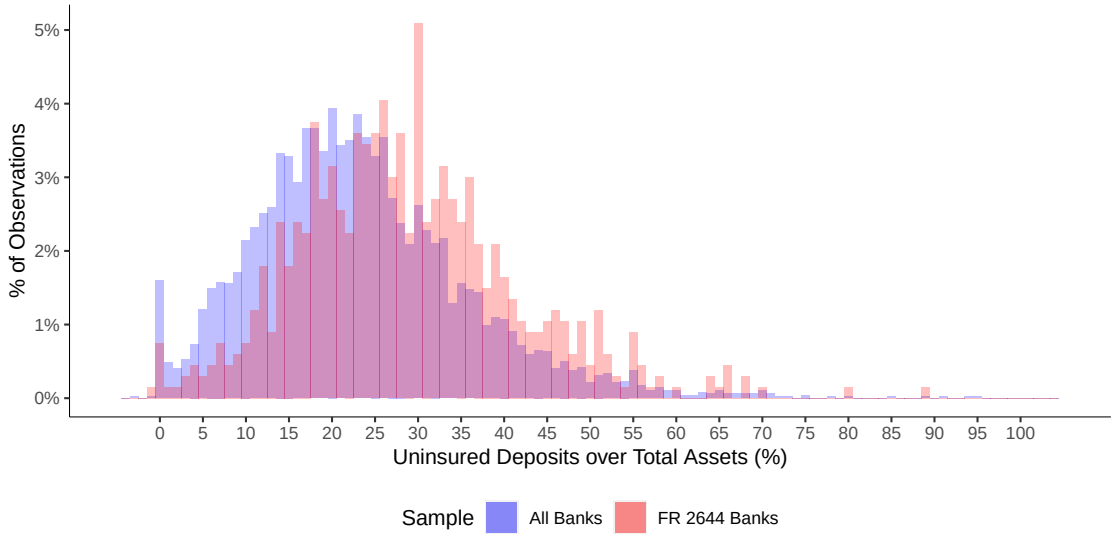
Note: The Figure shows the distribution of HTM unrealized securities losses to total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A7: AFS Unrealized Securities Losses to Total Assets



Note: The Figure shows the distribution of AFS unrealized securities losses to total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Figure A8: Uninsured Deposits to Total Assets



Note: The Figure shows the distribution of uninsured deposits to total assets for all commercial banks (4746 banks, shown in blue) and the subset of banks in our sample (668 banks, shown in orange).

Table B1: Determinants of Deposit Outflows - Controlling for AFS Securities Losses

	$\frac{\Delta\text{Deposits}}{\text{Assets}}$							
	March 8 to May 3		May 3 to June 28		June 28 to August 23		August 23 to October 18	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	-0.04**	-0.01	0.01	0.01	0.00	0.00	0.01^{+}	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$		-0.03**		-0.00		0.01		-0.01
		(0.01)		(0.01)		(0.01)		(0.01)
$\times \frac{\text{AFS Security Losses}}{\text{Assets}}$		-0.01*		0.00		-0.00		0.00
		(0.00)		(0.00)		(0.00)		(0.00)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$	-0.02	0.98**	0.16	0.26	0.24*	-0.04	-0.01	0.28
	(0.14)	(0.37)	(0.12)	(0.33)	(0.12)	(0.33)	(0.11)	(0.32)
$\frac{\text{AFS Security Losses}}{\text{Assets}}$	0.01	0.29^{+}	0.05	0.05	0.03	0.05	0.05	-0.00
	(0.07)	(0.15)	(0.06)	(0.13)	(0.06)	(0.13)	(0.06)	(0.13)
$\frac{\Delta\text{Loans}}{\text{Assets}}$	0.27**	0.26**	0.35**	0.35**	0.26**	0.26**	0.22**	0.22**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)
$\frac{\text{Liquid Assets}}{\text{Assets}}$	-0.02*	-0.02*	-0.05**	-0.05**	-0.04**	-0.04**	-0.03**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Avg. Funding Cost	0.61*	0.64**	-0.18	-0.18	0.57**	0.57**	0.30	0.29
	(0.24)	(0.23)	(0.21)	(0.21)	(0.21)	(0.21)	(0.20)	(0.20)
2022 Dep. Growth	0.04**	0.04**	0.00	0.00	-0.01	-0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\frac{\text{FHLB Advances}}{\text{Assets}}$	0.04	0.04	0.01	0.01	-0.03	-0.03	0.00	0.00
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Community Bank	0.87	0.74	-0.31	-0.32	0.90	0.93	1.27^{+}	1.24^{+}
	(0.79)	(0.79)	(0.76)	(0.76)	(0.73)	(0.73)	(0.67)	(0.67)
Regional Bank	1.58^{+}	1.50^{+}	0.48	0.47	0.97	0.98	1.20^{+}	1.19^{+}
	(0.82)	(0.82)	(0.78)	(0.78)	(0.75)	(0.75)	(0.69)	(0.69)
Constant	-1.90*	-2.66**	0.42	0.40	-0.58	-0.54	-1.46^{+}	-1.42^{+}
	(0.92)	(0.95)	(0.85)	(0.88)	(0.82)	(0.85)	(0.77)	(0.80)
R^2_a	0.117	0.130	0.113	0.110	0.067	0.065	0.053	0.052
Observations	668	668	674	674	678	678	674	674

Notes: The table shows results from cross-sectional regressions of changes in banks' core deposits relative to beginning on period total assets ($\Delta Deposits_{i,t,t'}/Assets_{i,t}$) over three eight-week intervals on uninsured deposits, HTM security losses, AFS security losses, contemporaneous loan growth ($\Delta Loans_{i,t,t'}/Assets_{i,t}$), liquid asset holdings (the sum of cash, federal funds, reverse repo and securities holdings), average funding cost (annualized interest expense as a percent of total liabilities), deposit growth in 2022, FHLB advances, and bank size indicators (i.e., community banks are ones with assets under $10 billion in assets and regional banks ones with assets between $10 and $ 250 billion in assets) measured as of 2022:Q4. Core deposit and contemporaneous loan growth are winsorized at the 1 and 99 percent levels. All variables except indicators, deposit growth in 2022, and average funding cost are relative to total assets. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table B2: Pecking Order of Funding Sources

	$\frac{\Delta BTFP\ Borrowings}{Assets}$	$-\frac{\Delta Cash}{Assets}$	$\frac{\Delta NonFed\ Borrowings}{Assets}$	$\frac{\Delta LT.\ Dep.}{Assets}$	$-\frac{\Delta Securities}{Assets}$
	(1)	(2)	(3)	(4)	(5)
$\frac{\Delta \text{Deposits}}{\text{Assets}}$	-0.04	-0.47**	-0.33**	-0.07**	-0.01
	(0.03)	(0.05)	(0.04)	(0.02)	(0.02)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$	-0.09**	0.03	0.02	0.01	0.02
	(0.03)	(0.05)	(0.04)	(0.02)	(0.02)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$	-0.04	-0.02	0.09	-0.00	0.09
	(0.11)	(0.19)	(0.15)	(0.08)	(0.06)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	0.02*	-0.01	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$\frac{\Delta \text{Loans}}{\text{Assets}}$	0.10*	0.45**	0.25**	0.07*	-0.01
	(0.05)	(0.09)	(0.07)	(0.03)	(0.03)
$\frac{\text{Liquid Assets}}{\text{Assets}}$	0.01	0.03**	-0.04**	-0.02**	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Avg. Funding Cost	0.21	0.37	-0.32	-0.10	-0.13
	(0.15)	(0.28)	(0.22)	(0.11)	(0.09)
2022 Dep. Growth	-0.02*	0.02^{+}	0.01	0.00	-0.01*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$\frac{\text{FHLB Advances}}{\text{Assets}}$	0.05*	-0.01	-0.01	-0.00	0.02^{+}
	(0.02)	(0.03)	(0.03)	(0.01)	(0.01)
Community Bank	0.70	0.67	-1.98**	0.45	-0.18
	(0.52)	(0.94)	(0.74)	(0.37)	(0.30)
Regional Bank	0.76	-0.35	-0.92	0.30	0.02
	(0.54)	(0.97)	(0.76)	(0.38)	(0.31)
Constant	-1.27*	-2.83**	3.08**	0.81^{+}	0.16
	(0.61)	(1.10)	(0.86)	(0.43)	(0.36)
R^2_a	0.066	0.169	0.145	0.042	0.020
Observations	668	668	668	668	668

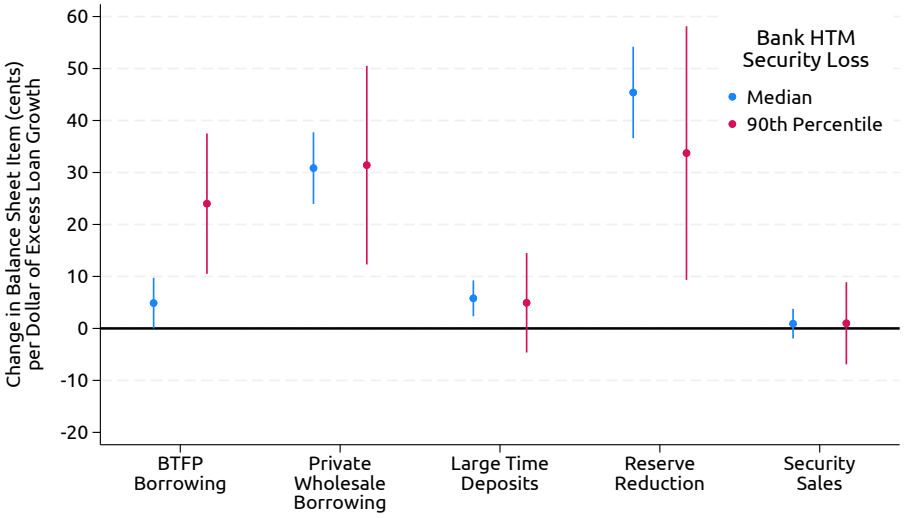
Notes: The table shows results from regressing changes in various balance sheet items—increases in BTFP (Columns 1–2), reductions in cash holdings (Columns 3–4), increases in non-Fed Borrowings (Columns 5–6), increases in large time deposits (Columns 7–8), and reductions in security holdings—on banks' excess loan growth like in specification (2). Among the explanatory variables, we also include losses on securities holdings (the difference between the value of security holdings when measured at market value and at amortized cost) as a share of assets, both in levels and interacted with excess loan growth. The remaining explanatory variables are like in Table 3. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table B3: BTFP Collateral Pledging

	Total		MBS/CMO		Agency Securities		Treasury Securities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\frac{\Delta\text{Deposits}}{\text{Assets}}$	-0.12**	-0.06	-0.08*	-0.05	-0.03*	-0.02	-0.01	0.00
	(0.04)	(0.05)	(0.04)	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$		-0.16**		-0.08*		-0.04*		-0.05**
		(0.05)		(0.04)		(0.02)		(0.01)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$	0.26^{+}	-0.11	0.18	0.00	0.06	-0.02	0.01	-0.09*
	(0.15)	(0.19)	(0.12)	(0.15)	(0.05)	(0.06)	(0.03)	(0.04)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	0.05**	0.05**	0.04**	0.04**	0.00	0.00	0.01*	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
$\frac{\Delta\text{Loans}}{\text{Assets}}$	0.17*	0.19*	0.09	0.10	0.07*	0.07*	0.02	0.02
	(0.08)	(0.08)	(0.07)	(0.07)	(0.03)	(0.03)	(0.02)	(0.02)
$\frac{\text{Liquid Assets}}{\text{Assets}}$	0.01	0.01	0.00	0.00	0.01**	0.01**	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Avg. Funding Cost	-0.25	-0.29	-0.11	-0.12	-0.07	-0.08	-0.08	-0.09
	(0.27)	(0.27)	(0.21)	(0.21)	(0.09)	(0.09)	(0.06)	(0.06)
2022 Dep. Growth	-0.03*	-0.03*	-0.02*	-0.02*	-0.00	-0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
$\frac{\text{FHLB Advances}}{\text{Assets}}$	0.06^{+}	0.06^{+}	0.04	0.04	0.01	0.01	0.01^{+}	0.01^{+}
	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)
Community Bank	-1.22	-1.43	-1.26^{+}	-1.36^{+}	0.26	0.22	-0.23	-0.29
	(0.91)	(0.90)	(0.72)	(0.72)	(0.30)	(0.30)	(0.21)	(0.21)
Regional Bank	-0.31	-0.43	-0.20	-0.26	0.19	0.16	-0.29	-0.33
	(0.94)	(0.94)	(0.75)	(0.74)	(0.31)	(0.31)	(0.22)	(0.22)
Constant	0.11	0.55	0.36	0.58	-0.44	-0.34	0.19	0.32
	(1.06)	(1.06)	(0.83)	(0.84)	(0.34)	(0.35)	(0.24)	(0.24)
R^2_a	0.088	0.101	0.091	0.095	0.029	0.035	0.011	0.032
Observations	668	668	668	668	668	668	668	668

Notes: The table shows results from cross-sectional regressions of changes in banks' BTFP collateral pledging over the interval March 8—May 3 on contemporaneous deposit growth ($\Delta Deposits_{i,t,t'}/Assets_{i,t}$) uninsured deposits, HTM security losses, contemporaneous loan growth ($\Delta Loans_{i,t,t'}/Assets_{i,t}$), liquid asset holdings (the sum of cash, federal funds, reverse repo and securities holdings), average funding cost (annualized interest expense as a percent of total liabilities), deposit growth in 2022, FHLB advances, and bank size indicators (i.e., community banks are ones with assets under $10 billion in assets and regional banks ones with assets between $10 and $ 250 billion in assets) measured as of 2022:Q4. Core deposit and contemporaneous loan growth are winsorized at the 1 and 99 percent levels. All variables except indicators, deposit growth in 2022, and average funding cost are relative to total assets. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Figure B1: How Banks Fund Excess Loan Growth: Increase Liabilities or Reduce Assets



Notes: The chart presents estimates of how much various funding sources are used (in cents) to meet a $1 increase in funding needs (as measured by excess loan growth). Blue dots (lines) present point estimates (95% confidence intervals) for how much a particular source is used overall. Red dots and lines present equivalent estimates for a bank at the 90th percentile in securities losses as a share of assets. The regressions underlying these estimates are in Table B4.

Table B4: Funding of Excess Loan Growth

	$\frac{\Delta BTFP\ Borrowings}{Assets}$	$-\frac{\Delta Cash}{Assets}$	$\frac{\Delta NonFed\ Borrowings}{Assets}$	$\frac{\Delta LT.\ Dep.}{Assets}$	$-\frac{\Delta Securities}{Assets}$
	(1)	(2)	(3)	(4)	(5)
$\frac{\Delta(\text{Loans-Deposits})}{\text{Assets}}$	0.05*	0.45**	0.31**	0.06**	0.01
	(0.02)	(0.04)	(0.04)	(0.02)	(0.01)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$	0.08**	-0.05	0.00	-0.00	0.00
	(0.03)	(0.05)	(0.04)	(0.02)	(0.02)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$	-0.08	0.06	0.04	-0.00	0.05
	(0.12)	(0.22)	(0.18)	(0.09)	(0.07)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	0.02**	-0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$\frac{\text{Liquid Assets}}{\text{Assets}}$	0.01	0.03**	-0.04**	-0.02**	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Avg. Funding Cost	0.22	0.40	-0.31	-0.10	-0.13
	(0.15)	(0.28)	(0.22)	(0.11)	(0.09)
2022 Dep. Growth	-0.02*	0.02	0.00	0.00	-0.01*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$\frac{\text{FHLB Advances}}{\text{Assets}}$	0.04*	-0.02	-0.02	-0.01	0.02^{+}
	(0.02)	(0.03)	(0.03)	(0.01)	(0.01)
Community Bank	0.74	0.72	-2.04**	0.46	-0.22
	(0.52)	(0.93)	(0.73)	(0.37)	(0.30)
Regional Bank	0.76	-0.35	-1.00	0.29	-0.01
	(0.54)	(0.97)	(0.76)	(0.38)	(0.31)
Constant	-1.27*	-2.88**	3.12**	0.83^{+}	0.19
	(0.61)	(1.10)	(0.86)	(0.43)	(0.36)
R^2_a	0.063	0.169	0.150	0.038	0.020
Observations	668	668	668	668	668

Notes: The table shows results from regressing changes in various balance sheet items—increases in BTFP (Column 1), reductions in cash holdings (Column 2), increases in non-Fed Borrowings (Column 3), increases in large time deposits (Column 4), and reductions in security holdings (Column 5)—on banks' excess loan growth like in specification (2). Among the explanatory variables, we also include losses on securities holdings (the difference between the value of security holdings when measured at market value and at amortized cost) as a share of assets, both in levels and interacted with excess loan growth. The remaining explanatory variables are like in Table 3. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table B5: Deposit Pricing

	3 Month		6 Month		12 Month		24 Month	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\frac{\Delta\text{Deposits}}{\text{Assets}}$	-2.07*	-0.55	-0.41	0.19	0.78	1.49	0.03	0.20
	(0.89)	(0.97)	(0.95)	(1.04)	(0.86)	(0.94)	(0.56)	(0.61)
$\times \frac{\text{HTM Security Losses}}{\text{Assets}}$		-3.09**		-1.36		-1.65^{+}		-0.39
		(0.85)		(0.97)		(0.89)		(0.58)
$\frac{\text{HTM Security Losses}}{\text{Assets}}$	7.37**	0.74	1.06	-1.90	1.69	-1.89	-2.23	-3.05
	(2.64)	(3.19)	(2.88)	(3.56)	(2.65)	(3.28)	(1.73)	(2.12)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	0.02	-0.12	-0.12	-0.17	0.07	0.02	-0.04	-0.05
	(0.23)	(0.23)	(0.24)	(0.24)	(0.21)	(0.21)	(0.14)	(0.14)
$\frac{\Delta\text{Loans}}{\text{Assets}}$	-0.15	0.23	-0.77	-0.62	-0.14	0.05	0.52	0.57
	(1.65)	(1.63)	(1.74)	(1.74)	(1.60)	(1.60)	(1.03)	(1.03)
$\frac{\text{Liquid Assets}}{\text{Assets}}$	0.34^{+}	0.33^{+}	0.39*	0.38^{+}	0.43*	0.41*	0.28*	0.28*
	(0.18)	(0.18)	(0.20)	(0.20)	(0.18)	(0.18)	(0.12)	(0.12)
Avg. Funding Cost	1.28	1.13	-1.47	-1.55	-6.13	-6.48	-4.40	-4.47
	(6.25)	(6.18)	(6.64)	(6.63)	(5.73)	(5.72)	(3.71)	(3.71)
2022 Dep. Growth	-0.15	-0.12	-0.07	-0.06	-0.13	-0.12	0.04	0.05
	(0.24)	(0.24)	(0.26)	(0.26)	(0.23)	(0.23)	(0.15)	(0.15)
$\frac{\text{FHLB Advances}}{\text{Assets}}$	0.77	0.68	0.50	0.46	0.27	0.24	0.10	0.09
	(0.65)	(0.65)	(0.72)	(0.72)	(0.65)	(0.65)	(0.42)	(0.42)
Community Bank	71.99**	67.22**	-12.06	-14.40	17.80	14.98	13.68	13.05
	(20.54)	(20.34)	(20.85)	(20.90)	(19.26)	(19.28)	(12.29)	(12.34)
Regional Bank	70.42**	67.91**	-17.67	-19.08	13.10	11.30	14.37	13.96
	(20.93)	(20.69)	(21.47)	(21.47)	(19.80)	(19.78)	(12.62)	(12.65)
Constant	-79.73**	-68.20**	19.87	24.98	-15.61	-9.40	-10.05	-8.65
	(23.28)	(23.22)	(23.86)	(24.11)	(21.98)	(22.19)	(14.12)	(14.28)
R^2_a	0.045	0.068	-0.000	0.001	0.007	0.011	0.006	0.005
Observations	507	507	581	581	593	593	576	576

Notes: The table shows results from cross-sectional regressions of basis point changes in 3,6,12,24 month CDs offered by banks over the interval March 8—May 3 on contemporaneous deposit growth ($\Delta Deposits_{i,t,t'}/Assets_{i,t}$) uninsured deposits, HTM security losses, contemporaneous loan growth ($\Delta Loans_{i,t,t'}/Assets_{i,t}$), liquid asset holdings (the sum of cash, federal funds, reverse repo and securities holdings), average funding cost (annualized interest expense as a percent of total liabilities), deposit growth in 2022, FHLB advances, and bank size indicators (i.e., community banks are ones with assets under $10 billion in assets and regional banks ones with assets between $10 and $ 250 billion in assets) measured as of 2022:Q4. Core deposit and contemporaneous loan growth are winsorized at the 1 and 99 percent levels. All variables except indicators, deposit growth in 2022, and average funding cost are relative to total assets. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*