The 2023 Banking Turmoil and the Bank Term Funding Program*

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Abstract

The effectiveness of lender of last resort (LOLR) actions depends on the trade-off between achieving the goal of stopping bank runs while minimizing unintended consequences, including moral hazard. We assess the effectiveness of the Bank Term Funding Program (BTFP), which addressed interest rate risk by extending long-term, fixed-rate funding against the par value of government-backed collateral in response to the deposit runs of March 2023. While the BTFP played a relatively modest role in banks' overall funding needs, it successfully channeled funds to vulnerable banks with outsized unrealized losses on securities portfolios and large uninsured deposits. The program allowed banks to replace lost deposits and build liquidity in defense against potential subsequent outflows. We find no evidence of moral hazard in the form of risky lending. However, some borrowing after the period of acute stress appears to have been driven by arbitrage incentives resulting from declines in expected interest rates. These findings suggest that unintended consequences were confined to the friction the program was designed to address, providing insight into potential benefits and costs that should be incorporated in LOLR design.

Keywords: Lender of last resort, emergency liquidity facilities, 2023 banking turmoil, deposit outflows, interest rate risk, Bank Term Funding Program (BTFP)

JEL Classifications: E52, E58, G01, G21

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1 Introduction

Central banks serve as the lender of last resort (LOLR), providing liquidity against good collateral at a penalty rate (Bagehot, 1873). LOLR interventions can stop bank runs and prevent an associated credit crunch and broader economic contraction (Diamond and Dybvig, 1983; Rochet and Vives, 2004). At the same time, interventions may lead to unintended consequences, including moral hazard. Ex post, borrowing banks can take on more risk using the liquidity provided by the central bank, or ex ante, banks can change behavior with the expectation that government support will mitigate risks. With this trade-off between stopping runs and moral hazard, a key question arises regarding the design and efficacy of LOLR facilities: How can central banks design facilities to best address financial system stress, while minimizing unintended consequences (Drechsler *et al.*, 2016)?

This paper seeks to address this question and advance our understanding of LOLR programs by analyzing a recent LOLR intervention—the Bank Term Funding Program (BTFP). The BTFP was a 13(3) facility that was created by the Federal Reserve Board on March 12, 2023. Earlier that week, Silicon Valley Bank experienced a run, sparked by a combination of unrealized losses on government securities holdings resulting from the rapid increase in interest rates over 2022, and the use of uninsured deposits to finance them (Jiang *et al.*, 2023). With the failure of two other banks the same week, concerns mounted that other similarly-situated banks would also experience runs (Cipriani *et al.*, 2024). Meanwhile, the ways in which central banks have provided liquidity as an LOLR have broadened beyond traditional discount window lending, with programs targeting specific frictions, risks or institutions. Consistent with the narrow approach of other 13(3) programs, the BTFP specifically addressed interest rate risk at depository institutions by extending one-year loans at a penalty rate against the par value of government-guaranteed collateral.[1]

We analyze the effectiveness of the BTFP by examining what kind of banks borrowed from the BTFP and how the funds were used. Our three main findings are as follows. First, although the BTFP played a modest role in how banks met overall funding needs, it successfully channeled borrowings to "vulnerable" banks—with uninsured deposits and outsized securities losses—during the period of stress. Specifically, the BTFP allowed banks to replace lost deposits and build liquidity in defense against potential subsequent outflows. Second, we demonstrate that banks largely used BTFP funds to build up cash reserves. We find no evidence of moral hazard in the form of BTFP borrowing being used to fund risky lending. And third, while moral hazard was absent, there was interest-rate arbitrage motivated borrowing after the stress subsided, suggesting unintended consequences were confined to the friction the program was designed to address. Even with this arbitrage, the costs of the arbitrage were likely less than the benefits of the intervention, supporting tailored and narrow LOLR policies.

[1] The BTFP ceased extending new loans on March 11, 2024.

We present findings from four pieces of analysis. First, we identify the banks that were vulnerable to deposit outflows—the population that the BTFP was designed to reach. We find that banks with both high reliance on uninsured deposit funding and large mark-to-market losses on securities holdings faced relatively more deposit outflows. At banks with no securities losses, core deposits fell by about 3 cents for every extra dollar of uninsured deposits. In contrast, at banks with securities losses at roughly the 90th percentile of the sample distribution, core deposits fell by about 7 cents for every additional dollar of losses.

Second, we show that in response to these deposit outflows, banks primarily reduced cash holdings in the form of reserve balances at the Federal Reserve or borrowed from non-Fed sources, such as Federal Home Loan Bank (FHLB) advances. On average, for every dollar of deposit outflows, banks reduced reserves and increased non-Fed borrowing by about 47 and 34 cents, respectively. Even though BTFP borrowings played a relatively modest role in how the average bank met funding needs, as the BTFP covered 7 cents of every dollar of deposit outflows on average, the BTFP was an important source of funding for vulnerable banks. We estimate that banks at the 90th percentile in held-to-maturity (HTM) securities losses (corresponding to losses that are 1.4% of total assets) covered nearly 2 1/2 times or 17 cents of every dollar of core deposit outflows with BTFP borrowings, and turned to other sources by less than the average bank. Furthermore, regional banks with high securities losses used BTFP borrowings even more, which covered about four times or 30 cents for every dollar of core deposit outflows. In short, BTFP disproportionately provided funding to vulnerable banks, highlighting the ability of tailored emergency lending facilities to address specific strains— in this case, interest rate risk—and fill a gap in private funding markets.

Third, beyond BTFP being used to meet realized deposit outflows, we also find evidence that vulnerable banks used the BTFP to position themselves against potential future outflows. That is, banks with large securities losses or large uninsured deposit shares borrowed more from the BTFP relative to banks with similar deposit outflows but smaller securities losses and a lower share of uninsured deposits. Moreover, banks with these risk factors pledged collateral to the BTFP beyond what was needed for actual borrowings, leaving these banks prepared to borrow more should additional outflows materialize. Furthermore, we find that banks held large portions of their BTFP borrowings as cash. Mechanically, the immediate effect of borrowing from the BTFP was to increase banks' reserves. To explore the longer-run effects, we use local projections to examine the dynamics of various balance sheet items around BTFP borrowing. We find that banks borrowed from the BTFP following a sustained period of deposit outflows or loan growth, and that reserves remained persistently elevated (up to 10 weeks) after borrowing.

Fourth, we examine potential unintended consequences of the program. We find no evidence of moral hazard, which we define as riskier, lower-capitalized banks using the facility to take on

additional credit risk. To test for moral hazard, we estimate how banks with different capital ratios used BTFP funds. Importantly, we adjust reported regulatory ratios for unrealized losses due to interest rate increases as in Jiang *et al.*, 2023. Using this adjusted capital measure, we find that less-well-capitalized banks mostly held excess cash and modestly increased securities holdings, consistent with use of the program to avoid realizing interest-rate related losses from securities sales. For well-capitalized banks, we find an increase in lending after borrowing from the BTFP, although the magnitude is economically small. Taken together, these results suggest that banks largely used BTFP funds to accumulate reserve balances, and not for activities that add credit risk, such as extending risky loans.

However, we find some evidence of interest rate arbitrage later in the program. When the expected average federal funds rate over the next year moved down in late 2023, the BTFP rate fell below the interest on reserve balances (IORB) rate. As a result, banks with sufficient eligible collateral could borrow from the BTFP to fund reserves and earn the spread between the two rates risk free. We show that BTFP borrowing during this later period was only weakly associated with funding needs resulting from deposit outflows or loan growth. That said, a back-of-the-envelope calculation suggests that the excess interest expense from borrowing was an order of magnitude lower than the potential costs of borrowing institutions experiencing a run, supporting the idea that a narrow program addressing one friction is a reasonable LOLR strategy.

Our findings contribute to the literature in three ways. First, they inform theories of LOLR. The classical theory of LOLR predicts that banks use LOLR borrowing to stop bank runs and finance existing assets (e.g., Freixas *et al.*, 2004; Rochet and Vives, 2004). However, LOLR facilities may prompt borrowing for undesired reasons, such as risk-shifting or gambling for resurrection, undermining the facilities' financial stability goals (Carpinelli and Crosignani, 2021; Jasova *et al.*, 2021, 2023; Van Bekkum *et al.*, 2018; Drechsler *et al.*, 2016). In part for this reason, or to lean against central bank credit allocation more generally, Goodfriend and King (1988) suggest that open market operations against government collateral, instead of discount window lending against private collateral, should be used to address liquidity needs. We contribute to this literature by providing a comprehensive analysis of the BTFP, a 13(3) LOLR intervention to address interest rate risk. The BTFP's fixed-rate long-term funding allowed banks to simultaneously preserve liquidity and address their underlying vulnerability. Moreover, requiring government collateral and helping preserve banks' deposit franchise values (by reducing depositors' incentives to run) appears to have limited risk-shifting behavior. As banks will always face the risk of losses from maturity transformation, these lessons likely extend well beyond the 2023 banking turmoil.[2]

[2]While the run up in security holdings during the pandemic amplified interest rate risk, banks' vulnerability to increases in rates is not wholly unique to this episode. Banks typically rely on their deposit franchise to hedge interest rate risk (Drechsler *et al.*, 2021), rather than derivatives (McPhail *et al.*, 2023; Granja *et al.*, 2024). However, this

Second, we contribute to the literature on bank runs. In the classic Diamond and Dybvig (1983) model, runs occur because bank loans are illiquid. Illiquidity lowers the value of the bank if depositors run. If the value of the bank is low enough, a run equilibrium exists. More recent literature has shown that runs can occur even when assets are fully liquid and high-quality (Drechsler *et al.*, 2023; Jiang *et al.*, 2023; Haddad *et al.*, 2023). In these models, run risk reflect banks' accumulated interest rate losses. In this setting, banks only remain solvent if banks maintain their deposit franchises. We contribute by empirically analyzing how banks manage their balance sheets in the face of interest rate losses and deposit outflows, and the role an LOLR intervention plays in helping banks position themselves amid and against such runs.

Finally, our analysis contributes to the literature on the 2023 banking turmoil. 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. Cipriani *et al.* (2024) examine similar questions to those we study here, and focuses on the role of fundamentals and public signals in prompting bank runs and examines banks' balance sheet adjustment strategies during runs. Our paper differs from theirs in two important ways. First, we analyze BTFP borrowing and distinguish it from other types of wholesale borrowing in banks' balance sheet management strategies. Second, we examine developments over a longer time horizon (10 weeks before and 10 weeks after BTFP borrowing occurs), rather than just the week of SVB's failure. The longer time horizon helps us illustrate that banks borrow from the BTFP after a sustained period of deposit outflows, confirming that the BTFP was an important margin of balance sheet adjustment beyond the acute period of stress.

2 Institutional Background

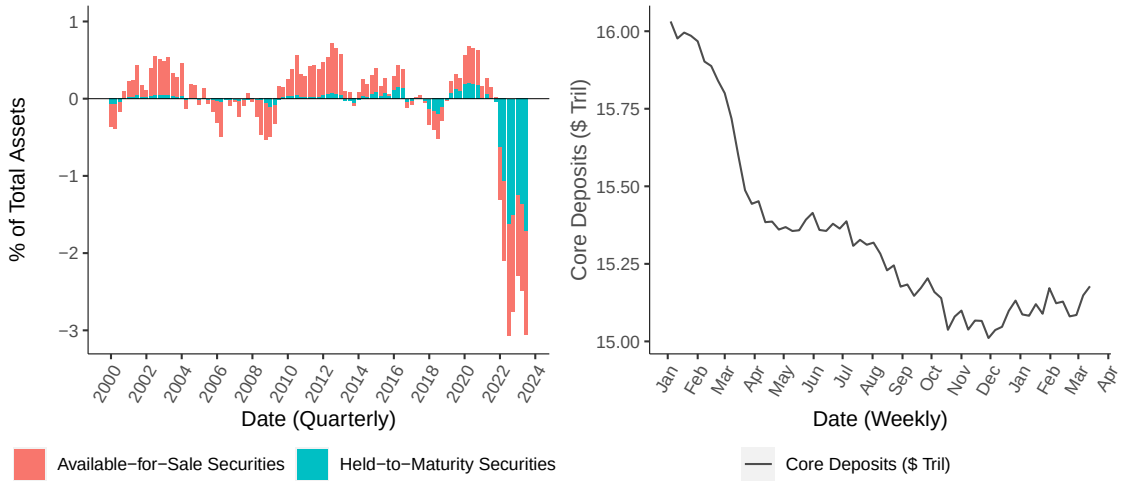
Heading into March 2023, the banking system became increasingly more risky along two key dimensions. First, banks substantially increased their holdings of longer-term securities during the COVID-19 pandemic. Second, the percent of banks' balance sheets funded by uninsured deposits increased notably. In late 2022, some regional banks (banks with $10 to $250 billion in assets) had uninsured deposit shares that exceeded 40 percent.

As the level of interest rates started to rise in the spring of 2022, banks accumulated significant unrealized losses on securities holdings (Figure 1, left panel). Meanwhile, uninsured deposits [are sensitive] to solvency risk. The combination of unrealized losses and reliance on uninsured deposits culminated in runs in March 2023 and the failures of Silicon Valley Bank (SVB), Silvergate Bank, and Signature Bank. The speed and magnitude of the deposit runs were unprecedented (Rose, 2023). For example, SVB—a $200 billion bank with a concentrated customer base in the technology

natural hedge is imperfect, and may open banks up to run risk when rates rise (Drechsler *et al.*, 2023).

industry— 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. Following these failures, concerns mounted over the health of other banks with similar characteristics—significant unrealized securities losses funded with uninsured deposits—prompting deposit outflows at other vulnerable banks (Figure 1, right panel).

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.

To limit contagion from the runs, and to support the ability of the banking system to provide credit to households and businesses, 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 Board announced the establishment of the BTFP. The terms of the BTFP addressed the vulnerabilities that destabilized deposit franchises. First, since the runs were prompted by declines in the market value of securities holdings, BTFP collateral was valued at par rather than market value. However, the BTFP only accepted securities eligible for purchase in open market operations and owned by eligible depository institutions as of March 12, 2023. The at-par feature of the program extended beyond the usual haircut subsidy—the difference between the private market and central bank haircuts—of LOLR interventions (e.g., Drechsler *et al.*, 2016; Jasova *et al.*, 2021, 2023). It aimed to increase borrowing capacity especially for the institutions most likely in need of it. It also gave them the option to meet deposit outflows without having to realize losses from selling securities at depressed valuations (e.g., Brunnermeier and Pedersen, 2009).

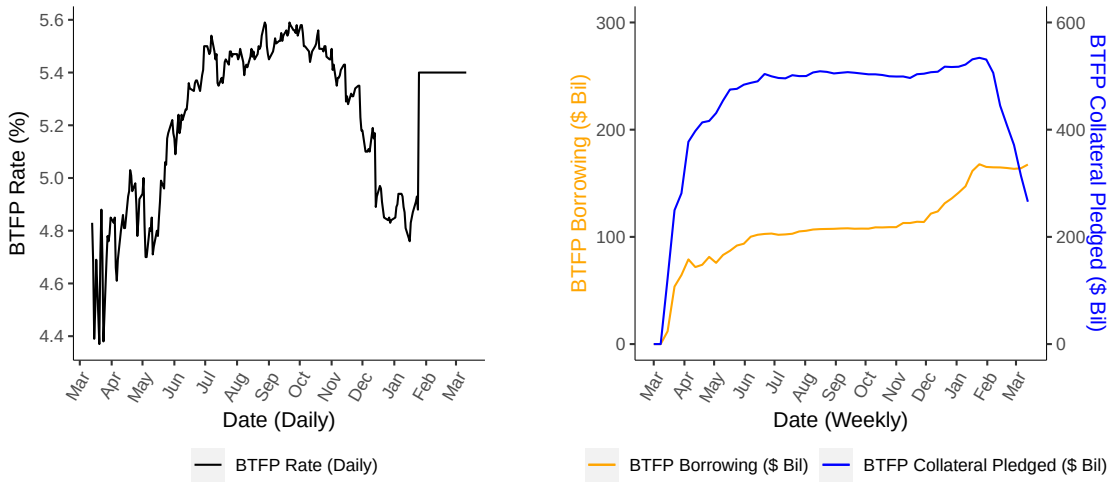
Second, the BTFP allowed depository institutions that were eligible for primary credit at the

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. A bank that substitutes deposit outflows with BTFP borrowing replaces demandable debt with one-year term borrowing, thus lengthening the duration of its liabilities. Additionally, if banks hold the BTFP funds as remunerated reserves for precautionary reasons, they fund a floating-rate asset (reserves) with debt that reprices annually, thus reducing the net duration of their balance sheets.

Consequently, the BTFP provided banks means of addressing liquidity strains that were unique relative to alternative funding options. For example, although FHLBs offer longer-term funding options, collateral is generally valued at market prices and subject to haircuts, reducing the borrowing capacity of banks contending with valuation declines. In addition, while the Federal Reserve's discount window accepts a wider range of collateral, loans have floating rates and shorter terms ($\leq$90 days) and thus do not address interest rate risks.

The evolution of the BTFP rate and BTFP borrowing and collateral throughout the lending period of the program are shown in Figure 2. 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. On January 24, 2094, the interest rate on new BTFP loans was adjusted to be no lower than the interest rate on reserve balances (IORB) on the day of originiation. 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, perhaps reflecting precautionary motives. After January 24, 2024, when the Federal Reserve Board announced that the BTFP would cease extending new loans as scheduled on March 11, the amount of pledged collateral fell while borrowing gradually slowed.

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 Data and Methodology

3.1 Data

Our analysis draws on data reported on form FR 2644, which provides detailed information on banks' assets and liabilities at a weekly frequency. FR 2644 data come from a stratified random sample of U.S. banks. Since the data are collected to produce estimates of banking sector aggregates, larger banks (which have a greater influence on such aggregates) are disproportionately covered in the data. To gauge how this sampling affects the representativeness of the banks in our analysis, Figure A1 compares selected balance sheet characteristics of FR 2644 filers to the universe of banks (Call Report data). In general, FR 2644 banks have very similar characteristics to the broader sample of all commercial banks for core deposits, FHLB advances, and unrealized securities losses relative to total assets. The most significant differences are that banks in the FR 2644 sample are larger and rely more on uninsured deposits than the overall banking universe. Therefore, while community banks are underrepresented in the data, our sample is well suited for analyzing how banks responded to the banking stress episode in March 2023, since it covers regional banks and banks with high reliance on uninsured deposits, which were disproportionately implicated by the episode. We restrict the sample to domestically chartered banks.[3]

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

[3]We omit banks in bank holding companies principally involved in investment banking or custodian activities. In addition, although credit unions participated meaningfully in the BTFP, we restrict our attention to banks due to the lack of high frequency credit union data.

balances, as well as aggregate wholesale borrowings.[4] 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.[5] Outside of the largest banks, which are more active in repo markets, the remaining part of wholesale borrowings is mostly FHLB advances. Finally, we rely on bank Call Reports data as of December 2022 to measure ex-ante vulnerabilities, including securities losses and uninsured deposit shares.

3.2 Methodology

The analysis begins with identifying the banks that were vulnerable to deposit outflows, and hence the population that the BTFP was designed to reach. 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 affect the incentives of uninsured depositors to withdraw funds (Jiang *et al.*, 2023). We focus on the HTM securities portfolio since banks are restricted in hedging interest rate risk for HTM securities and face greater impediments to selling these assets (Granja *et al.*, 2024). However, our findings are broadly similar when considering securities losses in the combined AFS and HTM portfolios, or incorporating imputed losses from long-duration loans as in Jiang *et al.* (2023).[6] $X_{i,t}$ is a vector of controls that includes loan growth, $\Delta\text{Loans}_{i,t,t'}/\text{Assets}_{i,t}$, and the following balance sheet items from 2022q4 Call

[4] "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.

[5] 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).

[6] Appendix Table A2 presents results from the interaction of uninsured deposits with both HTM and AFS securities losses. It shows that AFS securities losses also interact with uninsured deposits, but the effect is smaller.

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. We control for loan growth because we are interested in how banks meet funding needs driven by deposit changes beyond those related to loan growth. Deposit growth attributable to draws on credit lines, where borrowers initially hold funds in deposits for precautionary reasons, does not relieve funding needs, since loans rise in tandem (Glancy *et al.*, 2020; Cooperman *et al.*, 2023). How banks with similar loan growth respond to changes in deposits is thus more informative as to how banks meet withdrawals. Finally, we include bank size indicators 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).[7]

We then investigate how banks managed core deposit outflows. When banks lose deposits, they can either increase funding from other sources, such as the BTFP, or reduce liquid asset holdings. To examine these margins of adjustment, we replace the left-hand side variable of specification (1) with changes in either BTFP borrowing normalized by total assets or changes in other balance sheet items that could be used to meet funding needs. We aim to determine how banks adjusted balance sheets in response to deposit outflows, or to the risk factors making them vulnerable to such outflows. 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 one dollar of deposit outflows. In some specifications, we interact deposit outflows with HTM securities losses to investigate how the response to deposit outflows shifts with this factor. $X_{i,t}$ has the same controls as in equation (1).[8]

Finally, we estimate the dynamics of how banks use BTFP funds. While the immediate effect of borrowing from the Federal Reserve is an increase in a bank's reserves, eventually, reserves are often used to pay off liabilities or fund asset acquisitions over time. To estimate the relationship between borrowing and other balance sheet developments, we use local projections to trace out

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

[8] 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 the bank needs to raise (besides from core deposits) to fund the growth in their loan portfolio.

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 an increase in BTFP balances relative to banks that did not change BTFP borrowing in a particular week. We also estimate a similar specification for non-Fed borrowings. In this sample, t ranges from March 15th to July 26th. We investigate leads/lags up to 10 weeks (i.e., $h \in [-10, -9, ..., 10]$), implying that the estimation data include balance sheet changes from January 4th to October 4th.

4 Results

4.1 Which banks experienced core deposit outflows?

In this section, we investigate the risk factors associated with deposit outflows and, which banks had financing needs that could be addressed by the BTFP. Table 1 regresses changes in core deposits on banks' 2022q4 uninsured deposit volumes and HTM securities losses, all measured as a share of total assets.[9] 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 an average change of -1.7%). Securities losses in isolation, 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 HTM securities losses exhibit a slightly smaller sensitivity to uninsured deposit shares than the overall sample (core deposits at such banks fall by 3 cents per

[9] Table A1 presents summary statistics of the main variables used in the analysis.

dollar of uninsured deposits.) However, deposit outflows for a bank where securities losses were 1.4 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 the overall sample, with core deposits falling by about 7 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. However, in contrast to the period of stress, held-to-maturity securities losses and its interaction with uninsured deposits were not associated with outflows.

Table 1: 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)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$		-0.03**		-0.00		0.01		-0.01
		(0.01)		(0.01)		(0.01)		(0.01)
$\frac{\text{Loss HTM}}{\text{Assets}}$	-0.02	0.90*	0.13	0.23	0.23*	-0.08	-0.03	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**	0.25**	0.34**	0.34**	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**	-0.03**	-0.02**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Avg. Funding Cost	0.61**	0.61**	-0.20	-0.20	0.54**	0.54**	0.27	0.26
	(0.23)	(0.23)	(0.20)	(0.20)	(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	0.90	0.82	-0.22	-0.23	0.94	0.97	1.33*	1.30^{+}
	(0.78)	(0.78)	(0.75)	(0.75)	(0.72)	(0.72)	(0.66)	(0.66)
Regional Bank	1.60*	1.57^{+}	0.54	0.54	1.00	1.02	1.26^{+}	1.24^{+}
	(0.81)	(0.81)	(0.77)	(0.77)	(0.74)	(0.74)	(0.68)	(0.68)
Constant	-1.94*	-2.19*	0.39	0.37	-0.59	-0.51	-1.46^{+}	-1.52*
	(0.91)	(0.91)	(0.85)	(0.85)	(0.82)	(0.82)	(0.77)	(0.77)
R^2_a	0.119	0.128	0.112	0.111	0.067	0.067	0.054	0.054
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 four 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 continuous variables are measured in percentage points (specifically, with the exception of 2022 deposit growth and average funding cost, measure variables as a percent of initial total assets). $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Figure A2 presents binscatters of deposit growth against uninsured deposit shares controlling for the same variables as in Table 1 in order to more flexibly capture the relationship between these variables. During the period of stress (the top panel), there is a fairly linear relationship between uninsured deposit shares and deposit outflows, but with a steeper slope for high-HTM-loss banks. Deposit outflows were then modest, on average, after May 2023, regardless of uninsured deposit exposure or HTM losses (bottom panel).

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, focusing in particular on the role BTFP played in allowing banks to meet liquidity needs. Table 2 investigates how banks adjusted non-deposit borrowing from March 8 to May 3 in response to deposit outflows during that interval. Columns 1 to 3 predict changes in BTFP borrowing as a share of total assets, while columns 4 to 6 predict changes in non-Fed borrowing (borrowings besides BTFP and discount window) as a percent of total assets.[10]

We start with the average response of BTFP borrowing to deposit outflows, without additional controls. The results in column 1 suggest that for a one dollar decline in core deposits, on average, BTFP borrowing increased by 8 cents.

Next, we investigate whether our key risk factors of securities losses and deposit outflows influence influence BTFP borrowing. Banks with high HTM securities losses might be expected to meet more of their marginal funding needs with BTFP, both because these banks may be reluctant to sell HTM securities to meet outflows, and because collateral used for BTFP borrowings was valued at par, the the BTFP increased borrowing capacity more for banks with greater unrealized losses.

Column 2 presents the results. Risk factors that were associated with deposit outflows also affected BTFP borrowing beyond their effect on actual deposit outflows. A one standard deviation increases in HTM securities losses and in 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 suggest that BTFP was used both to meet realized deposit outflows and to raise precautionary funding for banks vulnerable to potential future outflows resulting from their securities losses.

To examine the effect of unrealized securities losses on banks' 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

[10]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.

(1.4%) would replace about 17 cents of every dollar of deposit outflows with BTFP borrowing.

An important question remains: Is this higher demand for BTFP borrowing by banks with high securities losses 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 to 6 repeat the same analysis, but for non-Fed borrowing, consisting predominantly of FHLB advances. This borrowing was a more prominent source of funding overall, with banks increasing borrowing by about 27 cents for every dollar of outflows. However, there is no statistically significant interaction between deposit outflows and HTM losses. Banks with greater HTM securities 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 use of BTFP for banks with greater securities losses did not reflect a general increase in the demand for wholesale funding, but rather, targeted borrowing to address the specific vulnerabilies of these institutions.

Table 2: 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	-0.27**	-0.33**	-0.34**
	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$			-0.09**			0.02
			(0.03)			(0.04)
$\frac{\text{Loss HTM}}{\text{Assets}}$		0.15^{+}	-0.05		0.05	0.09
		(0.09)	(0.11)		(0.12)	(0.15)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$		0.02**	0.01*		0.00	0.00
		(0.01)	(0.01)		(0.01)	(0.01)
$\frac{\Delta\text{Loans}}{\text{Assets}}$		0.08^{+}	0.09^{+}		0.27**	0.27**
		(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		0.24	0.22		-0.34	-0.33
		(0.15)	(0.15)		(0.21)	(0.21)
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		0.82	0.71		-2.03**	-2.01**
		(0.52)	(0.52)		(0.73)	(0.73)
Regional Bank		0.83	0.76		-0.95	-0.93
		(0.54)	(0.54)		(0.76)	(0.76)
Constant	0.43**	-1.47*	-1.23*	0.27*	3.09**	3.03**
	(0.09)	(0.61)	(0.61)	(0.12)	(0.85)	(0.86)
R^2_a	0.014	0.053	0.065	0.077	0.151	0.151
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 continuous variables are measured in percentage points (specifically, with the exception of 2022 deposit growth and average funding cost, measure variables as a percent of initial total assets). $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Overall, the findings in Table 2 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 helped to channel funding to banks with a greater need for it.

We also see evidence supporting these interpretations in banks' collateral pledging decisions. Table A4 presents similar estimates, but with the amount collateral pledged to BTFP as a share of assets as the dependent variable. Two findings stand out. First, deposit outflows, HTM losses, and uninsured deposits prompt banks to increase collateral pledged to the BTFP by almost twice as much as they actually borrow.[11] 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, which disproportionately experienced fair value declines.[12]

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 securities losses to assets. Estimates predicting changes in borrowing come from columns 3 and 6 of Table 2, while the estimates underlying the other funding sources are displayed in Table A3.

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.

[11] The estimates from Table A4, 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 2, column 2 BTFP borrowing was only found to increase by 7 cents, 15 cents, and 2 cents, respectively.

[12] 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 HTM losses. Banks with HTM losses used BTFP funding more on the margin to fund deposit outflows (17 cents per dollar of core deposit outflows) and turned less to the other four funding sources (reduced cash by 43 cents, increased non-Fed borrowing by 31 cents, raised large-time deposits by 6 cents, and actually increased security holdings by 2 cents). In short, banks with high HTM losses relied more on BTFP to meet deposit outflows, but other funding decisions were similar to that of the rest of the banking sector.

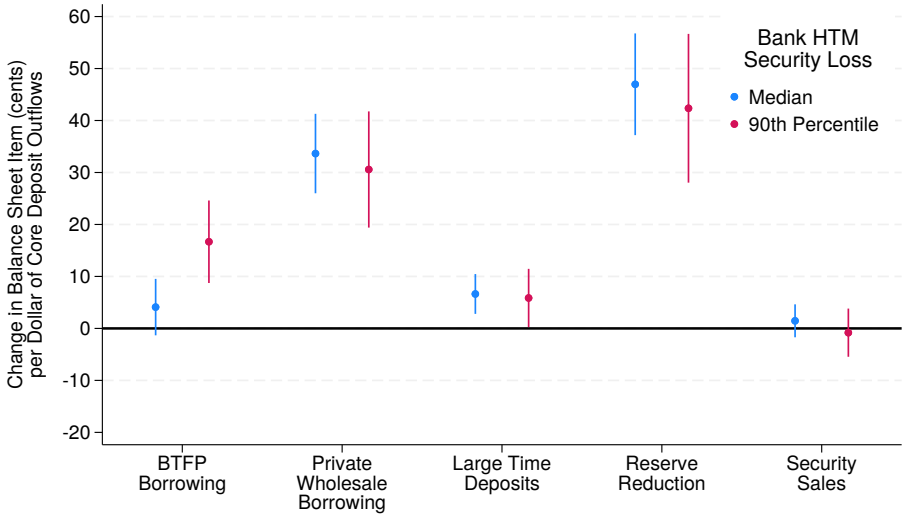
Figure 4 presents similar estimates, disaggregated by bank size. Broad funding patterns are similar across bank sizes; in the absence of notable HTM securities losses, both regional and community banks respond to deposit outflows by raising private borrowing or reducing reserves, with BTFP borrowings having a relatively limited role into the funding mix. 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 about one-third 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 used the BTFP most heavily, namely regional banks with high HTM losses and large deposit outflows.

Deposit flows are not the only factor that affects bank funding needs: banks also need to accommodate lending. Interestingly, the coefficients on Loan Growth in Tables 2 and A3 demonstrate that loan growth has a roughly symmetric effect on banks' funding decisions: banks increased BTFP borrowing by about 10 cents per dollar of loan growth, while reducing cash by 45 cents, increasing private borrowing by 25 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 A3 and Table A5 show that the main results are robust to this alternative measure.

To summarize, while most banks did not use BTFP funding, those that did appear to do so for precautionary reasons or to replace deposit outflows. Though banks typically met such funding needs by raising private borrowing or reducing cash holdings, banks with high HTM securities 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.[13]

[13]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 A6 presents estimates from the specification in equation (2), but with changes in time deposit pricing at various horizons as the dependent variable. We find that

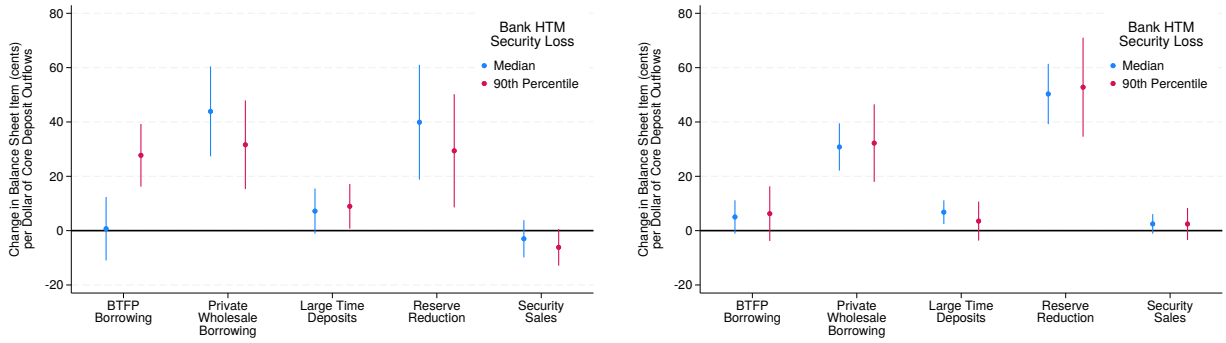
Figure 3: How Banks Fund Core Deposit Outflows



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 A3.

a 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.

Figure 4: How Banks Fund Deposit Outflows, By Bank Size



(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 $250 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.

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

Finally, we shift our attention from what prompts banks to borrow from the BTFP to how BTFP funds were used. Instead of investigating changes in bank balance sheets over specified windows, we use local projections to trace out how various balance sheet items change in the period following an 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.

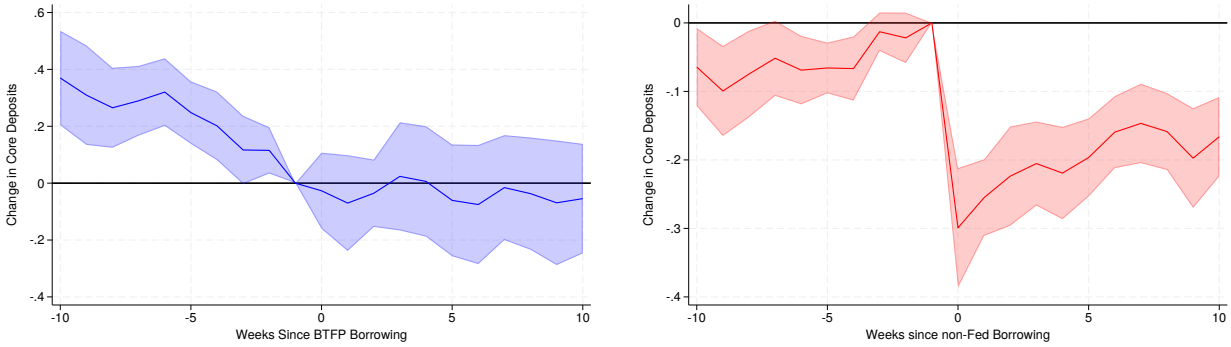
To preview the results, we find that banks use BTFP to build up cash holdings, consistent with BTFP helping banks to satisfy precautionary demand for liquidity. We also find that banks use BTFP borrowings to meet funding needs arising from loan growth and deposit outflows. These results provide additional support to our earlier results in Section 4.2, by providing a perspective on the use of funds over time.

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 week they occur, while the BTFP appears to be tapped after a period of sustained outflows. This outcome is consistent with the BTFP having some fixed cost that inhibits use, which is apparently larger than the benefit of at-par collateral valuation. This fixed cost causes banks to wait until funding needs pass a threshold level of need to pay the cost to access BTFP funding. Non-Fed borrowing, on the other hand, is not subject to these frictions, and thus is used immediately when deposits decline.

Figure 5: Relationship Between Core Deposits Growth and Borrowing

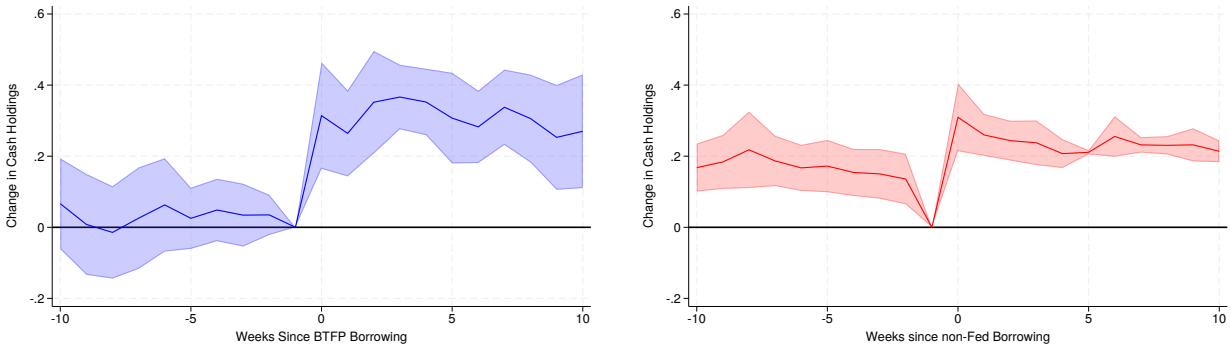


(a) Change around BTFP Borrowing (b) Change around non-Fed Borrowing

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

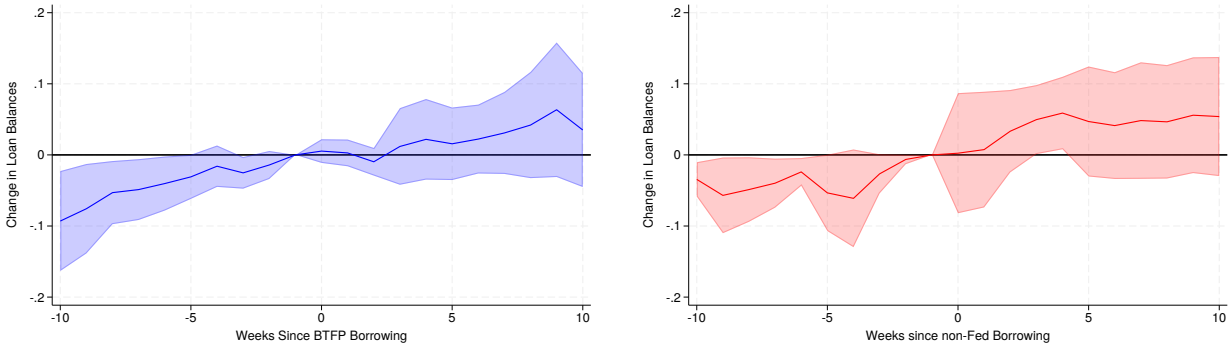


(a) Change around BTFP Borrowing (b) Change around non-Fed Borrowing

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.

4.4 Moral Hazard Concerns of the BTFP

What do our findings illustrate regarding banks' motivation for using the BTFP? As discussed earlier, LOLR facilities can relieve financial stability risks if they enable fundamentally-sound banks to meet liquidity strains; in contrast, they can exacerbate risks if they lead strained banks to engage in risky activities, and in extreme cases, gamble for resurrection. The design of the BTFP had elements that could both dampen or amplify these risks. On one hand, by providing fixed-rate, term financing, BTFP borrowing could mitigate the duration mismatch that made banks vulnerable to interest rate increases. On the other hand, the at-par valuation of collateral disproportionately increased borrowing capacity for banks with high securities losses. While these banks had greater liquidity needs, they could also have a greater incentive to use BTFP funds to engage in risky activities, in part due to limited liability.

The broad patterns shown in Section 4.3 are generally more consistent with banks using BTFP funds to meet liquidity strains rather than increase risk-taking. Namely, banks use BTFP funds to replace lost deposits, and funds are predominantly held as reserves rather than deployed into riskier assets. This means that the primary use of funds is for transactions that do not add credit risk—accumulating reserves rather than loans—and reduce interest rate risk—by using fixed-rate, term debt to either replace demandable debt or accumulate a floating-rate asset.

While there is some loan growth after borrowing, this growth is small (about 5 cents per dollar of borrowing), and mostly constitutes a continuation of existing trends. This is more consistent with banks that face strong loan demand using BTFP funding to meet that demand, rather than banks extending loans because of moral hazard generated by BTFP borrowing.

Though aggregate usage seems more consistent with banks using BTFP to meet liquidity needs, is there evidence of moral hazard in the cross-section of banks? To test this, we follow Drechsler *et al.* (2016) and examine differences in the utilization of LOLR facilities by bank capitalization. Specifically, we estimate Equation (3), but interact BTFP borrowing with an indicator for whether a bank's tangible common equity ratio (adjusting for marked-to-market security and loan losses as in Jiang *et al.*, 2023) is under 3 percent. These weakly capitalized banks would have a greater risk of failure and thus stronger incentives to acquire riskier, higher-yielding assets.

The results of this analysis are displayed in Figure 8. Overall, banks with high and low capital ratios appear to use BTFP funds similarly, and neither group seems to take on more risk. Reserves rise by similar amounts following BTFP borrowing at banks with high (blue) and low (red) capital ratios (top-left). The slightly lower intermediate-term reserve accumulation at less-well-capitalized banks may reflect the fact that those banks experience a greater decline in core deposits after accessing the BTFP (top-right panel). These patterns are generally consistent with less-well-capitalized banks using BTFP funds to maintain liquidity in the face of deposit outflows.

Regarding credit risk, it is only well-capitalized banks that increase lending after accessing the BTFP, but the effect is small and not statistically different from zero (bottom-left panel). Less-well-capitalized banks instead increase securities holdings slightly after borrowing (bottom-right). This result is consistent with less-well-capitalized banks using BTFP to avoid selling securities (and realizing losses), rather than taking on credit risk. We corroborate these findings by providing additional evidence on risk-taking by bank capitalization and loan type (Figure 9). The increase in loan balances after borrowing is principally accounted for by the increase in C&I loans by well-capitalized banks (top-left), though less-well-capitalized banks also see a slight increase in residential loan balances. For the loan types that experienced greater strains in 2023—CRE and consumer loans—there was no increase in loan balances after borrowing from the BTFP (bottom panels).

More generally, one can also conclude from these exercises that banks did not pull back significantly from extending credit, despite the banking stresses through the spring of 2023. Had the runs resulted in a credit crunch, we would have seen a severe contraction in lending. Across types of loans and borrowers, we do not see a pullback in loans for at least two months after banks borrowed from the BTFP.

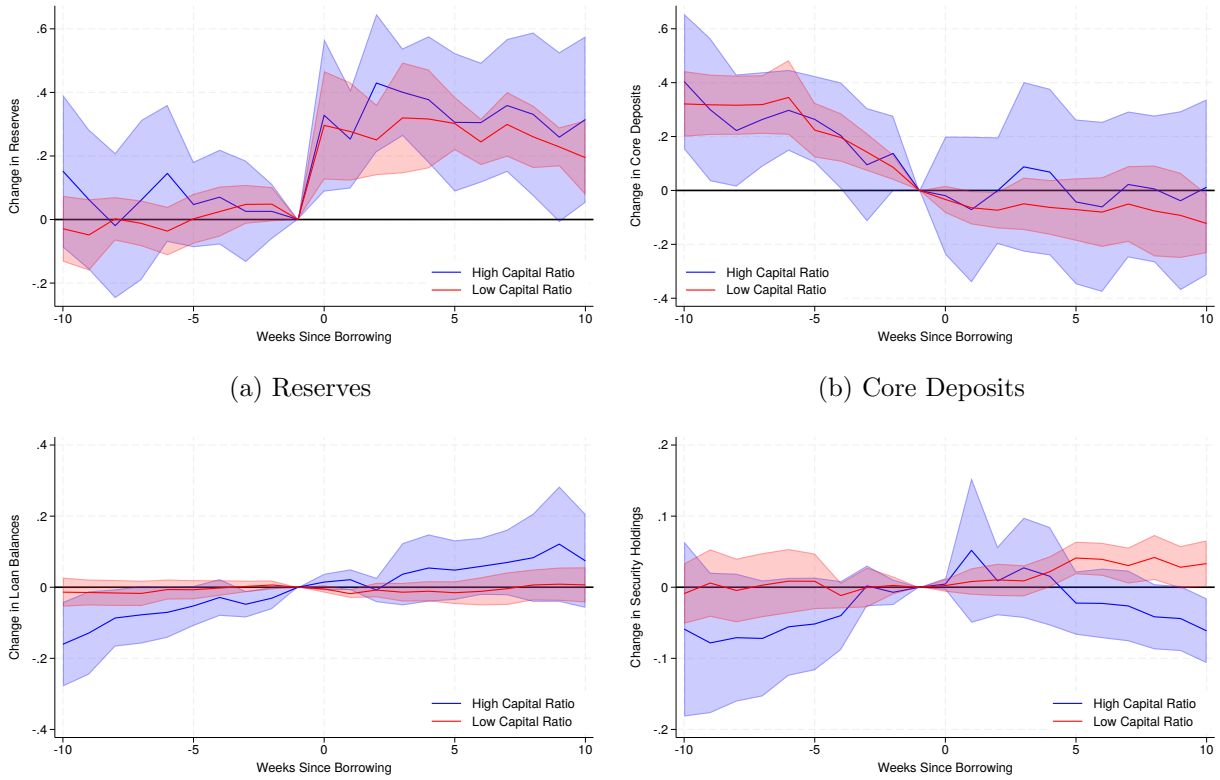
4.5 Arbitrage and the BTFP

We next analyze whether arbitrage opportunities motivated borrowing when the BTFP rate fell below the IORB rate in late 2023. Banks had the opportunity to earn a risk free spread by borrowing at the BTFP and holding funds as reserves at the Fed. Between November 29th, 2023 and January 24th, 2024, aggregate BTFP outstanding rose from $114 billion to $168 billion. Here we show that the increase in BTFP borrowing was unrelated to funding vulnerabilities, suggesting that borrowing was motivated by arbitrage.

Table A7 estimates regressions predicting wholesale borrowing using the same specification as in Table 2, but for the time period from November 29th, 2023 to January 24th, 2024. The only difference is that we include an indicator for whether a bank had BTFP borrowings outstanding as of the start of the interval. This variable proxies for the non-pecuniary costs of using the program since banks that have previously borrowed had already incurred any fixed costs associated with gaining access to the program. In addition, previous borrowings might also directly affect willingness to use the program since a bank's participation would be disclosed after the program regardless of whether or not they borrowed more.

Column (1) shows that BTFP borrowing was no longer responsive to deposit outflows during this period; one dollar in deposit outflows only increased BTFP borrowing by one cent. However, whether banks had outstanding BTFP loans is strongly related to additional borrowing. Assuming deposits are about flat, the regression predicts that new borrowers increase borrowing by 30 basis

Figure 8: BTFP Usage by Bank Capitalization



(a) Reserves

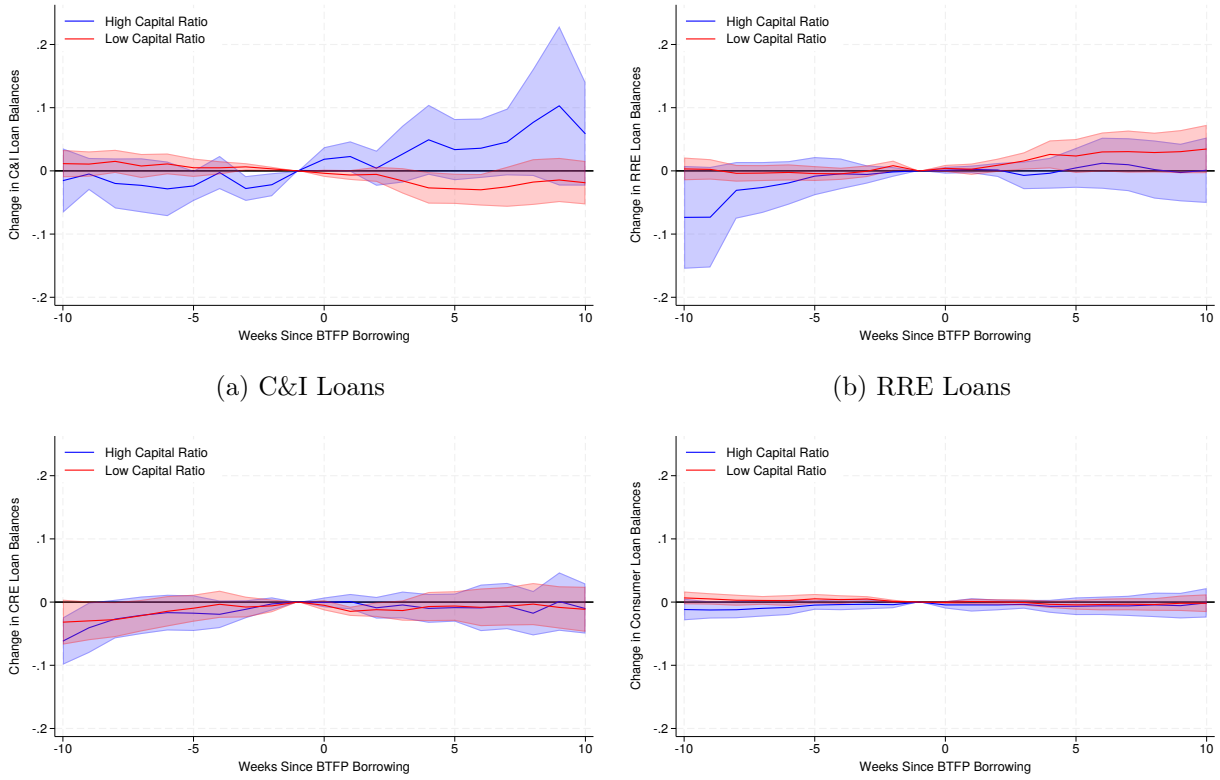
(b) Core Deposits

(c) Loans

(d) Securities

Notes: The charts show changes in various balance sheet items surrounding a change in BTFP borrowing as a share of assets The coefficients show the estimated change in reserves (top-left), core deposits (top-right), loan balances (bottom-left) and security holdings (bottom-right) at various horizons surrounding a $1 increase in BTFP borrowing. Red (blue) lines show estimates for banks with an adjusted tangible common equity ratio below (above) 3 percent.

Figure 9: BTFP Usage by Bank Capitalization and Loan Type



(a) C&I Loans

(b) RRE Loans

(c) CRE Loans

(d) Consumer Loans

Notes: The charts show changes in various loan types surrounding a change in BTFP borrowing as a share of assets The coefficients show the estimated change in CRE loans (top-left), RRE loans (top-right), C&I loans (including non-core loans) (bottom-left) and consumer loans (bottom-right) at various horizons surrounding a $1 increase in BTFP borrowing. Red (blue) lines show estimates for banks with an adjusted tangible common equity ratio below (above) 3 percent.

points as a share of assets over those eight weeks, while existing ones increase BTFP borrowing by 64 basis points. Column (2) adds in the other controls pertaining to funding vulnerabilities, and none are predictive of BTFP borrowing. Column (3) interacts deposit growth with HTM securities losses, and we see the interaction effect flip relative to the period of stress; HTM securities losses are only associated with BTFP borrowing for banks where deposits are increasing. In contrast to BTFP, borrowers continued to use private wholesale borrowing to meet deposit outflows and loan growth, similar to earlier in the year (columns 4–6).

How were BTFP funds used if not for meeting contemporaneous loan growth or deposit outflows? Figure A4 presents local projections estimates of the relationship between core deposit growth (left) and reserve growth (right) and BTFP borrowing during the period of arbitrage incentives. The figures show that there was some deposit declines in the period before banks borrowed from the BTFP, however the relationship is weaker than during the period of stress. Instead the strongest effect is an increase in reserves; reserves rise by about 40 cents per dollar of borrowing and remain elevated through at least the next 10 weeks.

While the response in reserves is similar in magnitude to during the period of stress, the motivation likely differs. Early in the program, banks borrowed for precautionary reasons, while later in the program, arbitrage effects may have dominated. During the spring of 2023, the banks that increased BTFP borrowing disproportionately had vulnerabilities such as uninsured deposits, HTM securities losses, or deposit outflows that would motivate precautionary borrowing. During the later period, marginal borrowing reflected preexisting borrowing status, correlated with nonpecuniary costs of utilizing the program.

5 Conclusion

We find that the BTFP successfully served as a backstop source of liquidity for banks that either experienced deposit outflows or had risk factors associated with deposit outflows (i.e., banks with high HTM securities losses or a high reliance on uninsured deposit funding). The BTFP was designed such that borrowing hedged the primary risk faced by stressed banks. The immediate effect of borrowing from the BTFP is to add floating rate asset (reserves) using fixed-rate term debt, which reduces a bank's maturity mismatch. While BTFP borrowing played a relatively modest role in how banks met funding needs overall—most banks met deposit outflows with reserves or private wholesale borrowing—it was an important funding source for banks with greater securities losses.

Even beyond the actual borrowing, banks at risk of deposit outflows also pledged additional collateral to the BTFP to prepare for potential future outflows. The availability of these reserves and additional borrowing capacity have contributed to the short lived nature of the crisis by making banks less susceptible to runs; by late spring, aggregate deposit growth normalized, and uninsured

deposits and HTM losses ceased to be associated with deposit outflows.

In terms of the program potentially inducing adverse incentives, we find that while banks increased lending somewhat after borrowing from the BTFP, this effect was driven by well-capitalized banks. Weakly-capitalized banks predominantly used funds to preserve reserves in the face of deposit outflows. These banks appear to have used BTFP funds to meet liquidity needs and reduce interest rate risk but not add credit risk. Furthermore, we find that some of the participants continued to borrow under the program later on to hold reserves, even though they were no longer in need of funding. Instead, they capitalized on the risk-free spread between the IOR and the BTFP rate, albeit this arbitrage-motivated behavior was limited.

We believe that our analysis holds lessons that extend well beyond the 2023 banking turmoil. In line with the prescriptions set forth by Goodfriend and King (1988), the BTFP provides evidence that a lender-of-last resort intervention limited to government collateral has the ability to quell banking stress. Distinct from their vision of open market operations as the primary method of providing central bank liquidity during a crisis, the BTFP used the same collateral but tailored access to smaller institutions, without reliance on primary dealers to reallocate funds, to match the characteristics of the stress in March 2023. Even with this tailoring, unintended consequences were limited to interest rate arbitrage, in modest amounts.

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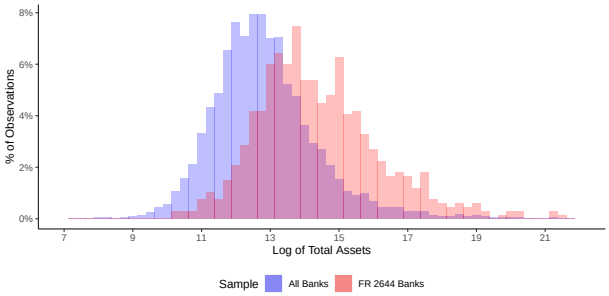
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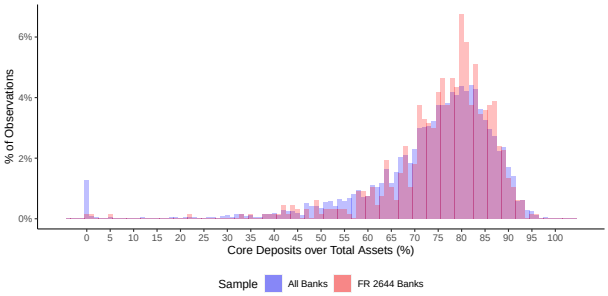
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A Appendix

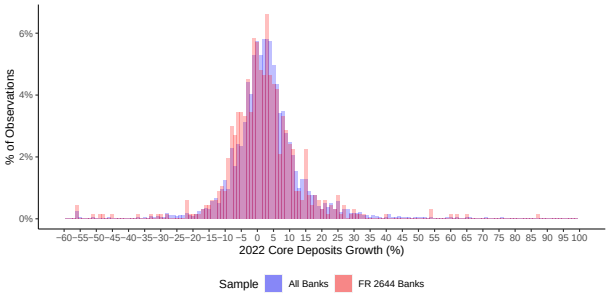
Figure A1: Sample Representativeness



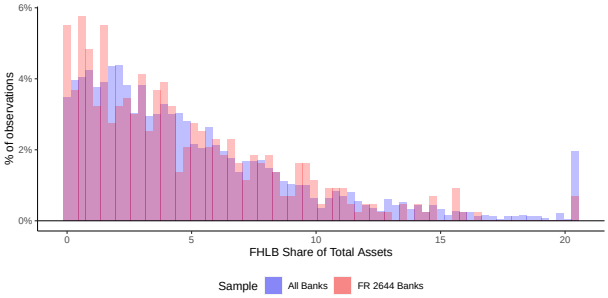
(a) Log(Total Assets)



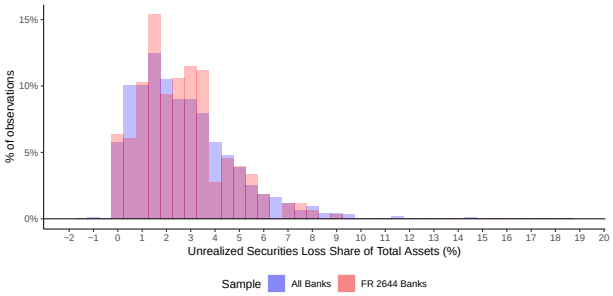
(b) Core Deposits to Assets



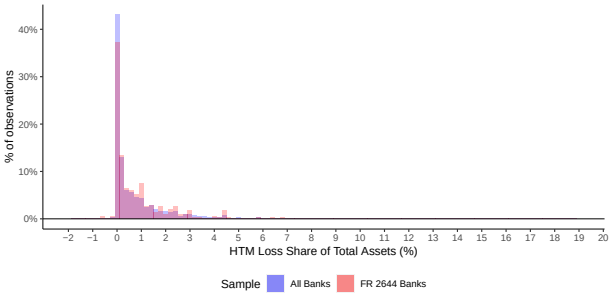
(c) Core Deposit Growth



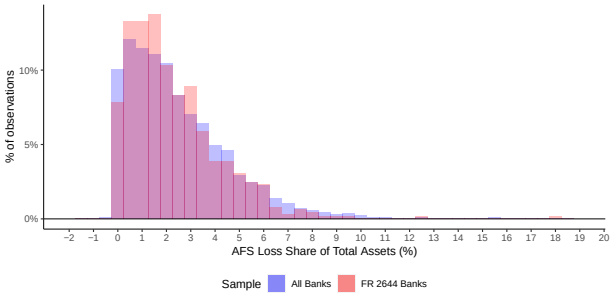
(d) FHLB Advances to Assets



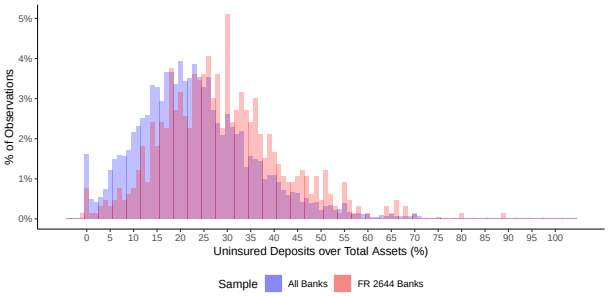
(e) Security Losses to Assets



(f) HTM Security Losses to Assets



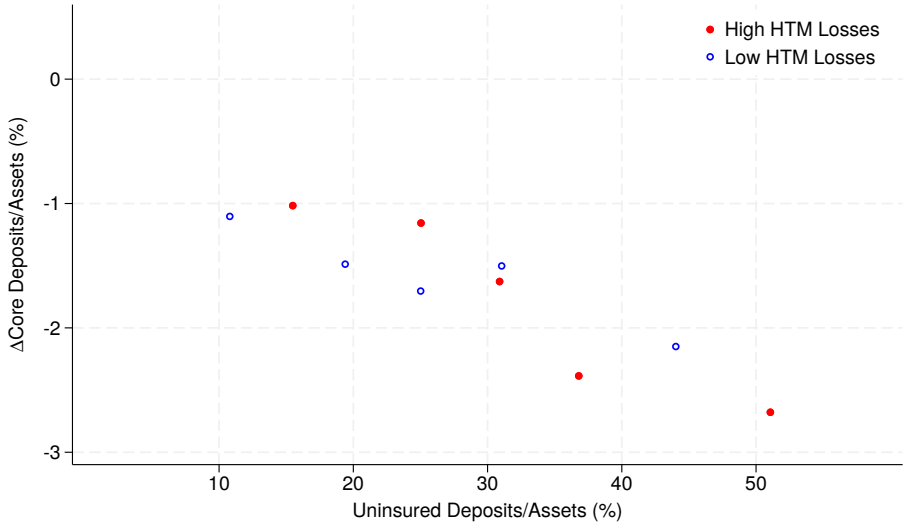
(g) AFS Security Losses to Assets



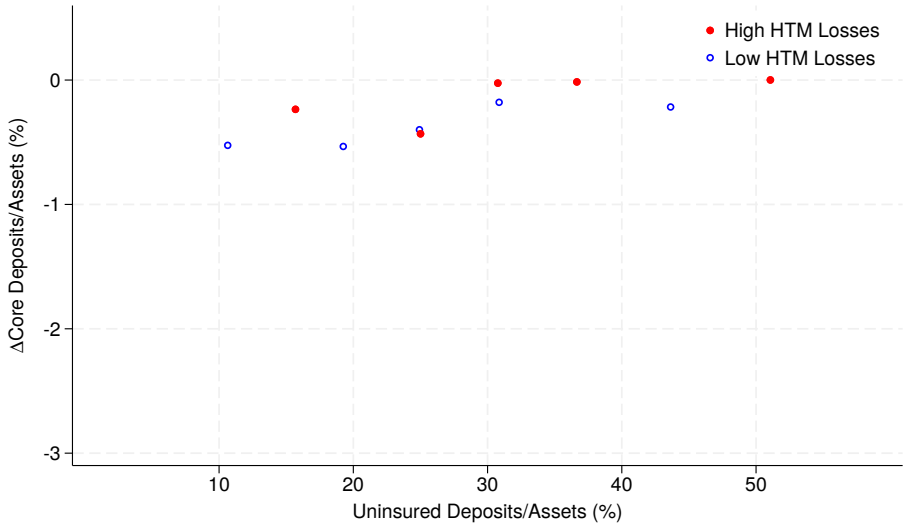
(h) Uninsured Deposit Share

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

Figure A2: Determinants of Deposit Outflows - Binscatter regressions



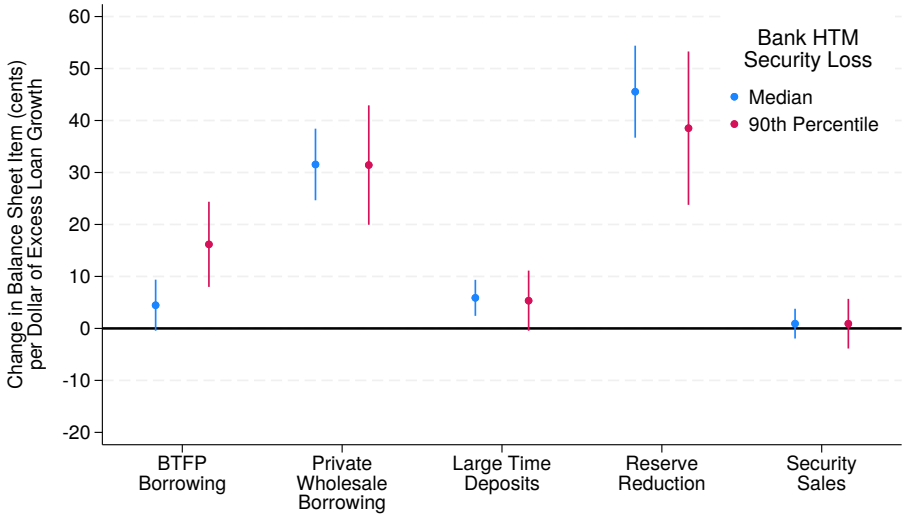
(a) March 8 to May 3



(b) May 3 to Oct 18

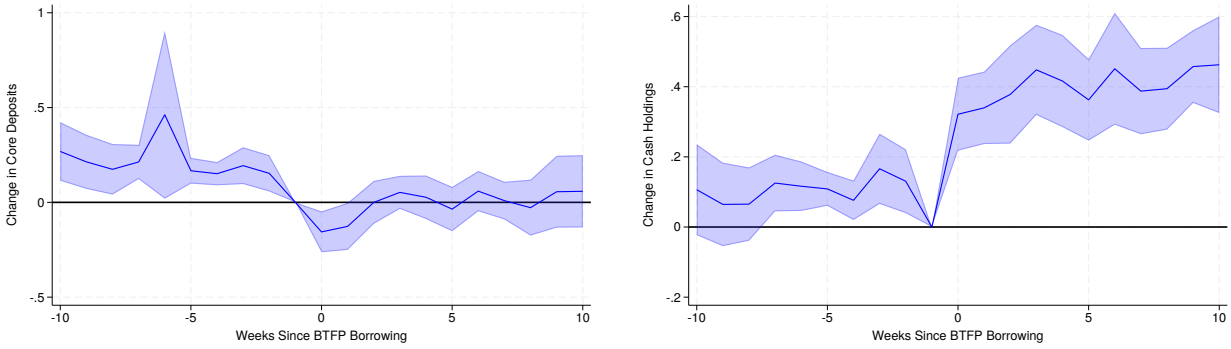
Note: Each figure plots a binned scatter regression of core deposit growth against banks' uninsured deposit share. The binscatters follow the same specification as in Table 1, except that the relationship is separately estimated by whether banks have HTM security losses above the sample median (rather than having a interaction term between HTM losses and uninsured deposit shares). The top chart plots the relationship for the period of stress (March 8 to May 3), while the bottom plots presents results pooling across the time horizons for the later periods (covering May 3 to October 18). The plots are produced using the Stata command "binsreg" (Cattaneo *et al.*, 2024).

Figure A3: 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 A5.

Figure A4: Changes in Core Deposits and Cash Holdings around BTFP Borrowing, Arbitrage Incentives



(a) Core Deposits

(b) Cash Holdings

Notes: The charts show the dynamic relationship between banks' weekly core deposits (panel a) or Cash Holdings (panel b) around a change in BTFP borrowing. The coefficients show the relationship between these variables at various horizons (in dollars) surrounding a $1 increase in BTFP borrowing in the presence of week fixed effects. The week 0 effect gives the change in the week of borrowing.

Table A1: Summary Statistics

Variable	Mean	Std. Deviation	Median	Observations
ΔCore Deposits/Assets	-1.67	3.08	-1.82	668
ΔBTFP/Assets	0.57	1.97	0.00	668
ΔNon-Fed Borrowing/Assets	0.72	2.91	0.00	668
Uninsured Deposits/Assets	28.57	12.76	27.54	668
Loss HTM/Assets	0.40	0.90	0.00	668
ΔLoans/Assets	0.92	1.56	0.76	668
Liquid Assets/Assets	31.00	15.87	27.96	668
Avg. Funding Cost	0.80	0.56	0.68	668
2022 Dep. Growth	3.15	11.80	2.44	668
FHLB Advances/Assets	3.01	4.08	1.36	668
Community Bank	0.82	0.39	1.00	668
Regional Bank	0.16	0.37	0.00	668

Notes: The table presents summary statistics for the main variables used in the analysis. Units are percentage points besides for the bank size dummy variables.

Table A2: 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)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$		-0.03**		-0.00		0.01		-0.01
		(0.01)		(0.01)		(0.01)		(0.01)
$\times \frac{LossAFS}{Assets}(\%)$		-0.01*		0.00		-0.00		0.00
		(0.00)		(0.00)		(0.00)		(0.00)
$\frac{\text{Loss HTM}}{\text{Assets}}$	-0.02	0.99**	0.15	0.26	0.24*	-0.05	-0.01	0.28
	(0.13)	(0.37)	(0.12)	(0.33)	(0.12)	(0.33)	(0.11)	(0.31)
$\frac{LossAFS}{Assets}$	0.01	0.29^{+}	0.05	0.04	0.03	0.05	0.04	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**	0.34**	0.34**	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**	-0.02**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Avg. Funding Cost	0.62**	0.65**	-0.17	-0.17	0.56**	0.56**	0.29	0.29
	(0.23)	(0.23)	(0.21)	(0.21)	(0.20)	(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	0.89	0.76	-0.29	-0.30	0.90	0.92	1.27^{+}	1.24^{+}
	(0.79)	(0.78)	(0.76)	(0.76)	(0.73)	(0.73)	(0.67)	(0.67)
Regional Bank	1.59^{+}	1.51^{+}	0.49	0.48	0.97	0.98	1.21^{+}	1.20^{+}
	(0.82)	(0.81)	(0.78)	(0.78)	(0.74)	(0.75)	(0.69)	(0.69)
Constant	-1.94*	-2.70**	0.40	0.38	-0.58	-0.55	-1.44^{+}	-1.43^{+}
	(0.91)	(0.94)	(0.85)	(0.88)	(0.82)	(0.85)	(0.77)	(0.80)
R^2_a	0.118	0.131	0.111	0.109	0.066	0.064	0.054	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 four 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 continuous variables are measured in percentage points (specifically, with the exception of 2022 deposit growth and average funding cost, measure variables as a percent of initial total assets). $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table A3: 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**	-0.34**	-0.07**	-0.01
	(0.03)	(0.05)	(0.04)	(0.02)	(0.02)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$	-0.09**	0.03	0.02	0.01	0.02
	(0.03)	(0.05)	(0.04)	(0.02)	(0.02)
$\frac{\text{Loss HTM}}{\text{Assets}}$	-0.05	-0.02	0.09	-0.00	0.09
	(0.11)	(0.19)	(0.15)	(0.08)	(0.06)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$	0.01*	-0.01	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
$\frac{\Delta \text{Loans}}{\text{Assets}}$	0.09^{+}	0.46**	0.27**	0.08*	-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	0.22	0.37	-0.33	-0.09	-0.13
	(0.15)	(0.27)	(0.21)	(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	0.71	0.68	-2.01**	0.45	-0.19
	(0.52)	(0.94)	(0.73)	(0.37)	(0.30)
Regional Bank	0.76	-0.34	-0.93	0.30	0.01
	(0.54)	(0.97)	(0.76)	(0.38)	(0.31)
Constant	-1.23*	-2.86**	3.03**	0.81^{+}	0.17
	(0.61)	(1.10)	(0.86)	(0.43)	(0.35)
R^2_a	0.065	0.169	0.151	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 (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 2. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table A4: 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**	-0.07	-0.08*	-0.05	-0.03*	-0.02	-0.01	0.00
	(0.05)	(0.05)	(0.04)	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$		-0.16**		-0.08*		-0.04*		-0.05**
		(0.05)		(0.04)		(0.02)		(0.01)
$\frac{\text{Loss HTM}}{\text{Assets}}$	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)
$\frac{\Delta\text{Loans}}{\text{Assets}}$	0.18*	0.19*	0.09	0.10	0.07*	0.07*	0.02	0.02
	(0.09)	(0.09)	(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	-0.26	-0.30	-0.11	-0.13	-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	-0.02*	-0.02*	-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	-1.24	-1.45	-1.27^{+}	-1.38^{+}	0.26	0.21	-0.23	-0.29
	(0.91)	(0.90)	(0.72)	(0.72)	(0.30)	(0.30)	(0.21)	(0.21)
Regional Bank	-0.33	-0.45	-0.21	-0.27	0.18	0.16	-0.30	-0.33
	(0.94)	(0.94)	(0.75)	(0.74)	(0.31)	(0.31)	(0.22)	(0.22)
Constant	0.13	0.58	0.38	0.60	-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	0.030	0.035	0.011	0.033
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 continuous variables are measured in percentage points (specifically, with the exception of 2022 deposit growth and average funding cost, measure variables as a percent of initial total assets). $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table A5: 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)
$\frac{\Delta(\text{Loans-Deposits})}{\text{Assets}}$	0.04^{+}	0.46**	0.32**	0.06**	0.01
	(0.03)	(0.05)	(0.04)	(0.02)	(0.01)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$	0.08**	-0.05	-0.00	-0.00	-0.00
	(0.03)	(0.06)	(0.04)	(0.02)	(0.02)
$\frac{\text{Loss HTM}}{\text{Assets}}$	-0.09	0.06	0.05	-0.00	0.06
	(0.12)	(0.22)	(0.17)	(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	0.23	0.41	-0.32	-0.09	-0.13
	(0.15)	(0.28)	(0.21)	(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*	-0.02	-0.02	-0.01	0.02^{+}
	(0.02)	(0.03)	(0.03)	(0.01)	(0.01)
Community Bank	0.74	0.74	-2.06**	0.46	-0.22
	(0.52)	(0.93)	(0.73)	(0.37)	(0.30)
Regional Bank	0.76	-0.34	-1.01	0.30	-0.01
	(0.54)	(0.97)	(0.75)	(0.38)	(0.31)
Constant	-1.22*	-2.90**	3.07**	0.83^{+}	0.20
	(0.61)	(1.10)	(0.86)	(0.43)	(0.36)
R^2_a	0.063	0.168	0.155	0.039	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 percent of assets, both in levels and interacted with excess loan growth. The remaining explanatory variables are like in Table 2. $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table A6: 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 continuous variables are measured in percentage points (specifically, with the exception of 2022 deposit growth and average funding cost, measure variables as a percent of initial total assets). $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*

Table A7: Wholesale Borrowing, Arbitrage Incentives

	$\frac{\Delta\text{BTFP Borrowings}}{\text{Assets}}$			$\frac{\Delta\text{Non-Fed Borrowings}}{\text{Assets}}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta\text{Deposits}}{\text{Assets}}$	-0.01	-0.01	-0.04^{+}	-0.18**	-0.21**	-0.21**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
$\times \frac{\text{Loss HTM}}{\text{Assets}}$			0.10**			-0.02
			(0.03)			(0.04)
$\text{BTFP}_t > 0$	0.34**	0.31*	0.31*	-0.14	-0.09	-0.09
	(0.13)	(0.13)	(0.13)	(0.19)	(0.19)	(0.19)
$\frac{\text{Loss HTM}}{\text{Assets}}$		0.09	0.20**		-0.04	-0.07
		(0.06)	(0.07)		(0.08)	(0.10)
$\frac{\text{Uninsured Deposits}}{\text{Assets}}$		0.00	0.00		-0.00	-0.00
		(0.00)	(0.00)		(0.01)	(0.01)
$\frac{\Delta\text{Loans}}{\text{Assets}}$		0.03	0.03		0.29**	0.29**
		(0.04)	(0.04)		(0.05)	(0.05)
$\frac{\text{Liquid Assets}}{\text{Assets}}$		-0.00	-0.00		-0.00	-0.00
		(0.00)	(0.00)		(0.01)	(0.01)
Avg. Funding Cost		-0.11	-0.11		0.25^{+}	0.25^{+}
		(0.11)	(0.11)		(0.15)	(0.15)
2022 Dep. Growth		-0.00	-0.00		0.01	0.01
		(0.00)	(0.00)		(0.01)	(0.01)
$\frac{\text{FHLB Advances}}{\text{Assets}}$		-0.01	-0.01		-0.01	-0.01
		(0.01)	(0.01)		(0.02)	(0.02)
Community Bank		0.27	0.29		1.38**	1.37*
		(0.37)	(0.37)		(0.53)	(0.53)
Regional Bank		0.21	0.23		1.64**	1.63**
		(0.38)	(0.38)		(0.55)	(0.55)
Constant	0.30**	0.11	0.07	-0.21*	-1.82**	-1.81**
	(0.06)	(0.43)	(0.42)	(0.09)	(0.61)	(0.61)
R^2_a	0.008	0.005	0.020	0.054	0.105	0.104
Observations	672	672	672	672	672	672

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 Nov 29, 2023–Jan 24, 2024 on contemporaneous deposit growth ($\Delta Deposits_{i,t,t'}/Assets_{i,t}$), an indicator for whether the bank had outstanding BTFP loans at the start of the interval, 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 continuous variables are measured in percentage points (specifically, with the exception of 2022 deposit growth and average funding cost, measure variables as a percent of initial total assets). $^{+}$,,** indicate significance at 10%, 5%, and 1%, respectively.*