Intraday Liquidity Management and the Value of Flexibility

Stefan Gissler * Borghan Narajabad †

September 2025

Abstract

Interbank trading in the federal funds market has declined sharply since 2008, raising questions about its relevance for assessing banks' liquidity conditions. This paper shows that the market continues to convey valuable information—not through bank-to-bank trading, but through the liquidity management behavior of the Federal Home Loan Banks (FHLBs), which now account for over 90% of daily lending. Using transaction-level data from the fed funds market and the Fedwire system, we show that FHLBs adjust their fed funds lending volumes, rates, and timing in response to daily liquidity outflows to their members, which use FHLBs as a source of funding or liquidity provision. On days with high outflows, FHLBs reduce early lending and shift volumes later into the day, pricing loans based on borrowers' flexibility and proximity to counterparty limits. These behaviors reveal a clear pecking order among borrowers and help FHLBs retain cash to meet uncertain late-day demand. Aggregated indicators based on FHLB trading—such as late-loan spreads and the timing of intraday lending—predict periods of system-wide liquidity stress. These measures reliably align with known episodes of market disruption, including the 2019 repo spike, the COVID-19 shock, and the March 2023 banking stress. Despite reduced interbank activity, the fed funds market remains a reliable indicator of liquidity conditions.

*Board of Governors of the Federal Reserve System, 1801 K St NW, Washington, D.C. 20006, USA. Email: stefan.gissler@frb.gov.

†Board of Governors of the Federal Reserve System, 1801 K St NW, Washington, D.C. 20006, USA. Email: borghan.narajabad@frb.gov.

1 Introduction

Since 2008, the role of the federal funds market in managing liquidity among U.S. banks has declined sharply. Abundant reserves have reduced the need for interbank reserve trading, and only a limited set of institutions remain active participants. Despite this, the market retains a central role in the Federal Reserve's monetary policy implementation, and the effective fed funds rate remains a key policy tool. Yet with few banks trading for liquidity, it is unclear whether fed funds rates and volumes still convey meaningful information about liquidity conditions in the banking system.

This paper argues that understanding the modern fed funds market requires understanding its dominant participants: the Federal Home Loan Banks (FHLBs). These 11 government-sponsored wholesale banks provide term funding to their members—banks, credit unions, and insurance companies. Acting sometimes even as "lender of next to last resort", they are active participants in overnight money markets to manage their liquidity. In the overnight fed funds market, FHLBs account for more than 90% of daily volume.

We show that FHLBs' trading behavior is driven by their liquidity management and has systematic effects on both rate dispersion and intraday volume dynamics. Using the fed funds market as their main tool to manage their liquidity, each trading day, FHLBs must manage a tradeoff: they must retain cash to satisfy uncertain late-day loan demand from members, but also avoid holding idle reserves overnight, which earn no return, instead of lending them in the fed funds market. Depending on FHLBs' expectations about liquidity demand in the broader banking system, they adjust how much cash they hold early in the day and how much more expensive early-day fed funds loans are. And even though only a handful of banks use the fed funds market for liquidity, FHLB activity embeds information about system-wide liquidity conditions.

A striking example of these dynamics comes from the March 2023 banking turmoil. Following the failure of Silicon Valley Bank, FHLBs extended over $150 billion in additional loans to members, funded mostly through debt issuance. Although the effective fed funds rate remained flat, the Federal Reserve Bank of New York noted that FHLBs sharply reduced fed funds lending "to conserve liquidity to meet member advance demand." We

document this shift in intraday trading in Figure 1: FHLBs largely ceased lending before 1 p.m. and concentrated activity at the market close. These patterns—absent in normal times—indicated underlying liquidity stress in the banking system even though the effective fed funds rate did not.

We build on this intuition using transaction-level fed funds data and Fedwire payment flows. We link FHLB cash outflows driven by loans to their members to their fed funds lending decisions, exploiting the fact that loans to members can deplete their same-day lending capacity in the fed funds market. On days with larger outflows, FHLBs lend less and at higher spreads—especially earlier in the day. Placebo tests using flows to other FHLBs confirm that the effect is driven by member-related liquidity demands. We show that FHLBs delay early-day lending when cash is tight, hoarding liquidity until advance demand is resolved.

Next, we explore how fed funds' borrower characteristics shape loan terms. FHLBs follow a clear pecking order: foreign banks, which borrow for arbitrage and not for liquidity needs, receive the most favorable rates; domestic banks subject to the Liquidity Coverage Ratio pay slightly more; and smaller banks borrowing for liquidity needs face significantly higher spreads—often over 200 basis points more relative to foreign banks. We argue that a key attribute valued by FHLBs is flexibility: the ability of a counterparty to absorb variable amounts of funds, especially late in the day.

We construct a measure of borrower flexibility based on the changes of their daily fed funds borrowing. More flexible borrowers receive better rates and are more likely to borrow late in the trading day—exactly when FHLBs seek to deploy excess cash. These patterns strengthen during periods of stress and are robust to borrower-time fixed effects, addressing concerns about reverse causality from borrower liquidity needs.

We also examine capacity constraints. FHLBs face regulatory counterparty limits tied to a borrower's Tier 1 capital. We show that borrowers with more unused capacity—i.e., farther from their limits—receive more favorable terms and are more likely to borrow late, when FHLBs need flexibility most.

Looking directly at loan characteristics, we show that late loans are cheaper than early fed funds loans. This discrepancy increases during times of heightened liquidity demand in

the banking system, as measured by higher repo rates. Yet it not only matters for FHLBs until when they have cash at hand, but also when cash is available in the morning. We show that loans repaid early the next day also enjoy favorable terms.

Finally, we aggregate these insights into indicators of system-wide liquidity pressure. We show that the late-loan spread (the rate difference between early and late trades of an FHLB in the same day) and FHLBs' fed funds lending when repo rates are high correlate strongly with known stress episodes, including the September 2019 repo spike, the onset of the COVID-19 crisis, and the March 2023 turmoil. During these periods, FHLBs delay early lending, hoard cash, and offer deeper discounts to flexible late-day borrowers. These behaviors often coincide with elevated repo rates—but not always. We document instances where FHLBs lend below repo returns, suggesting they prioritize liquidity over yield, which can create a disconnect between fed funds and repo indicators.

Our findings establish FHLBs' fed funds activity as a rich source of information about liquidity conditions in the banking system. Even as traditional interbank liquidity trading has diminished, the structure and timing of FHLB lending still offer valuable signals—provided one looks beyond aggregate rates.

Related literature. This paper contributes to several strands of the literature in banking, finance, and macroeconomics.

First, we add to the literature on reserve trading in interbank markets. Poole (1968) provided the foundational insight that, under uncertainty about outflows, the fed funds rate reflects banks' demand for liquidity. Afonso and Lagos (2015) formalize this idea within a search-theoretic model of the over-the-counter (OTC) fed funds market. Bianchi and Bigio (2022) implement the fed funds market in a macro model and show how OTC frictions in the fed funds market affect banks' liquidity behavior and the pass-through of monetary policy. We contribute a high-frequency empirical study using transaction-level data and institutional detail to show that, while the fed funds market continues to serve liquidity management purposes, this role is now concentrated on the supply side—primarily through FHLBs—rather than on the demand side by commercial banks.

A related literature monitors bank liquidity and system-wide reserve conditions. Copeland et al. (2025) use high-frequency payment data to develop indicators of reserve

scarcity. Similarly, Gissler et al. (2025) show that non-bank behavior can be informative about liquidity stress. Our paper complements this research by identifying additional indicators derived from FHLB trading behavior—such as the late-loan spread and fed funds lending below repo rates—that serve as real-time indicators of banking system liquidity.

We also add to the literature on the segmentation of money markets and how interbank frictions affect monetary policy transmission. Several papers mention the volatility in money markets rates and provide models to explain it. d'Avernas and Vandeweyer (2024) show theoretically how ample reserves together with regulatory constraints can lead to segmented money markets. Empirically, Eisenschmidt et al. (2024) show how segmented money markets in Europe can lead to frictions in the transmission of monetary policy. Duffie and Krishnamurthy (2016) provide a broad analysis of the effects of imperfect competition, regulation, money market mututal funds, and repo infrastrcture on monetary policy passthrough. We contribute to this literature by providing an additional factor of the potential disconnect between repo rates and fed funds

Lastly, our paper relates to research on the impact of financial institutions on asset markets in general and more specifically through liquidity management. Following the financial crisis, several studies, including Brunnermeier and Pedersen (2009), highlight how dealers' liquidity management impacts asset prices. More recently, Huang et al. (2024) show that mutual funds can affect Treasury yields through similar channels. We show that trading dynamics in the fed funds market are largely driven by FHLBs' liquidity management, emphasizing the growing importance of non-bank financial institutions.

The reminder of the paper is organized as follows. Section 2 provides the institutional details on the fed funds market and what role FHLBs play in it. Section 3 describes the different data sources, the construction of the sample, and the main variables. In Section 4 we show the main results and explain the mechanism in section 5. Section 6 shows the significance of our results for the broader banking system liquidity. Section 7 provides additional analysis and robustness and Section 8 concludes.

2 FHLBs' role in the federal funds market

Today's fed funds market is shaped by three key facts:

1. FHLBs are the dominant—and often sole—lenders.

2. Foreign banking organizations (FBOs) are the main borrowers, profiting from borrowing below the IORB.

3. Large domestic banks use fed funds borrowing from FHLBs to manage their LCR.

In this section, we will show that these features stem from segmentation across money markets and the regulatory treatment of FHLBs.

The federal funds market. The federal funds market is an overnight, unsecured, over-the-counter (OTC) market, where depository institutions and government-sponsored enterprises (GSEs) trade central bank deposits, so called reserves. As banks' most liquid assets, reserves play a central role in commercial banks' liquidity management, for example to settle payments. The fed funds market is also central to U.S. monetary policy because the Federal Reserve targets the effective federal funds rate (EFFR)—the volume-weighted median rate of all transactions—as its primary policy rate.

Before the 2008 financial crisis, banks held only modest reserves above their regulatory requirements, so called excess reserves, and relied on the fed funds market for short-term liquidity. Post-crisis, with ample excess reserves, the need for such trading declined. As a result, FBOs have emerged as the primary borrowers, and FHLBs as the main lenders. Figure 2, Panel (a), shows that FHLB-FBO transactions account for the vast majority of daily volume. Trades between FHLBs and LCR-regulated domestic banks form a secondary, but much smaller, segment. The remaining volume—between smaller domestic institutions—now constitutes a small portion of interbank activity. Panel (b) shows volume-weighted average spreads over IORB by counterparty pair. Two features stand out: most trades occur below IORB, and spreads are highly stable over time—except in trades involving smaller banks. As we will explain now, both outcomes directly reflect FHLBs' dominant position as lenders.[1]

[1]For a more detailed overview of the state of the fed funds market, see Anderson and Na (2024).

The Federal Home Loan Bank system. The FHLBs are 11 GSEs that provide collateralized loans ("advances") to member institutions—commercial banks, credit unions, and insurance companies—funded mainly through short-term debt purchased by money market funds. With over $1 trillion in outstanding debt, they are the second-largest U.S. debt issuers after the Treasury.

Two regulatory features shape FHLBs' liquidity behavior. First, they earn no interest on reserves held at the Fed. Second, they must be able to meet all maturing obligations and member advance requests over a 10-day horizon without issuing new debt. As a result, FHLBs face a daily trade-off: during the day, they maintain large reserve buffers to handle payment flows; by day's end, they seek to run down reserves—on which they earn no interest—by lending in overnight markets or placing funds in interest-bearing accounts, including the Fed's Overnight Reverse Repo Facility (ON-RRP).

Fedwire payments data (Figure 3) illustrate this cycle. Inflows dominate early in the day as FHLBs build buffers; outflows dominate later as reserves are lent out. The federal funds market plays a unique role here: unlike repo markets, it allows flexible, late-day lending and early repayment, making it the FHLBs' preferred tool for liquidity management.

Because FHLBs prioritize liquidity management over return maximization, they willingly lend below IORB to counterparties offering flexibility—especially those borrowing late in the day. FBOs, facing lower balance sheet costs (e.g., no FDIC fees), exploit this by borrowing at sub-IORB rates and holding reserves overnight for arbitrage profits.

Domestic banks subject to the liquidity coverage ratio (LCR) also borrow from FHLBs, since only 25% of such borrowing counts toward projected outflows while reserves fully count as high-quality liquid assets (HQLA). This makes fed funds borrowing an attractive tool for LCR management, even at rates near or above IORB.

Finally, because FHLBs value predictable counterparties over yield, lending rates exhibit striking stability. An AR(1) regression of borrower rates on their lagged values yields coefficients near one with little time-series variation; most dispersion is cross-sectional, reflecting borrower heterogeneity rather than changing market conditions.

The next section introduces our data before analyzing the determinants of this cross-sectional rate variation.

3 Data and summary statistics

Our analysis draws on two primary data sources: Form FR 2420 and the Fedwire Funds Service, which together allow us to observe fed funds transactions at the lender–borrower level, as well as the liquidity flows of individual Federal Home Loan Banks (FHLBs).

Form FR2420. Form FR 2420 is collected daily by the Federal Reserve Bank of New York and requires large U.S. commercial banks (with assets above $18 billion) and U.S. branches of foreign banks (with more than $2.5 billion in third-party assets) to report all transactions involving federal funds. The dataset provides the identity of the ultimate borrower, which is particularly useful in transactions involving correspondent banks. However, it only reports the lender type—not the specific institution—when the lender is a government-sponsored enterprise (GSE), such as an FHLB. All FHLBs, for instance, are categorized simply as "GSE lender."

Fedwire-FR2420 match. To recover individual FHLBs as lenders and construct borrower–lender relationships, we use Fedwire Funds Service data and apply a transaction identification algorithm based on Furfine (1999). Fedwire is a real-time gross settlement system operated by the Federal Reserve that records large-value payments between financial institutions. The data identify both parties to each transaction. While Fedwire may not always reflect the ultimate borrower, it does identify the actual lender, thereby resolving the main limitation of FR 2420.

Fedwire transactions. To track FHLBs' liquidity usage outside the fed funds market, we use broader transaction records from Fedwire. We identify each FHLB via its ABA routing number, which we match to its RSSD ID from FR 2420. We similarly match counterparties' ABA numbers to their RSSD IDs, where possible, particularly when the counterparty is a commercial bank. This allows us to categorize transactions into those between FHLBs, between FHLBs and commercial banks, and between FHLBs and the Office of Finance. The majority of activity consists of transactions between FHLBs and their member banks. We interpret these transactions as cash flows related to advances and use them as a proxy for day-to-day liquidity provision.

Additional data. To assess FHLBs' alternative investment opportunities, we use tri-party repo data from [SOURCE]. Bank-level regulatory data, including Tier 1 capital, are drawn from Form FR Y-9C. This form is filed quarterly by all U.S. bank holding companies with consolidated assets above $3 billion and allows us to measure capital for all large domestic banks and a substantial number of foreign banks. To calculate FHLBs' debt coming due, we use discount note and bond issuance data from the FHLB Office of Finance.

Sample. Our sample spans January 2016 to September 2024. We conduct analyses at two levels of aggregation: the borrower-lender-day level (mostly transaction level) and the borrower–lender–month level. Our total FR2420 sample has 504.000 observations. We keep the 311.494 observations that report a GSE as lender. Using Fedwire, we implement a modified Furfine algorithm to isolate likely fed funds transactions involving FHLBs as lenders. We then match these transactions to those reported in FR 2420 that show a GSE lender. Out of the 311.494 observations with a GSE lender, we can match 223.810 to individual FHLBs on timestamp, loan amount, and loan rate. We then aggregate everything to the borrower-lender-day level. While most borrower-lender pairs trade at most once a day, if there are multiple transactions between the same borrower and lender, we use the volume-weighted average loan rate and the total loan volume. This leaves us with our main FR2420/Furfine dataset of 190.745 observations and 570 unique borrower-lender relationships. When additionally matching Fedwire data for FHLB non-fed funds transactions, we end up with a sample of 121,517 observations.

Transaction-level analysis leverages high-frequency variation and is used to study intraday pricing, timing, and liquidity effects. Monthly aggregation allows us to focus on borrower characteristics and long-run relationships. Except for summary regressions, we limit our primary analysis to FBOs and large domestic banks subject to the Liquidity Coverage Ratio (LCR), since smaller non-LCR domestic banks borrow primarily for idiosyncratic liquidity reasons and are not suitable control groups.

Summary statistics. Table 1 presents summary statistics. For transaction-level analysis, we observe 105,788 borrower–lender transactions involving FBOs and LCR banks, and 15,729 transactions involving non-LCR domestic banks. The average spread over the Interest on Reserve Balances (IORB) is –5 basis points for larger banks and –4 basis points

for smaller banks. Loan sizes are notably different: the average loan for large banks is $2.8 million (log size of 6.45), compared to $177,000 for small banks.

Our main liquidity proxy is a variable called Large Cash Outflows, which is a daily indicator equal to one if a given FHLB's cash outflow exceeds one standard deviation of its past-year average. The mean daily outflow is around $500 million, with a standard deviation of over $900 million. On roughly 10% of trading days, individual FHLBs send out more than $1 billion.

At the monthly level, we use indicator variables for bank types (Small Bank, LCR Bank, FBO) and focus on borrower flexibility and capacity. Flexibility is measured by the coefficient of variation in daily loan volume. Capacity is calculated as the ratio of average daily borrowing from FHLBs to the borrower's Tier 1 capital at the end of the prior quarter. This measure is founded on FHLBs' regulatory counterparty limits, which depend on this ratio.

4 The effects of FHLBs' liquidity management on the fed funds market

We test the hypothesis that FHLBs' liquidity management affects both pricing and volumes in the federal funds market. Our identification strategy leverages variation in FHLBs' cash outflows to members, primarily through advance payments, which temporarily reduce their cash holdings and limit their lending capacity in fed funds.

Using Fedwire transaction-level data, we compute daily non-fed funds cash outflows from each FHLB to its members. We classify an outflow as "large" if it exceeds one standard deviation above that FHLB's 12-month rolling average cash outflows. We then estimate the following equation:

$$y_{fbt} = \beta LargeCashOutflow_{ft} + \alpha_f + \gamma_{bt} + \epsilon_{fbt} \tag{1}$$

The dependent variable y_{fbt} is either the log loan volume or the fed funds spread of a transaction between FHLB f and bank b on day t. $LargeCashOutflow_{ft}$ is a dummy that

is 1 if FHLB f has a cash outflow on day t that is more than 1 standard deviation of its average cash outflow for the prior year. By including α_{ft} and γ_{bt} we allow for heterogeneity across lenders and borrowers and days.

Price and Volume Effects. Table 2 columns (1)-(3) show that the average loan volume declines when FHLBs have high cash needs. When a FHLB experiences a 1 standard deviation increase in its cash outflows due to advance payments to its members, loan size to its borrowers in the fed funds market decreases by about 2-4 percent. Column 3 shows that these effects are not driven by borrowers' demand for fed funds. By allowing for borrower-time fixed effects, we compare borrowing from the same borrower at two different FHLBs at the same day, and one of the FHLBs faces larger cash needs.

Columns (4)-(6) show that fed funds become more expensive when FHLBs' buffers are depleted. Spreads over IORB rise by 13 basis points on high-outflow days. While this effect holds with lender-time fixed effects (column 2), it becomes statistically insignificant under borrower-time fixed effects, implying that the results reflect differences across borrowers rather than within-borrower price changes. This is in line with the observation that fed funds rates are very stale within a given borrower-lender relationship.

Volume and Pricing Dynamics Over the Day. The decline in loan volume suggests liquidity hoarding behavior by FHLBs. FHLBs appear to retain cash until later in the day to hedge against unexpected advance draws. Panel A of Table 3 confirms this. We measure, at the lender-day level, the time by which an FHLB completes 25%, 50%, 75%, or 90% of its daily fed funds lending. Regressing these timing measures on the large outflow dummy, we find that on high-outflow days, the first quartile of lending occurs roughly 20 minutes later (column 1). Similar delays are observed at the median and 75th percentile; only the timing of very late-day lending, 90th percentile, remains unchanged.

Panel B of Table 3 shows that these shifts in timing translate into pricing differentials. We define a "late-loan spread" as the difference between the volume-weighted average spread of loans made after 4 p.m. and those made before 2 p.m. We estimate:

$$LateLoanSpread_{ft} = \beta Cash_{ft} + \alpha_f + \delta_t + \epsilon_{ft} \tag{2}$$

where $LateLoanSpread_{ft}$ is the volume-weighted average spread between loans made after 4pm and before 2pm by FHLB f on day t. $Cash_{ft}$ is a specific measure of cash flows to and from FHLB f at day t, and all specifications control for lender and time fixed effects. The spread is typically negative, reflecting lower rates for late loans. A more negative value implies relatively higher early loan rates. In Table 3, column (1), large outflows are associated with a narrowing spread by 8 basis points, driven by more expensive early loans. Column (2) confirms this using a continuous measure of outflows. Column (3) shows that the effect is driven by payments to commercial banks—likely reflecting actual advances—while outflows to other FHLBs have no significant impact (column 4).

Taken together, these results demonstrate that FHLBs' intraday liquidity management materially affects fed funds pricing and timing.

5 Mechanism

We now explore the mechanism underlying the observed effects, focusing on borrower characteristics and loan attributes. The evidence points to a preference by FHLBs for borrowers that are more flexible in their borrowing behavior—particularly on days when FHLBs face uncertainty in advance demand due to heightened liquidity pressures in the banking system.

The Value of Flexibility. When FHLBs hoard cash until late in the day, they depend on reliable counterparties willing to borrow varying amounts toward the end of the trading day. This requires a high flexibility from a borrower over time. On days when FHLBs have large excess cash, borrowers are asked to take on large loans, whereas on days when FHLBs have depleted their liquidity, borrowers will receive very little. Borrowers therefore cannot rely on fed funds for funding or liquidity needs.

We first test the hypothesis that such "flexible" borrowers are indeed the ones borrowing later in the day. To measure a borrower's flexibility and denote those who can vary their borrowing volumes in response to changing FHLB liquidity conditions, we compute the absolute log-change in a borrower's fed funds volume from day $t-1$ to t. A borrower with low variability is less useful for FHLBs' liquidity management; they neither absorb excess

cash on unexpectedly quiet days nor reduce borrowing when liquidity is tight.

We then estimate the following equation:

$$y_{fbt} = \beta Abs(\Delta logloan)_{fbt} + \alpha_{ft} + \gamma_{bt} + \epsilon_{fbt} \tag{3}$$

The dependent variable y_{fbt} is either (i) a dummy that is one if a loans is made after 4 p.m., or (ii) the fed funds spread of a transaction between FHLB f and bank b on day t. $Abs(\Delta logloan)_{fbt}$ is the absolute log-change in borrower b's fed funds borrowing from FHLB f from day $t-1$ to t. By including $alpha_{ft}$ and γ_{bt} we allow for heterogeneity across lender-days and borrowers and days.

Panel A of Table 4, columns (1)–(3), show that more flexible borrowers are indeed significantly more likely to borrow after 4 p.m., even after controlling for lender- or borrower-time fixed effects. Column (4) shows that flexible borrowers also tend to take smaller loans on average. However, on days when systemic liquidity pressure is high—proxied by the repo rate exceeding IORB—flexible borrowers do borrow significantly more. Column (5) demonstrates that on these days, the interaction between flexibility and a high repo-IORB spread is associated with higher borrowing volumes, indicating that FHLBs rely on these borrowers to absorb late-day excess liquidity.

Panel B of Table 4 confirms that such flexibility comes with favorable loan terms. A one standard deviation increase in borrower flexibility is associated with a 1 basis point decline in spreads (column 1). The result holds with borrower and FHLB fixed effects (column 2) and remains robust when introducing borrower-time fixed effects (column 3), which compares the same borrower across FHLBs within a month. The magnitude is smaller, consistent with earlier evidence of rate stickiness, but the sign and significance reinforce the interpretation. Column (4) confirms the effect within FHLBs by adding lender-time fixed effects.

Late loans. Within large borrowers, more flexible ones receive favorable pricing and borrow late. Yet do other banks, less flexible ones, also receive better pricing terms if they are willing to take up late loans? To answer this question, we turn from borrower characteristics to loan characteristics and study the pricing of late loans during normal times and stress times.

Table 5 demonstrates that late loans—those executed after 4 p.m.—carry significantly lower spreads. The average discount is about 0.4 basis points (column 1) when only controlling for day fixed effects. The economic significance of this effects is rather limited, showing that during normal times, FHLBs manage their liquidity without the need to provide large incentives to late borrowers. In times of liquidity pressure, however, these incentives become large. When the repo rates are above IORB, a sign of increased liquidity pressure in the banking system, late loans are on average 8 basis points cheaper than loans made before 4 p.m. Controlling for time, lender, and borrower fixed effects does not significantly change these findings (columns 3-4). The effect diminishes under borrower-time fixed effects (columns 5-6), reflecting that there are few borrowers that borrow from different FHLBs at different times of the day. Controlling for lender-time fixed effects restores the overall findings of a large and economically significant discount for late loans during times of liquidity pressure.

Small versus large banks. To further establish that FHLBs have a preference for fed funds borrowers that are flexible and do not rely on fed funds for liquidity needs, we establish a systematic pecking order in borrowing costs. Table 6 presents regressions of monthly average fed funds spreads over IORB on borrower type. In columns (1)–(4), we include dummies for small domestic banks and LCR-regulated large domestic banks, with foreign banking organizations (FBOs) serving as the omitted category.

Column (1) shows that FBOs receive the most favorable rates, followed by large LCR banks, and then small domestic banks, which pay spreads roughly 2 basis points higher than FBOs. This ranking holds within FHLBs (column 2) and when restricting the sample to frequent borrowers—defined as those borrowing on at least 9 days per month (column 3). Column (5) investigates whether it is simple size differences driving these results and shows a negative relationship between loan size and spreads. However, this effect vanishes when the sample is restricted to LCR banks and FBOs (column 6), suggesting that borrowing size alone does not explain the pecking order. These results not only suggest that FHLBs clearly prefer borrowers that do not rely heavily on fed funds, but they also show why for all of our analysis, we restrict the sample to LCR banks and FBOs, as small banks are systematically different.

Capacity. We have so far assumed that FBOs and LCR banks can absorb any volume of funds that FHLBs wish to place. However, in practice, FHLBs frequently encounter borrower-specific counterparty limits, which constrain the amount they can lend to a given institution. When these limits bind, FHLBs must resort to lower-yielding alternatives such as the Federal Reserve's Overnight Reverse Repurchase Facility (ONRRP). As a result, FHLBs should prefer borrowers with greater unused capacity and may offer them more favorable loan terms.

To test this hypothesis, we compute a loan-to-capital ratio for each borrower–FHLB pair, defined as the borrower's monthly average fed funds borrowing from the FHLB divided by its Tier 1 capital. This ratio closely mirrors regulatory counterparty limits, which are a function of Tier 1 capital. Because capital is reported quarterly, we conduct this analysis at the monthly level.[2]

Table 7 presents the results. Column (1) shows that borrowers closer to their counterparty limits—those with higher loan-to-capital ratios—pay marginally higher spreads. A one standard deviation increase in the ratio is associated with a 0.1 basis point increase in the fed funds spread. This relationship is statistically significant and robust to various fixed effects, including borrower-time fixed effects (col. 3), indicating meaningful variation in capacity over time.

Column (4) shows that high-utilization borrowers are significantly less likely to borrow late in the day. Column (5) confirms that the effect persists even after controlling for borrower-time fixed effects. A one standard deviation increase in the loan-to-capital ratio reduces the likelihood of late-day borrowing by roughly 10 percent, reinforcing the idea that capacity constraints limit FHLBs' ability to rely on such borrowers for late-day liquidity absorption.

Having established the micro-fuondations that give rise to the pricing and volume dynamics in the fed funds market, we now turn to the question whether these insights can help us derive aggregate statistics that provide information about banks' liquidity conditions.

[2] 12 CFR § 1277.7 "Limits on unsecured extensions of credit"

6 FHLBs' liquidity management and broader banking system liquidity

We have shown that FHLBs' intraday liquidity management significantly influences fed funds market outcomes. In this section, we demonstrate that key summary statistics derived from FHLB activity in the fed funds market can provide informative signals about broader liquidity conditions in the banking system.

One such indicator is the **late-loan spread**, which reflects FHLBs' expectations about liquidity demands on any given day. As discussed earlier, FHLBs seek to balance late-day liquidity provision with minimizing unused reserves. This trade-off influences the relative pricing of early and late-day loans. Figure 4 plots the late-loan spread—defined as the volume-weighted average spread between loans made after 4pm and those before 2pm—aggregated across all FHLBs.

Strikingly, the late-loan spread becomes more negative around periods of known system-wide liquidity stress. These include the September 2019 repo turmoil, the onset of the COVID-19 pandemic in early 2020, and the March 2023 banking stress. The pattern is consistent with our interpretation: during periods of heightened liquidity uncertainty, FHLBs ration early-day lending and hold back cash, causing early loans to become relatively more expensive. If excess cash remains by the end of the trading day, late loans are issued at discounted rates to trusted, flexible borrowers—widening the spread.

Closely related to the late-loan spread is the **time of FHLB lending.** Previous results showed that each FHLB shifts their lending later into the trading day on days with high cash outflows. Yet looking at the timing of all FHLB lending does reveal a pattern that is largely in line with heightened liquidity demand in the broader banking system. Figure 5 shows the time of the day when 25, 50, 75, and 90 percent are lend out. Again, major episodes flagged by the late-loan spread are also very prominent for the statistics when 25 percent and 50 percent are lend out. As was the case at the FHLB level, lending usually done later in the day anyway does not react as strongly.

Another informative indicator stems from **FHLBs' lending below repo rates**. As we have shown, FHLBs value the flexibility and stability of relationships with key counterparties.

This means that, even when repo rates rise due to general liquidity stress, FHLBs may continue lending in the fed funds market at stable rates, foregoing the opportunity to earn higher returns in repo markets. This behavior can create a disconnect between repo rates and fed funds rates, potentially muting the fed funds market's responsiveness to systemic conditions.

To gauge this, we construct a measure of FHLBs' fed funds lending below their respective repo rates. Panel (a) of Figure 6 shows the total daily volume of fed funds transactions conducted below the combined FHLB repo rate, along with the average spread between those fed funds rates and the repo rate. Panel (b) shows the share of such below-repo lending relative to total FHLB lending in the fed funds market.

This below-repo lending is not a marginal phenomenon. During extended periods, especially during stress episodes, lending below the repo rate constitutes a substantial share of total fed funds volume. Thus, even though FHLBs' preference for stable pricing may dampen rate volatility, this simple descriptive statistic—the volume of below-repo lending—still provides timely information about banking system liquidity conditions.

These results highlight two scenarios for the observed disconnect between fed funds and repo rates. In the first scenario, FHLBs lend at a relatively constant spread below repo, and fed funds rates rise alongside repo rates when liquidity tightens—suggesting pressure in the repo market is transmitted into the fed funds market, albeit imperfectly. In the second scenario, FHLBs continue lending in the fed funds market at stale, stable rates regardless of repo market conditions, causing the spread between fed funds and repo rates to widen during stress episodes. Figure 7 shows the the second scenario. In this case, the fed funds rate underrepresents funding pressure, and arbitrage is inhibited.

Even in this second case, however, we can still extract meaningful signals. If FHLBs face a fixed cost to participate in the repo market, they will switch from fed funds to repo lending only once the spread exceeds that threshold. Until then, they continue lending below repo. Observing this wedge and the persistence of below-repo lending helps identify when liquidity strains are building—before they are reflected in headline rates.

Overall, these statistics—the late-loan spread and the volume of FHLBs' below-repo lending—offer two reliable, real-time indicators of latent liquidity pressure in the banking

system. They help close the informational gap left by the structural segmentation and rate stickiness in the fed funds market.

7 Additional results and robustness

This section provides additional results such as additional loan characteristics important to FHLBs and robustness checks.

Early repayment. Table 8 shows that FHLBs also value having cash returned early. We regress the fed funds spread on an indicator equal to one if a loan is repaid within the first decile of the lender's repayment distribution of loans extended the previous day. Results are robust to borrower, lender, and time fixed effects (column 2), and to lender-time fixed effects (column 4). The effect disappears with borrower-time fixed effects, indicating that variation in early repayment behavior is primarily across borrowers.

Alternative measure of flexibility. Our preferred measure of borrower flexibility is the absolute log change in daily fed funds borrowing, which allows for rich fixed effects but may introduce noise. To verify robustness, we construct an alternative monthly measure: the coefficient of variation (CV) of a borrower's daily borrowing from a specific FHLB.

Table 9 reports the results. Columns (1)–(3) show that borrowers with higher monthly CVs—i.e., more variable borrowing patterns—receive lower average fed funds spreads. Columns (4)–(6) show that these borrowers are also more likely to borrow late in the day, when FHLBs face the greatest uncertainty about their liquidity position and seek to place excess funds. These results confirm that our findings are not sensitive to the specific measure of flexibility.

Multiple lenders. One concern is that observed pricing advantages may reflect borrower bargaining power rather than flexibility—specifically, that borrowers with access to multiple FHLBs can shop for better rates. To test this, we create a dummy equal to one if a bank borrows from more than one FHLB on a given day. We then regress the bank's average daily spread on this indicator. The results indicate no statistically or economically significant relationship. Borrowing from multiple FHLBs does not affect the rate a bank receives, suggesting that our results are not driven by lender competition or rate shopping.

Multiple trades. We also examine whether borrowers that transact multiple times with the same FHLB on a given day receive different pricing. From the demand side, multiple trades might signal volatile liquidity needs and thus carry a premium. From the supply side, FHLBs might favor borrowers who spread their borrowing across the day, helping them manage intraday liquidity. However, we find no significant pricing difference for days with multiple trades. Borrowers that engage in more than one transaction with a given FHLB pay similar rates to those that borrow only once.

8 Conclusion

This paper examines the modern federal funds market through the lens of its dominant lenders: the Federal Home Loan Banks. In contrast to the traditional view of the fed funds market as a venue for interbank liquidity trading, we show that today's market is shaped by the liquidity management practices and regulatory constraints of FHLBs. Using detailed transaction-level and payments data, we uncover a pecking order in loan pricing based on borrower flexibility and capacity, and demonstrate how intraday timing, liquidity shocks, and institutional incentives drive both pricing and volume in the market.

These findings have two important implications. First, while the fed funds market no longer serves as a primary liquidity source for most banks, it remains an active and informative segment of the broader money markets—provided one understands its institutional structure. Second, FHLBs' lending behavior gives rise to summary statistics such as the late-loan spread and the volume of lending below repo rates, which serve as timely indicators of underlying liquidity conditions in the banking system. More broadly, our results highlight how the behavior of non-bank financial institutions—such as the FHLBs—can have outsized influence on market pricing and potentially on the transmission of monetary policy.

References

G. Afonso and R. Lagos. Trade dynamics in the market for federal funds. *Econometrica*, 83 (1):263–313, 2015.

A. Anderson and D. Na. The recent evolution of the federal funds market and its dynamics during reductions of the federal reserve's balance sheet. *FEDS Notes*, 2024.

J. Bianchi and S. Bigio. Banks, liquidity management, and monetary policy. *Econometrica*, 90(1):391–454, 2022.

M. K. Brunnermeier and L. H. Pedersen. Market liquidity and funding liquidity. *The review of financial studies*, 22(6):2201–2238, 2009.

A. Copeland, D. Duffie, and Y. Yang. Reserves were not so ample after all. *The Quarterly Journal of Economics*, 140(1):239–281, 2025.

D. Duffie and A. Krishnamurthy. Passthrough efficiency in the fed's new monetary policy setting. In *Designing Resilient Monetary Policy Frameworks for the Future. Federal Reserve Bank of Kansas City, Jackson Hole Symposium*, pages 1815–1847, 2016.

A. d'Avernas and Q. Vandeweyer. Treasury bill shortages and the pricing of short-term assets. *The Journal of Finance*, 79(6):4083–4141, 2024.

J. Eisenschmidt, Y. Ma, and A. L. Zhang. Monetary policy transmission in segmented markets. *Journal of Financial Economics*, 151:103738, 2024.

S. Gissler, S. Hempel, J. Kahn, P. McCabe, and B. Narajabad. Monitoring reserve scarcity through nonbank cash lenders. *FEDS Notes*, 2025.

S. Huang, W. Jiang, X. Liu, and X. Liu. Does liquidity management induce fragility in treasury prices? evidence from bond mutual funds. *The Review of Financial Studies*, 38 (2):337–380, 11 2024. ISSN 0893-9454. doi: 10.1093/rfs/hhae082. URL `https://doi.org/10.1093/rfs/hhae082`.

W. Poole. Commercial bank reserve management in a stochastic model: implications for monetary policy. *The Journal of finance*, 23(5):769–791, 1968.

9 Figures and Tables

Figure 1: Distribution of fed funds trading during the March 2023 banking stress

This figure shows the distribution of fed funds trading volume during an average trading day between March 1, 2023 and March 7, 2023 (grey area) and between March 12, 2023 and March 17, 2023 (red area). The underlying data comes from Form FR2420 and Fedwire.

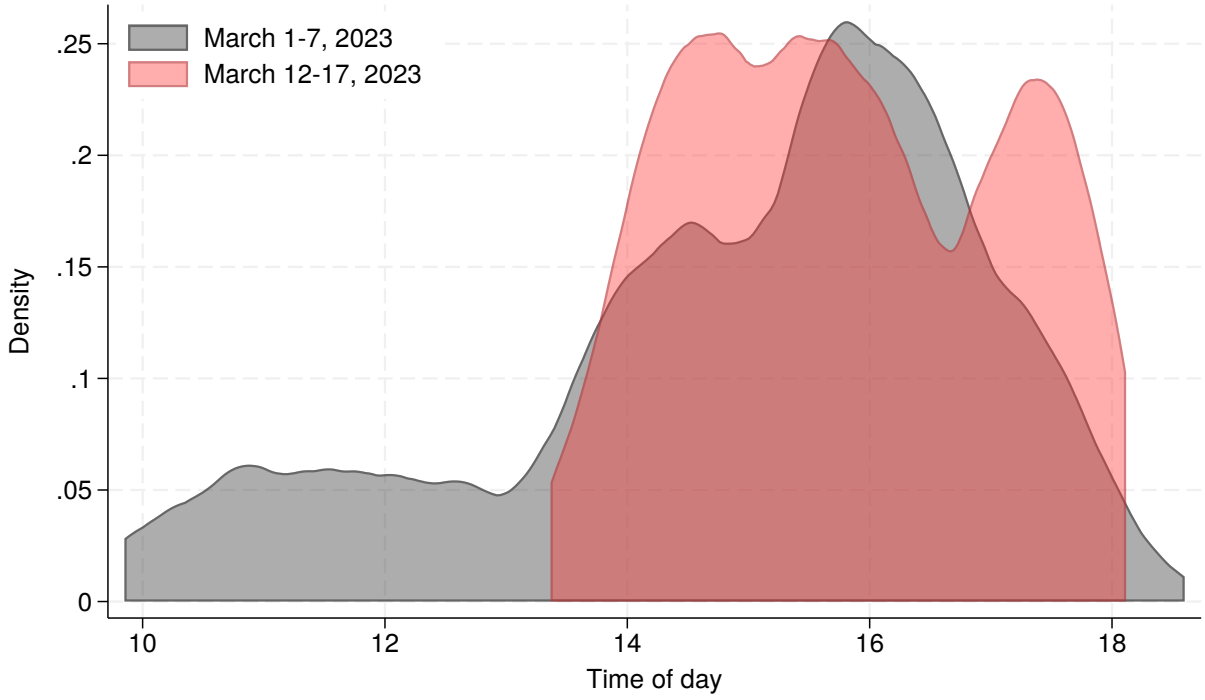
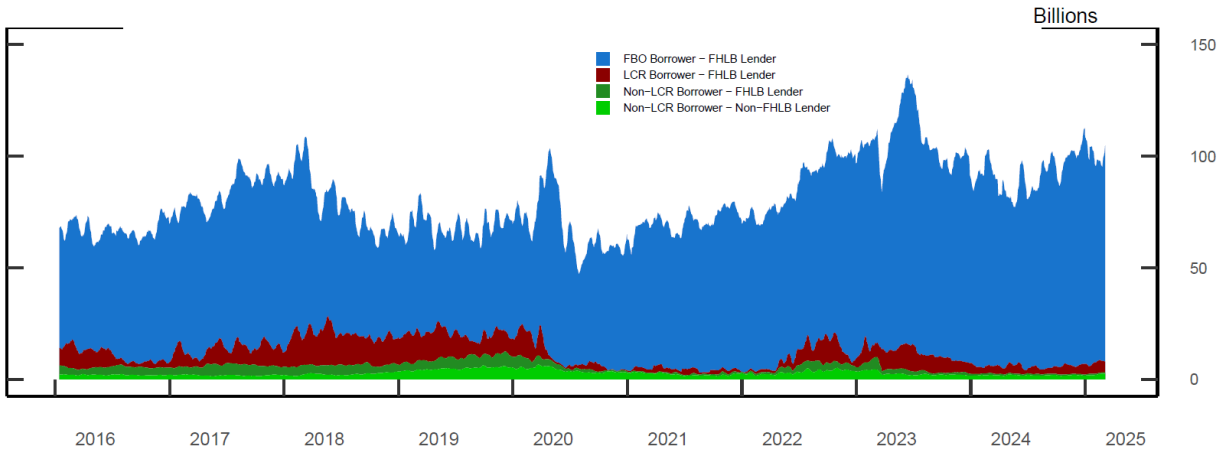


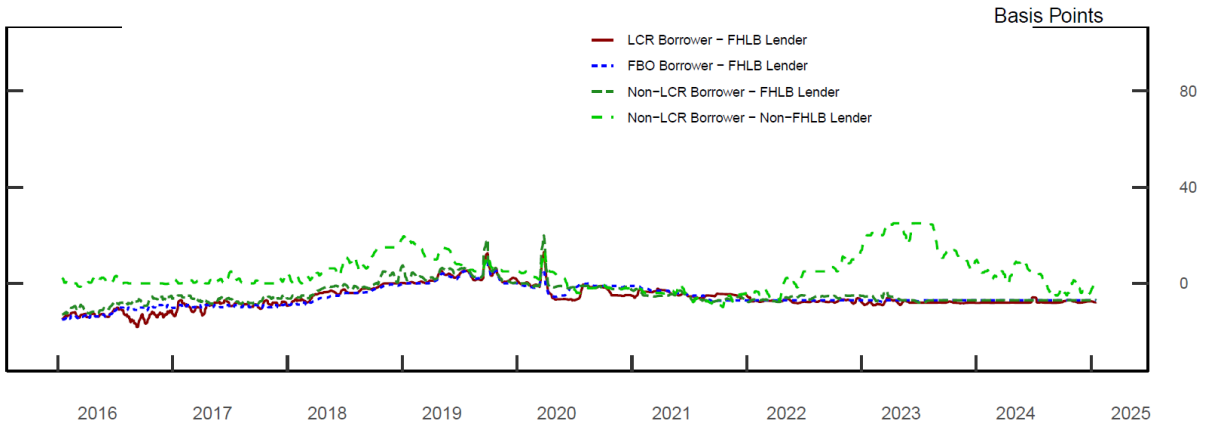
Figure 2: The fed funds market

These figures show 10-moving averages for fed funds trading volume and spreads over IORB by lender-borrower types. Panel (a) shows the total daily volume done between FBOs and FHLBs (blue), LCR banks and FHLBs (brown), non-LCR banks and FHLBs (dark green), and non-LCR banks and non-FHLBs (light green). Panel (b) shows the daily volume-weighted average spreads of those transactions over IORB. The underlying data comes from Form FR2420 and Fedwire.

(a) Volume



(b) Spreads

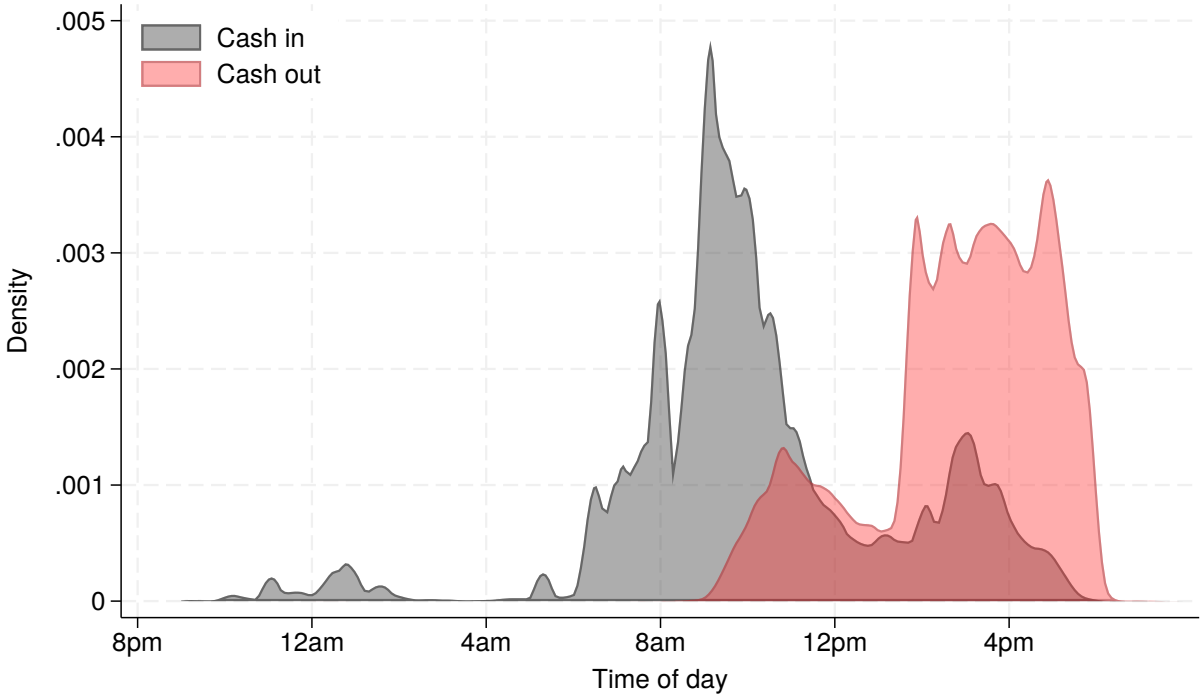


Source: FedWire, FR 2420
Note: FHLB series may include negligible amount of non–FHLB GSEs.

Figure 3: FHLBs' intraday payments

This figure shows payment flows to and from the FHLB system during the trading day. Panel A shows the frequency distribution of payment inflows and outflows during our sample period. Panel B shows median cumulative net payments in 5 minute intervals. The underlying data are all transactions involving FHLBs on the Fedwire Payments System.

(a) Panel A: Intraday payment frequency



(b) Panel B: Cumulative net payments

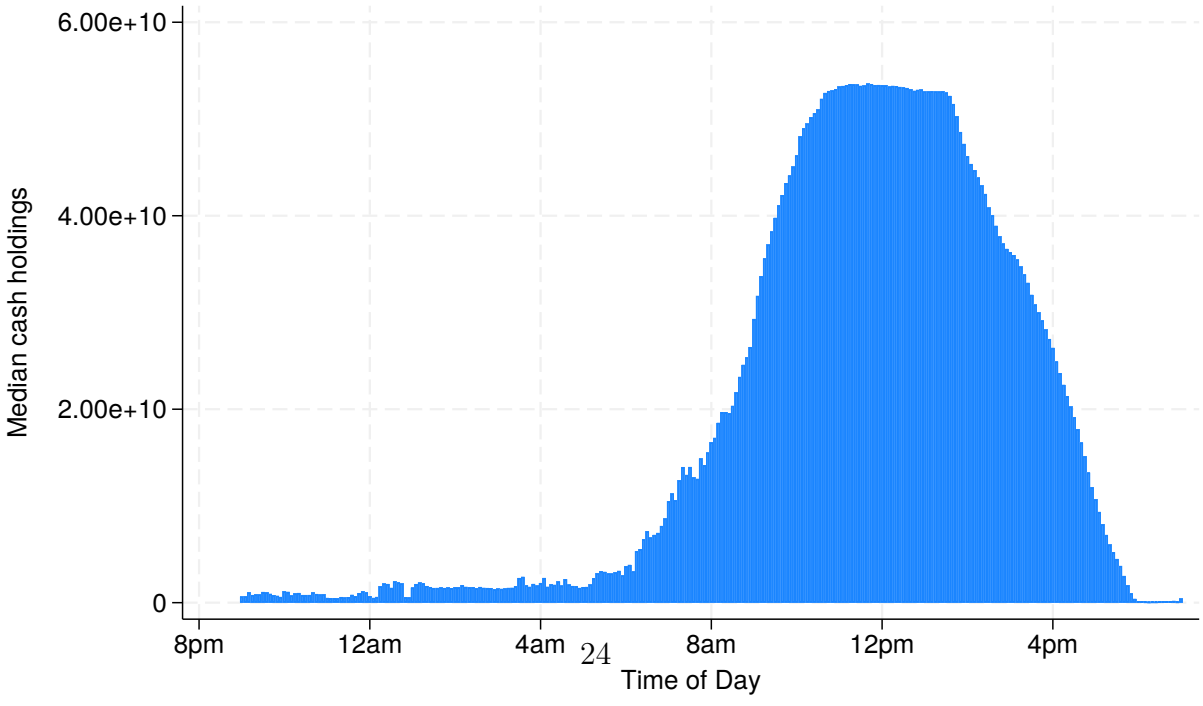
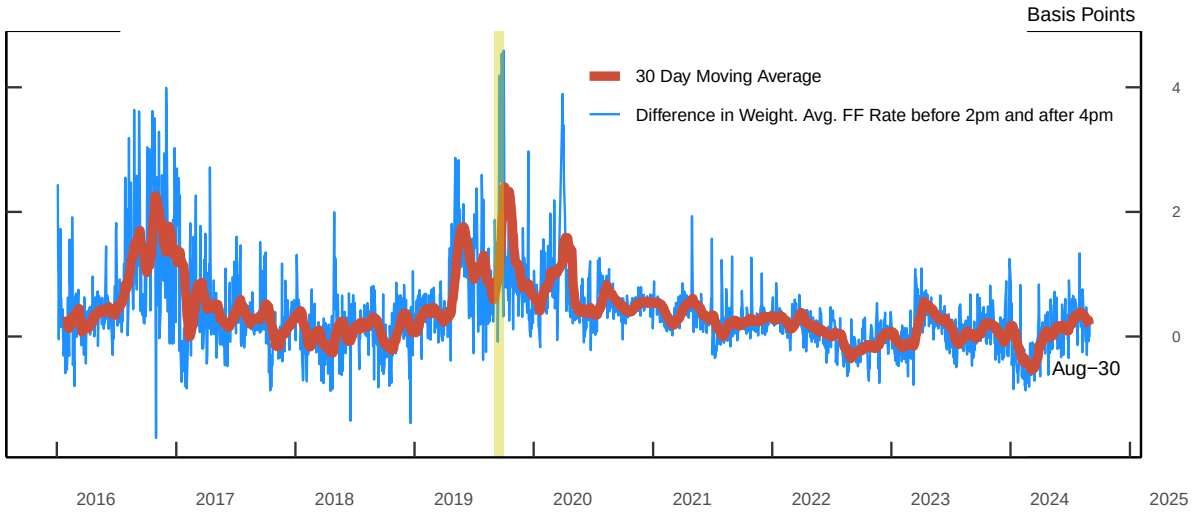


Figure 4: The late-loan spread

This figure shows the average daily spread between fed funds loans from FHLBs made after 4 p.m. and loans from FHLBs made before 2 p.m. The underlying data comes from Form FR2420 and Fedwire.



Source: FR 2420, FedWire.
Note: Shaded area spans September 2019.

Figure 5: FHLBs' lending and time of the day

This figure shows the distribution of FHLBs' lending during the trading day over time. The y-axis shows the time of the day when on a given day 25% (blue), 50% (red), 75% (green), and 90% (yellow) have been lend out. The underlying data comes from Form FR2420 and Fedwire.

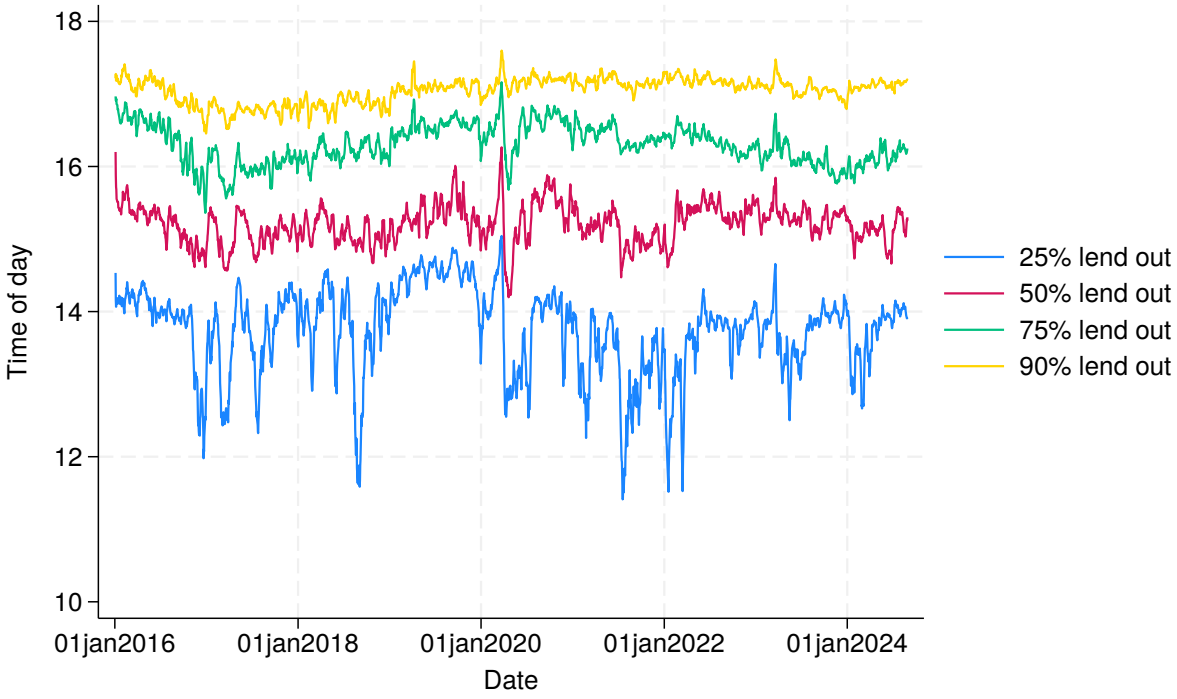
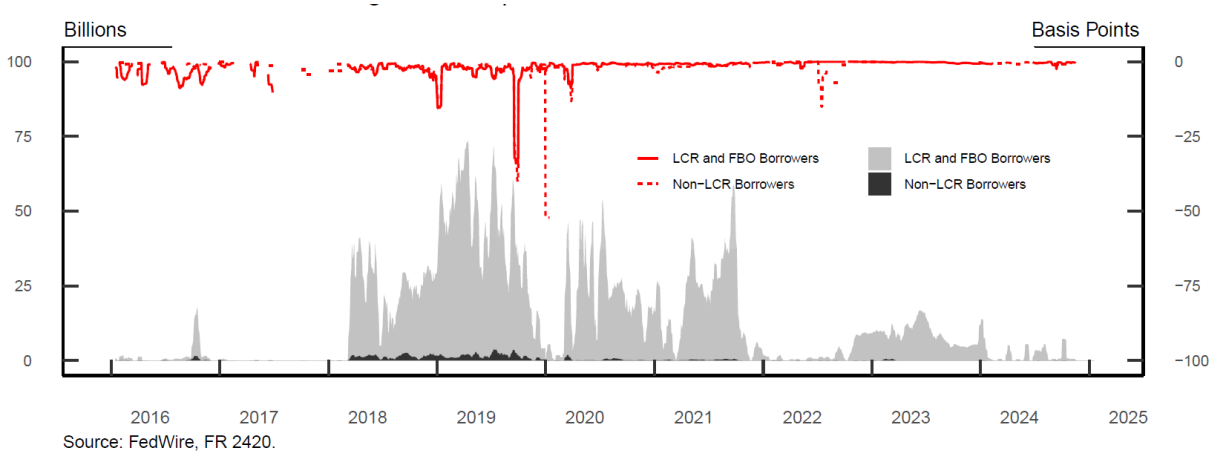


Figure 6: FHLB lending below repo

This figure shows the fed funds lending done by FHLBs at fed funds rates below their respective repo rates. Panel A shows daily lending volume and Panel B shows the share of the lending volume done below repo of total fed funds volume. Both graphs depict FHLB lending to foreign banks and LCR banks (grey), domestic non-LCR banks (black) and the volume weighted average spread between the fed funds rates and the repo rates (red). The underlying data comes from Form FR2420 and Fedwire.

(a) Volume



(b) Share of fed funds volume

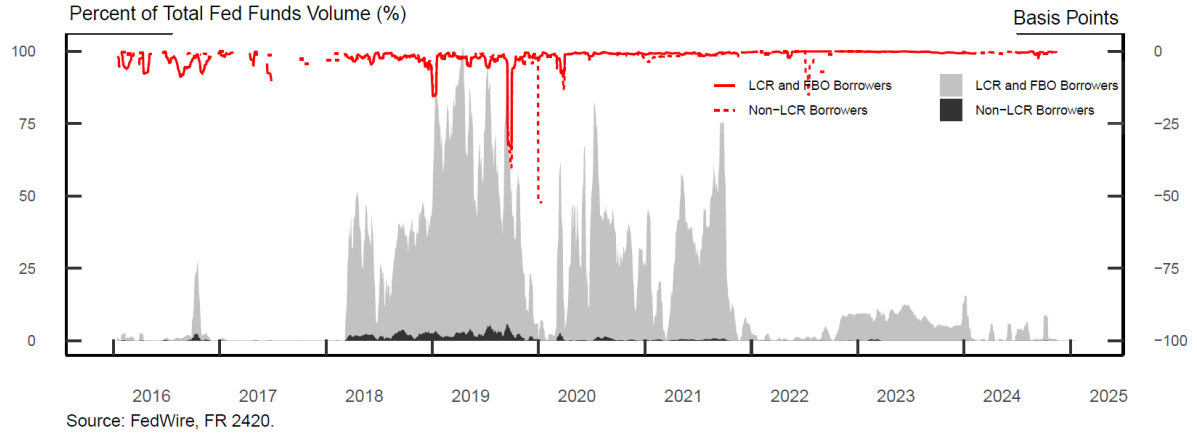


Figure 7: FHLB lending below repo at stale rates

This figure shows the fed funds lending done by FHLBs at fed funds rates below their respective repo rates at the same rates than the previous day. The figure shows daily lending volume and depicts FHLB lending to foreign banks and LCR banks (grey), domestic non-LCR banks (black) and the volume weighted average spread between the fed funds rates and the repo rates (red). The underlying data comes from Form FR2420 and Fedwire.

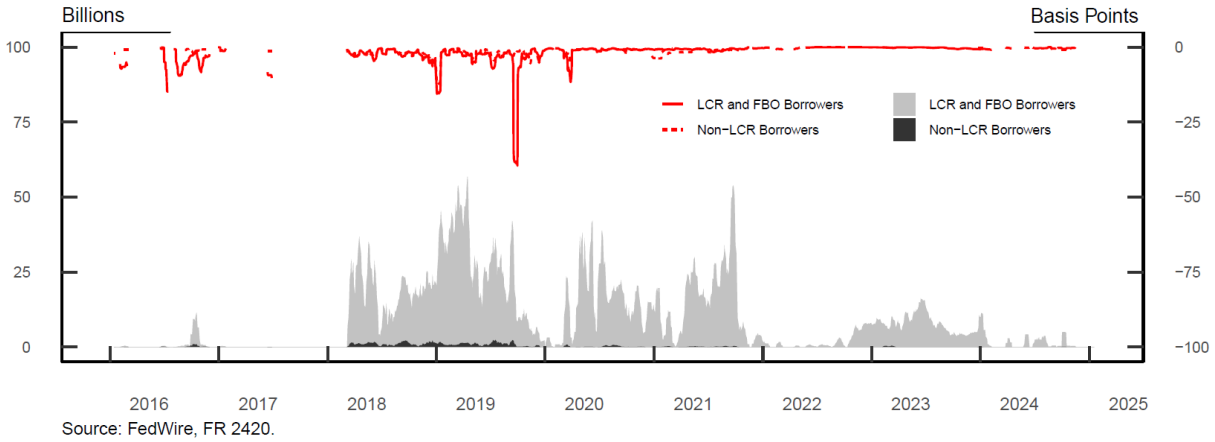


Table 1: Summary statistics

This table provides the summary statistics of the main variables used in this paper. For each variable, the table shows the number of observations, mean, standard deviation, and median. Columns 1-4 restrict the sample to domestic banks subject to LCR and foreign banks, columns 5-8 restrict the sample to domestic banks not subject to LCR. The sample period is from xx to xx.

Panel A: Transaction level

	LCR and foreign banks				Domestic non-LCR banks			
	n	mean	sd	p50	n	mean	sd	p50
FF spread	105788	-0.05	0.04	-0.07	15729	-0.04	0.06	-0.05
Late loan	105788	0.28	0.44	0.00	15729	0.11	0.31	0.00
Repo spread	105788	-0.07	0.05	-0.07	15729	-0.08	0.06	-0.10
Early repay	105788	0.10	0.30	0.00	15729	0.02	0.13	0.00
Abs log loan	105788	0.17	0.32	0.00	15729	0.07	0.20	0.00
log(loan)	105788	6.45	0.60	6.51	15729	5.25	0.61	5.30
Large cash outflow	105788	0.32	0.47	0.00	15729	0.42	0.49	0.00
log(cash out)	105788	19.35	1.22	19.38	15729	19.54	1.04	19.59
log(cash to bank)	105788	19.13	1.25	19.17	15729	19.38	1.05	19.44
log(cash to FHLB)	105788	4.42	6.40	0.00	15729	3.13	5.42	0.00

Panel B: Monthly level

	LCR and foreign banks				Domestic non-LCR banks			
	n	mean	sd	p50	n	mean	sd	p50
FF spread	4197	-0.05	0.05	-0.06	1883	-0.04	0.06	-0.05
Small bank	4197	0.00	0.00	0.00	1883	1.00	0.00	1.00
LCR bank	4197	0.68	0.47	1.00	1883	0.00	0.00	0.00
FBO	4197	0.32	0.47	0.00	1883	0.00	0.00	0.00
log(avg loan)	4197	6.14	0.56	6.20	1883	5.19	0.55	5.23
CV	4197	0.26	0.21	0.24	1883	0.15	0.18	0.06
Loan to capital ratio	4197	0.06	0.08	0.03	1883	0.09	0.05	0.07

Table 2: The effects of FHLBs' liquidity needs on the fed funds market

This table reports the results of the regression $y_{fbt} = \beta LargeCashOutflow_{ft} + \alpha_f + \gamma_b + \delta_t + \epsilon_{fbt}$, where the dependent variable y_{fbt} is either the log loan volume (columns 1-3) or the fed funds - IORB spread (columns 4-6) of a transaction between FHLB f and bank b on day t. $LargeCashOutflow_{ft}$ is a dummy that is 1 if FHLB f has a cash outflow on day t that is more than 1 standard deviation of its average cash outflow for the prior year. By including $alpha_f$, γ_b, and δ_t we allow for heterogeneity across lenders, borrowers, and days. Standard errors are clustered at the borrower-lender level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep.var.	log(loan)	log(loan)	log(loan)	FF spread	FF spread	FF spread
Large cash outflow	-0.0189***	-0.0423*	-0.0438**	0.0013***	0.0004**	0.0001
	(0.0053)	(0.0192)	(0.0196)	(0.0001)	(0.0001)	(0.0001)
Observations	167,682	167,680	157,685	167,682	167,680	157,685
R-squared	0.0816	0.3741	0.5287	0.8339	0.8766	0.9655
Time FE	✓	✓	-	✓	✓	-
Lender FE	-	✓	✓	-	✓	✓
Borrower FE	-	✓	-	-	✓	-
Borrower-Time FE	-	-	✓	-	-	✓

Table 3: FHLBs, the timing of their lending, and the late-loan spread

This table reports the results of the regression $y_{ft} = \beta x_{ft} + \alpha_f + \delta_t + \epsilon_{ft}$ where $y_{ft} = TimeOfDay^i_{ft}, i = (25, 50, 75, 90)$ is the time of the day (in U.S. East Coast Standard time) when i percent of the day's total lending by FHLB in the fed funds market are done in Panel A and $y_{ft} = LateLoanSpread_{ft}$ is the volume-weighted average spread between loans made after 4pm and before 2pm by FHLB f on day t in Panel B, x_{ft} is a specific measure of cash flows to and from FHLB f at day t, and all specifications control for lender, borrower, and time fixed effects. In Panel A and Panel B column 1, $x_{ft} = LargeCashOutflow_{ft}$, a dummy that is 1 if FHLB f has a cash outflow on day t that is more than 1 standard deviation of its average cash outflow for the prior year. In Panel B column 2, $x_{ft} = log(cashout)_{ft}$, the logarithm of all cash outflows except overnight lending from FHLB f on day t. In column 3, $x_{ft} = log(\text{cash out to bank})_{ft}$, the logarithm of all cash outflows except overnight lending from FHLB f to member banks on day t. In column 4, $x_{ft} = log(\text{cash out to FHLB})_{ft}$, the logarithm of cash outflows from FHLB f to other FHLBs. All standard errors are clustered at the lender level. *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Traded volume and time of the day

	(1)	(2)	(3)	(4)
Dep.var.:	Time(25%)	Time(50%)	Time(75%)	Time(90%)
Large cash outflow	0.1947**	0.1661**	0.1421**	0.0449
	(0.0761)	(0.0678)	(0.0669)	(0.0640)
Observations	1,673	2,600	2,985	2,824
R-squared	0.8370	0.7223	0.5477	0.5251
Time FE	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓

Panel B: Late-loan spread

	(1)	(2)	(3)	(4)
Dep.var.:	Late -loan spread			
Large cash outflow	-0.0008**			
	(0.0004)			
log(cash out)		-0.0007***		
		(0.0003)		
log(cash out to bank)			-0.0006***	
			(0.0002)	
log(cash out to FHLB)				-0.0000
				(0.0000)
Observations	8,718	8,718	8,718	8,718
R-squared	0.7129	0.7132	0.7130	0.7128
Time FE	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓

Table 4: The value of flexibility

This table reports the results of the regression $Spread_{fbd} = \beta Abs(\Delta log(loan))_{fbd} + X_{fbd} + \epsilon_{fbd}$, where $Spread_{fbd}$ is the spread over IORB of the rate on a fed funds loan made by FHLB f to borrower b during day d. $Abs(\Delta log(loan))_{fbd}$ is the absolute log change in loan volume between $d-1$ and d for borrower b and lender f. The matrix X_{fbd} consists of several fixed effects for time (column 1), borrower, lender (column 2), borrower-time (column 3), and lender-time (column 4). All standard errors are clustered at the borrower-lender level. *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Flexibility, late loans, and volume

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Late loan	Late loan	Late loan	log(loan)	log(loan)
Abs log loan	0.1525***	0.1446***	0.1482***	-0.3499***	-0.3241***
	(0.0150)	(0.0162)	(0.0189)	(0.0208)	(0.0252)
Abs log loan × Repo spread					0.4367*
					(0.2469)
Constant	0.2501***	0.2508***	0.2570***	6.5051***	6.5050***
	(0.0146)	(0.0144)	(0.0163)	(0.0154)	(0.0154)
Observations	106,763	105,639	99,028	106,763	106,199
R-squared	0.3025	0.4505	0.4477	0.4256	0.4258
Time FE	✓	-	-	✓	✓
Lender FE	✓	-	✓	✓	✓
Borrower FE	✓	✓	-	✓	✓
Borrower-Time FE	-	-	✓	-	-
Lender-Time FE	-	✓	-	-	-

Panel B: Flexibility and the fed funds spread

	(1)	(2)	(3)	(4)
Dep.var: FF spread				
Abs log loan	-0.0043***	-0.0017***	-0.0005**	-0.0023***
	(0.0008)	(0.0004)	(0.0002)	(0.0004)
Constant	-0.0528***	-0.0532***	-0.0533***	-0.0531***
	(0.0008)	(0.0002)	(0.0002)	(0.0002)
Observations	106,763	106,763	99,028	105,639
R-squared	0.8501	0.8954	0.9750	0.9140
Time FE	✓	✓	-	-
Lender FE	-	✓	✓	-
Borrower FE	-	✓	-	✓
Borrower-Time FE	-	-	✓	-
Lender-Time FE	-	-	-	✓

Table 5: Fed funds spreads and late loans

This table reports the results of the regressions $FF_{fbd} = \beta LateLoan_{fbd} + X_{fbd} + \epsilon_{fbd}$ and $FF_{fbd} = \beta_1 LateLoan_{fbd} + \beta_2(LateLoan_{fbd} \times Repo_{fd}) + \epsilon_{fbd}$, where FF_{fbd} is the spread over IORB of the rate on a fed funds loan made by FHLB f to borrower b during day d. $LateLoan_{fbd}$ is a dummy that is 1 if that loan was made after 4pm. $Repo_f d$ is the spread between FHLB f's repo rate on day d over IORB. The matrix X_{fbm} consists of several fixed effects for time (columns 1-2), borrower, lender (columns 3-4), borrower-time (columns 5-6), and lender-time (columns 7-8). All standard errors are clustered at the borrower-lender level. All standard errors are clustered at the borrower-lender level. *** p<0.01, ** p<0.05, * p<0.1. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep.var.:	FF spread							
Late loan	-0.0041***	-0.0093***	-0.0022***	-0.0066***	-0.0010***	-0.0025***	-0.0026***	-0.0079***
	(0.0009)	(0.0013)	(0.0005)	(0.0008)	(0.0003)	(0.0004)	(0.0005)	(0.0010)
Late loan ×		-0.0812***		-0.0688***		-0.0234***		-0.0869***
Repo spread		(0.0152)		(0.0128)		(0.0043)		(0.0152)
Constant	-0.0509***	-0.0509***	-0.0515***	-0.0515***	-0.0516***	-0.0516***	-0.0513***	-0.0514***
	(0.0008)	(0.0008)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Observations	167,682	166,977	167,680	166,975	157,685	157,021	166,920	166,219
R-squared	0.8353	0.8369	0.8769	0.8779	0.9655	0.9656	0.9005	0.9018
Time FE	✓	✓	✓	✓	-	-	-	-
Lender FE	-	-	✓	✓	✓	✓	-	-
Borrower FE	-	-	✓	✓	-	-	✓	✓
Borrower-Time FE	-	-	-	-	✓	✓	-	-
Lender-Time FE	-	-	-	-	-	-	✓	✓

Table 6: Borrower characteristics and rates: Small and large banks

This table reports the results of the following regression: $FF_{fbm} = \beta X_{fbm} + \alpha_f + \gamma_b + \epsilon_{bsm}$, where the dependent variable FF_{fbm} is the average fed funds lending rate over IORB between borrower b and lender f during month m. For columns 1 to 4, the vector X_{fbm} is a set of dummies $small_b$, which is 1 if borrower b is a domestic bank not subject to LCR, and LCR_b, which is 1 if borrower b is a domestic bank subject to LCR. In columns 5 and 6, X_{fbm} is the average daily loan size between borrower b and lender f during month m. All standard errors are clustered at the borrower-lender level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep.var.: FF-IORB spread						
Small domestic	0.0213***	0.0202***	0.0214***	0.0192***		
	(0.0032)	(0.0029)	(0.0036)	(0.0029)		
LCR domestic	0.0049***	0.0048***	0.0039***	0.0047***		
	(0.0011)	(0.0011)	(0.0015)	(0.0011)		
Avg loan volume					-0.0045***	0.0010
					(0.0011)	(0.0007)
Constant	-0.0514***	-0.0513***	-0.0539***	-0.0511***	-0.0204***	-0.0557***
	(0.0006)	(0.0006)	(0.0008)	(0.0007)	(0.0067)	(0.0043)
Sample	All	All	> 9 days	All	All	Large
Observations	18,698	18,698	9,711	18,698	18,698	16,345
R-squared	0.8505	0.8552	0.8834	0.8677	0.8427	0.8717
Time FE	✓	✓	✓	-	✓	✓
Lender FE	-	✓	✓	-	✓	✓
Lender-Time FE	-	-	-	✓	-	-

Table 7: Borrower characteristics and rates: Capacity

This table reports the results of the following regression: $FF_{fbm} = \beta X_{fbm} + \alpha_f + \gamma_b + \delta_m + \rho_{bm} + \epsilon_{bsm}$, where the dependent variable FF_{fbm} is the average lending rate over IORB between borrower b and FHLB f during month m. $x_{bfm} = LoanToCapitalRatio_{fbm}$, the ratio of a borrower b's average daily fed funds borrowing from lender f to its Tier 1 capital during month m. All standard errors are clustered at the borrower-lender level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep.var.:		*FF spread*			*Late loan*	
Loan to capital	0.0166***	0.0179**	0.0188**	-0.3754**	-1.0880**	-0.3984**
	(0.0063)	(0.0088)	(0.0073)	(0.1630)	(0.4823)	(0.1679)
Constant	-0.0498***	-0.0496***	-0.0498***	0.2933***	0.3293***	0.2937***
	(0.0005)	(0.0005)	(0.0005)	(0.0133)	(0.0270)	(0.0132)
Observations	5,506	5,257	5,428	5,506	5,257	5,428
R-squared	0.9074	0.9585	0.9244	0.3555	0.5154	0.4951
Time FE	✓	-	-	✓	-	-
Lender FE	✓	✓	-	✓	✓	-
Borrower FE	✓	-	✓	✓	-	✓
Borrower-Time FE	-	✓	-	-	✓	-
Lender-Time FE	-	-	✓	-	-	✓

Table 8: Loan characteristics: Early repayment

This table reports the results of the regression $Spread_{fbd} = \beta EarlyRepayment_{fbd} + X_{fbd} + \epsilon_{fbd}$, where $Spread_{fbd}$ is the spread over IORB of the rate on a fed funds loan made by FHLB f to borrower b during day d. $EarlyRepayment_{fbd}$ is a dummy that is 1 if the transaction between lender f and borrower b on day $d-1$ is repaid among the first 10$ of all loans on day d. The matrix X_{fbd} consists of several fixed effects for time (column 1), borrower, lender (column 2), borrower-time (column 3), and lender-time (column 4). All standard errors are clustered at the borrower-lender level. All standard errors are clustered at the borrower-lender level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
Dep.var.: FF-IORB spread				
Early repayment	-0.0044***	-0.0016***	-0.0002	-0.0017**
	(0.0015)	(0.0005)	(0.0003)	(0.0007)
Constant	-0.0517***	-0.0520***	-0.0519***	-0.0519***
	(0.0007)	(0.0002)	(0.0002)	(0.0002)
Observations	167,050	167,048	157,151	166,259
R-squared	0.8344	0.8766	0.9655	0.9002
Time FE	✓	✓	-	-
Lender FE	-	✓	✓	-
Borrower FE	-	✓	-	✓
Borrower-Time FE	-	-	✓	-
Lender-Time FE	-	-	-	✓

Table 9: Coefficient of variation as different measure of flexibility

This table reports the results of the following regression: $LateLoan_{fbm} = \beta x_{fbm} + \alpha_f + \gamma_b + \delta_m + \rho_{bm} + \epsilon_{bsm}$, where the dependent variable $LateLoan_{fbm}$ is the share of loans between borrower b and FHLB f during month m that was made after 4pm. In columns 1-3, $x_{fbm} = LoanToCapitalRatio_{fbm}$, the ratio of borrower b's average daily fed funds borrowing from lender f to its Tier 1 capital during month m. In columns 4-6, $x_{fbm} = CV_{fbm}$, the standard deviation of borrower b's borrowing from FHLB f during month m normalized by the average daily borrowing of b from f. All standard errors are clustered at the borrower-lender level.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep.var.:		*FF spread*			*Late loan*	
CV	-0.0067***	-0.0029***	-0.0083***	0.2678***	0.2382***	0.2573***
	(0.0010)	(0.0007)	(0.0010)	(0.0284)	(0.0338)	(0.0299)
Constant	-0.0485***	-0.0495***	-0.0481***	0.2389***	0.2487***	0.2416***
	(0.0003)	(0.0002)	(0.0003)	(0.0127)	(0.0145)	(0.0129)
Observations	13,638	13,239	13,638	13,638	13,239	13,638
R-squared	0.9298	0.9772	0.9377	0.3692	0.5074	0.4578
Time FE	✓	-	-	✓	-	-
Lender FE	✓	✓	-	✓	✓	-
Borrower FE	✓	-	✓	✓	-	✓
Borrower-Time FE	-	✓	-	-	✓	-
Lender-Time FE	-	-	✓	-	-	✓