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**Mark Carlson and Mary-Frances Styczynski**

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# Discount window borrowing and the role of reserves and interest rates

Mark Carlson and Mary-Frances Styczynski*

The Federal Reserve's discount window is a tool that can provide reserves to banks at a rate set by the Federal Reserve, the discount rate. During the past several years, there have been large fluctuations in the level of reserves in the banking system and in the level discount rate relative to other interest rates. In this paper, we explore how banks' holdings of reserves, especially relative to the amount of reserves that banks prefer to hold, and the interest rate available at the discount window influence borrowing at the window. We find that banks borrow more when their reserves are low and when the discount rate is relatively attractive, although the size of these effects depends on a bank's size, FHLB membership status, and financial condition.

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* Carlson: Mark.a.carlson@frb.gov.
Styczynski: mary-frances.styczynski@frb.gov.
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The discount window is a tool that the Federal Reserve uses to lend to depository institutions and provide them with reserves. The willingness of depository institutions to obtain reserves from the discount window influences the effectiveness of the window in responding to tightness in bank funding markets and ensuring the smooth operation of the banking system (Clouse 1994, 2000). Of course, depository institutions may obtain reserves and short-term funding from other sources, and their preference for using those other sources versus the discount window depends on, among other things, the relative price of doing so.

This paper investigates the extent to which the use of the discount window by banks is affected by the reserve holdings of the banks, especially when compared to levels that they appear to prefer to hold, and the interest rate at the discount window compared to interest rates on other source of funds, such as from the Federal Home Loan Banks (FHLBs).[1] In particular, we analyze whether bank borrowing during a particular week is related to the reserves held at the start of the week and the prevailing interest rates. We focus on these two items as they are relatively high frequency; as most discount window borrowing is overnight it is presumably related to current conditions at the bank and in money markets as might best be captured by higher frequency measures. We consider this question during the period from 2016 to 2024. This was a period in which the level of reserves changed notably and in which the primary credit rate, the interest rate on the Federal Reserve's main lending facility varied fairly substantially. These changes occurred as the stance of monetary policy changed, as well as in response to financial market stresses, such as those associated with the onset of the Covid-19 pandemic and public health response to stop its spread, in which the Federal Reserve sought to ensure that the financial system had access to liquidity.

We find, not too surprisingly, that both interest rates and bank holdings of reserves mattered. However, the fairly high sensitivity we find is notable. Indeed, with respect to interest rates, we find sharp shifts in borrowing responsiveness as the primary credit rate becomes just slightly more attractive than other interest rates. We also find that borrowing decisions are quite responsive to the extent to which the level of reserves the bank is holding at the start of the week is above or below the average level of reserves that the bank had been holding over the preceding four months. In addition, it is notable that we find that reserves matter at all given the abundant level of reserves that prevailed for much of our sample period.

In addition, we are able to explore whether the responsiveness to interest rates and reserve levels varies over sub-sample periods and for different groups of banks. Medium sized banks—those with assets between $1 billion and $10 billion—are the most responsive to the developments regarding reserves. Larger banks are particularly responsive to relative interest rates. FHLB member banks are more responsive to the primary credit rate relative to the rates offered by the FHLBs, though the difference in responsiveness is not as substantial

[1] The institutions eligible to borrow at the discount window are depository institutions, which include commercial banks, credit unions, branches and agencies of foreign banks. The analysis in this paper focuses specifically on commercial banks, savings and loan institutions and U.S. branches and agencies of foreign banks. Credit unions are excluded from the analysis.

as one might have expected. We also find evidence consistent with the idea that banks borrow overnight to adjust reserve positions, but use term primary credit for other reasons.

We are able to aggregate our results to the level of the banking system. That allows us to connect the aggregate level of reserves to the number of banks that borrow in a particular week. We start by first verifying that institutions are more likely to end up having lower levels of reserves relative to the average levels that they had held on average during the preceding four months when reserves are lower relative to banking system deposits. We then estimate the relationship between the number of depository institutions that borrow in a particular week to the level of reserves and the relative attractiveness of the discount window. We find that this simple model does provide a general indication of the number of banks likely to borrow.

These findings complement previous research on the factors affecting bank decisions about borrowing from the discount window. For instance, using quarterly Call Report data, Ennis and Klee (2024) find that banks that hold less reserves relative to their assets borrow more in normal times. Findings that borrowing is related to both low level of reserves relative to assets and relative to recent levels of reserve holdings provide complementary, but differing, lens on how the availability of reserves shapes borrowing. Other studies, such as Ashcraft, Bech and Frame (2010) find that interest rates mattered during stress; we find that they mattered during the normal course of business as well. Finally, our findings that reserves matter suggest that something like the borrowing functions relating reserves and money supply to discount window use estimated by Goldfeld and Kane (1966), Dutkowsky (1993), and Dow (2001) still matter, even with the level of reserves being substantially larger than had been the case prior to 2008.

The paper proceeds as follow. Section 2 provides background on the discount window and discusses related literature. Section 3 describes the data we use and presents the analysis of the factors influencing borrowing by individual banks. Section 4 discusses aggregating the analysis to the system level. Section 5 concludes.

## Section 2. Background and related literature

### *Section 2.1 Background on the discount window*

The discount window can be used to lend reserves to depository institutions (DIs). All discount window loans are initiated at the request of the depository institution. When extending a loan, the Federal Reserve simply credits the account that the DI maintains at the Federal Reserve. Those additional reserves may be used by the DI to make payments. All discount window loans must be secured to the satisfaction of the lending Reserve Bank; many bank assets are eligible to serve as collateral, including many types of loans and most investment-grade securities.

There are three discount window lending programs. The main lending program, and the focus of this paper, is the primary credit program. Primary credit is available to DIs that are in generally sound financial condition. Secondary credit provides loans to DIs that are not eligible for primary credit. Seasonal credit is available to smaller DIs that demonstrate considerable seasonal volatility in their balance sheets.

There have been a variety of changes to the terms on primary credit loans since 2016. The interest rate charged on primary credit loans is the primary credit rate. That rate moves as the Federal Reserve adjusts the stance of monetary policy. In 2016, that rate was set 50 basis points above the top of the range that the Federal Reserve maintains for the target for the federal funds rate (that target is the main reference point when setting monetary policy) and the rate would move up or down as the target for the federal funds rate was changed. In March 2020, during the financial turmoil associated with the onset of the Covid-19 pandemic, the primary credit rate was adjusted so that it was positioned at the top of the range for the target federal funds rate. That eased access to liquidity and contributed to easing financial market stresses.

The maximum maturity of primary credit loans has also been increased. In 2016, there was a strong presumption that primary credit loans would be overnight. In March 2020, in addition to reducing the primary credit rate, the Federal Reserve announced that DIs would be able to borrow from the discount window for periods as long as 90 days.

The primary credit rate is a floating rate. So if an DI has a term discount window loan and the Federal Reserve raises the primary credit rate while that loan is outstanding, the interest rate the DI pays will reflect the earlier rate for the days the loan was outstanding prior to the change in the rate and the new rate while the loan is outstanding following the rate change.[2] Discount window loans are pre-payable so that the DI can repay the loan if the new primary credit rate is unattractive.

*Section 2.2 Background on reserves*

While the discount window is one way that the Federal Reserve provides reserves to the banking system, it is not the only source. When the Federal Reserve conducts open market operations and purchases Treasury or agency securities, that increases the amount of reserves in the system. Since the Global Financial Crisis in 2008, the Federal Reserve has supplied a large amount of reserves to the banking system. This generally abundant level has kept money market rates, including the effective federal funds rate, in the vicinity of the interest rate that the Federal Reserve pays on the balances that banks leave in their accounts at the Federal Reserve.

Between 2016 and 2019, the Federal Reserve was reducing the amount of reserves in the system. In 2019, the Federal Reserve stopped reducing the amount of reserves and began

[2] We considered the role of expectations about the path of interest rates into the analysis by looking at whether the inclusion of overnight index swap rates with three-month maturities provided additional information. However, we did not find any evidence that it did.

to hold that amount roughly steady. During the pandemic, and to provide liquidity support to the banking system and to ease monetary conditions to support the economy, the Federal Reserve purchased a substantial amount of securities and notably increased the supply of reserves in the system. Since 2021, the Federal Reserve has once again begun reducing the reserves.

DIs in need of reserves are able to obtain them from other DIs (by trading in the federal funds market) or from other providers. (Several government sponsored enterprises, including the Federal Home Loan Banks, hold account balances at the Federal Reserve and are able to lend them to DIs in the federal funds market.) When reserves are more plentiful, DIs in need of reserves may more easily borrow them for other private sector actors. When reserves are scarcer, DIs in need would be less able to borrow them from others and are more likely to have to turn to the Federal Reserve.

*Section 2.3 Related literature*

A range of factors have been found in the literature to influence discount window borrowing. One strand of relevant research has found that interest rates have also played a role in shaping borrowing. For instance, Ashcraft, Bech, and Frame (2010) find that borrowing at the discount window increased notably in 2008 when rates on FHLB advances moved above the primary credit rate. That finding suggests that depository institutions are sensitive to how the pricing of the discount window compares to close substitutes. That this finding is related to FHLB rates is an important reason that we compare the primary credit rate to FHLB advance rates in this analysis.

The level of reserves is likely to matter. Ackon and Ennis (2017) note that borrowing was less frequent in the years after the Global Financial Crisis, when reserves were more plentiful, than the years preceding it. However, they note that a number of other aspects of the financial landscape had changed as well. In their analysis of bank level determinants of borrowing, Ennis and Klee (2024) find that banks that hold fewer reserves as a share of their assets, as indicated in the quarterly Call Reports, were more likely to borrow, although Ennis and Klee note that this effect is fairly modest in magnitude.[3] These findings provide one motivation for the analysis in this paper that looks at more high frequency data on reserves. Ennis and Klee look at other bank balance sheet items and find that banks that rely on less stable funding sources and that have riskier and more illiquid assets are more likely to use the discount window. They further find that banks that use the discount window are more likely to also borrow from the FHLBs; that finding again supports our comparison of the primary credit rate to interest rates on FHLB advances. Finally, they find that use varies by bank size with larger banks, all else equal, being more likely to borrow from the discount window than smaller banks.

[3] Moreover, Ennis and Klee find that banks that gain access to the discount window tend to increase their level of reserves. That suggests it is not the case that banks reduce reserve holdings because of better access provided by the discount window.

There is a fair-sized literature on the relationship between discount window borrowing, money market interest rates, and reserves prior to 2002 and the adoption of an above market discount window rate with the introduction of primary credit. This relationship was often referred to as the borrowing function and was studied by, among others, Goldfeld and Kane (1966), Thornton (1988), Dutkowsky (1993), and Dow (2001). This research also noted that that borrowing should be higher when reserves were scarce and when interest rates in private markets were, or were expected to be, higher. We build on this analysis by examining whether the availability of reserves matters even when there are more substantial levels of reserves in the banking system.

One reason that DIs may opt not to borrow from the discount rate is concerns about possible reputational risks associated with doing so, this is often referred to as discount window stigma. Since the discount window is typically above private money market rates, market participants may wonder why an institution has chosen to borrow from the window. They may reason that the institution was unable to obtain funds in the private market, possibly because the institution was troubled. The further the discount rate is set above private market rates, the more market participants may be curious about the decision to borrow. Conversely, when the discount window rate is close to market rates, market participants are less likely to view borrowing as exceptional. Hence we might expect to see an increase in borrowing at times when the discount rate moves below market rates. (See Carlson and Rose (2017) and Armantier, Cipriani, and Sarkar (2024) for a further discussion of stigma.[4]) While it is important to keep in mind that these stigma issues provide an important backdrop for discussions of discount window use, this analysis does not provide any direct evidence on their size or effect.

**Section 3. Analysis of bank level data**

We are interested in whether discount window borrowing decisions are related to the level of reserves and how the primary credit interest rates compares to other interest rates. As noted above, these two variables are available at a relatively high frequency. Since borrowing is typical overnight and most banks do not seek to roll that funding over, looking at higher frequency indicators of factors that would shape borrowing decisions is valuable.

Even so, when considering borrowing, we look to see if a bank borrows during a particular week, measured on a Thursday to the following Wednesday basis. This aggregation facilitates connections to the aggregate levels of reserves discussed in Section 4. Using daily observations provides very similar results.

[4] As noted by Kleymenova (2016), the disclosure of discount window borrowing likely matters. Following the passage of the Dodd-Frank Act, the Federal Reserve began to disclose the names of discount window borrowers with a two-year lag. The Federal Reserve also publishes its weekly balance sheet, including Federal Reserve District level data. In 2020, discount window borrowing at the district level was changed from being a separate line item to being included among other items; system level discount window borrowing continued to be a separate lime item. That information shift may have affected discount window stigma.

To conduct our analysis, we combine several public and private data sets to construct a final data set with bank level information for weeks that range from January 2016 to March 2024.[5] A week runs from a Thursday to the following Wednesday. The panel is not balanced; banks come in and out of the panel based on their life cycle. Overall, there are approximately 5,000 banks in our sample made up of commercial banks, savings and loan institutions, and U.S. branches and agencies of foreign banks.[6]

Lending data are available daily from internal Federal Reserve records.[7] Lending data focuses on non-test loans made via the primary credit facility of the discount window.[8] For each loan, we have information on the amount of loan outstanding, the rate at which it was lent, and the term of the loan. Summary statistics regarding borrowing, as well as all other data, are available in Table 1.

*Section 3.1 Interest rates metrics*

Constructing a measure of the relative attractiveness of the primary credit rate is fairly straightforward, we simply calculate a spread between the primary credit rate and other interest rates. Based on results in previous literature highlighting the role of the FHLBs, we focus on how the primary credit rate compares to the rate offered by the FHLBs and in particular, due to the availability of a historical time series, the rate offered by the Des Moines. Data on the primary credit rate is available daily and is based on the rate set for the Federal Reserve Bank of New York.

We look at the spread for two maturities. Most primary credit loans have an overnight maturity so we look at the spread between the primary credit rate and the overnight FHLB rate. The evolution of the spread between the primary credit rate and the overnight FHLB advance rate is shown in Figure 1. Negative spreads indicate that the primary credit rate is more attractive. The reduction in the primary credit from being 50 basis points above the top of the target rate to being set at the top of the target range is an important shift in the attractiveness of primary credit. However, there is still considerable variation over time. We conduct some sensitivity tests with respect to this policy shift below.

In addition, we consider the spread between the primary credit rate and the three-month FHLB rate. Following March 2020, there was an announcement that DIs were able to borrow from the discount window for periods as long as 90 days. Hence a comparison of term rates also seems appropriate. Even though there was a shift in the Federal Reserve stance on term discount window loans in March 2020, we include this spread throughout as some DIs that needed funds may have compared the prospect of using the discount window, perhaps rolling credit over a few times, to borrowing for a few months from an FHLB.

[5] Banks cover U.S. commercial banks, U.S. branches and agencies of foreign banks, and savings and loan institutions. Credit unions are excluded from the analysis.
[6] Credit unions are excluded from this analysis, but they are considered DIs that are eligible to use primary credit.
[7] Primary credit data are sourced from ARC and reserve balances are from the NRBL data series in FDR.
[8] A non-test loan is identified at the time the primary credit loan is made.

We use the published FHLB rates. FHLB members receive a dividend from the FHLBs based on the amount that they borrow and the "dividend adjusted rate" would provide a more accurate comparison of interest rates. However, calculation of the dividend adjustment is not straightforward. Moreover, we are already making some generalizations by using the Des Moines rate for all banks when in fact rates may vary across FHLBs. Hence this interest rate spread should be viewed as more indicative rather than as the precise spread differential.

In some analysis, we differentiate between FHLB members and non-members. Data on a bank's membership status with a Federal Home Loan Bank (FHLB) are available point in time from internal Federal Reserve Records.

*Section 3.2 Reserve metrics*

The second factor we consider as a motivator for borrowing is the level of reserves maintained by the bank. Reserve balance data are available daily from internal Federal Reserve records. Reserve balances represent a bank's end-of-day balance in a master account at a Federal Reserve Bank.

Banks that find themselves with insufficient or levels of reserves below what they would like can obtain additional reserves by borrowing at the discount window.[9] However, it can be difficult to determine what level of reserves that bank would prefer to be holding. That level certainly differs across banks and might well change over time.

To get a sense of a bank's preferences for the level of reserves it maintains, we compute the average level of reserves at each bank over 120-day windows (calendar days, not business days) and take this as the preferred level of reserves. This average should reflect the preference of the bank for reserves given its business model without us having to make any assumptions about the factors that determine those preferences. In addition, using these rolling windows allows for those preference to change over time depending on economic conditions as well as respond to changes in the availability of reserves.

We align this data so the last day of this 120-day window is the Wednesday preceding the week over which we will look to see if borrowing occurs (which as before is from Thursday to Wednesday). In some extensions below, we also consider the volatility of reserves, as measured by the standard deviation in the daily level, over the 120-day period. Some banks may have preferences for having large reserve buffers while others may prefer to operate with small buffers. Using the 120-day average as the benchmark against which to compare the current level of reserves should automatically take into account those particular preferences.

[9] For banks that use a correspondent as part of their reserves management, we also tried looking at whether the likelihood of borrowing depended on that correspondent was also short of reserve. However there was not enough borrowing amid these banks to accurately assess whether this relationship mattered.

To get a sense of whether reserves are high or low on the Wednesday at the end of the 120-day window, we compare the reserves on that day to the preferred level of reserves. Thus, for bank *j* on day *t*, the bank-level reserve to preference ratio is:

$$\text{Bank\_reserve\_to\_preference\_ratio}_{j,t} = \frac{reserves_{j,t}}{Average\ reserves_{j,(t-120\ to\ t)}} \quad (1)$$

The reserve to preference ratio is the independent variable that we use in the regressions below. There are some notable outliers when considering the ratios of individuals banks; to limit the impact of these outliers, we winsorize the top and bottom 1 percent of the data.

*Section 3.3 Other items*

Some parts of the analysis include controls for bank size or for adequacy. Information for both these items come from the FFIEC's quarterly reports of condition (Call Reports). Size is measured by total assets. Consideration of the capital adequacy of the banks in our sample is based on the FDIC's Prompt Corrective Action (PCA) categories of well capitalized and adequately capitalized.[10] Since our focus is on primary credit loans, banks will either be well-capitalized or adequately capitalized. The standard metrics for PCA—total risk-based capital ratio, tier 1 risk-based capital ratio, common equity tier 1 capital ratio, and the leverage ratio—are used to determine whether a bank is well capitalized or adequately capitalized.[11] For community banks, these metrics are not always available. So instead, we define a well-capitalized bank as one with a leverage ratio greater than or equal to 9 percent. These metrics are not available for U.S. branches and agencies of foreign banks, so they are excluded from this part of the analysis.

During the sample period there were a few episodes of financial stress. The first was the disruption in financial markets associated with the onset of Covid-19 and the efforts to prevent its spread. Amid that distress, there was more discount window borrowing than usual. A second stress episode occurred in March 2023 following the closure of Silicon Valley Bank. Again discount window borrowing was unusually elevated. We include an indicator variable to indicate that a particular week is one in which there is financial stress. Those stress indicators are set to one during the weeks from March-May 2020 and March-May 2023 and are zero otherwise.

*Section 3.4 Baseline results*

Our baseline regression is a logit regression of whether a bank borrows during a particular week and whether that borrowing is affected by the level of reserves relative to preference, the relative attractiveness of the primary credit rate, and whether the week is one in which there is financial stress. Hence the baseline regression is:

[10] Specifically, we use Schedule RC-R from FFIEC 031, 041, and 051.

[11] We apply the percentages listed in the table on page 3 of Chapter 5 of the FDIC's Formal and Informal Enforcement Actions Manual to the measures found on Schedule RC-R of the Call Reports.

$$\begin{aligned}\text{Bank borrows } [0/1]_{j,t} = \text{function of (constant} \\ + \beta 1 * \text{reserve to preference ratio}_{j,t} \\ + \beta 2 * (\text{primary credit rate}_t - \text{overnight FHLB rate}_t) \\ + \beta 3 * (\text{primary credit rate}_t - \text{90 day FHLB rate}_t) \\ + \beta 4 * \text{financial stress}_t)\end{aligned} \tag{2}$$

where *t* indicates a particular week and *j* denotes a particular bank. The estimation period is again from January 2016 to March 2024.

The baseline results are presented in Table 2 for all banks. We find, unsurprisingly, that banks with higher reserve-to-preference ratios—more reserves than they typically have—are less likely to borrow. A one-percentage point increase in the ratio of reserves on the last day of the observation period relative to the average level over the past 120 days results in a decrease in the probability of borrowing of 0.3 percentage points. As a baseline, 0.6 percent of observations involved borrowing.

The coefficients on the cost of borrowing relative to FHLB rates have the expected signs. Banks are less likely to borrow when the spread between the primary credit rate and the overnight FHLB rate is wider. The coefficients suggest that a 50 basis point reduction in the spread between the primary credit rate and the overnight FHLB advance rate would increase the probability (which might reflect the policy rate change made in 2020) by 0.45 percent. Given the low baseline volume of borrowing, this is again a sizeable effect.

Unsurprisingly, banks are significantly more likely to borrow from the discount window during stress periods when regular funding markets are not necessarily operating smoothly.

*Section 3.5 Extensions of the individual bank analysis*

The baseline results are intuitive and straightforward. To gain additional insights, we extend the analysis in a variety of ways.

Section 3.5.1 Analysis during different subsample periods

The first extension is to consider how the responsiveness of borrowing to reserves and relative interest rates differs during different sample sub-periods.

We start by re-running the baseline regression splitting the sample into two periods: before and after March 2020. As shown in the first two columns of Table 3, the response to the reserve preference ratio is lower than the baseline before March 2020 and higher than the baseline after March 2020. This suggests banks altered how they consider reserve levels when making discount window borrowing decisions. In contrast, the responsiveness to relative interest rates is similar between the two sub-periods. The same interest rate differential in the overnight rate produces the same response in both periods. The responsiveness to the relative

attractiveness at 3-month levels is an outlier. We find that a relatively more attractive primary credit rate has a more substantial effect in increasing the likelihood that a bank borrows after March 2020. This is not surprising since it was only after the onset of Covid that longer-maturity borrowing was more encouraged.

We also consider how the results compare during stress and non-stress periods. As they comprise the bulk of the sample period, the non-stress results in column 5 look very similar to the baseline. We also observe that during panic periods the reserve to preference ratio continues to matter. The responsiveness of borrowing behavior to overnight rates is also different and the sign of the coefficient is unexpected; we attribute this to the fact that short-term funding markets are disrupted at these points in time.

Section 3.5.2 Nonlinearities in borrowing

The second extension explores whether there are nonlinearities with respect to how interest rates affect banks' propensities to borrow. To do this, we calculate deciles of the distributions of each of our three explanatory variables. We then use indicators for a particular explanatory variable being in a decile bin in the baseline regression. (We do this one variable at a time so that two variables remain continuous while the third consists of nine indicator variables; with a middle decile being omitted.) This procedure allows us to see whether there are non-linearities in the response to the different variables. If there are no non-linearities, we should expect the coefficients to change roughly monotonically as we move through the deciles.

The first variable for which we analyze deciles is the ON spread between the primary credit rate and the FHLB overnight advance rate. These results, shown in Table 4, are fully consistent with previous results that when the primary credit rate is more attractive that there is more borrowing. They do suggest though that there is some non-linearity in the relationship. Decile 6 contains the point where the two interest rates are equal. The marginal effects for deciles 4 and 5, which are larger than deciles 1-3, suggest that there is a notable shift in behavior at the point where the discount rate becomes more attractive than the FHLB advance rate while further decreases have only a more modest impact. When looking at the 3-month spread, we find a similar jump in the size of the coefficient in decile 5, when the primary credit rate becomes slightly lower than the FHLB advance rate (Table 5). Otherwise, the coefficients on the different deciles show a more linear progression.

The relationship of different deciles of the reserve-to-preference ratio and borrowing are shown in Table 6. The coefficients indicate how the likelihood of borrowing when that ratio is in a particular decile compares to the likelihood of borrowing when in the omitted decile (the 5$^{th}$ decile). As might be expected, banks in the lowest decile (reserves are close to zero) are much more likely to borrow than banks with reserves about equal to the average level over the past 120 days. That greater propensity to borrow diminishes as the bank reserves at the end of the 120-day window gets closer to the median level of reserves held. Banks holding more reserves at the end of the 120-day window than they typically held during that period were generally less likely to borrow. However, banks in the top decile (with

reserves considerably higher than average) are more likely to borrow; this result appears to be due to stress situations, especially at the time of the onset of Covid-19, when asset purchases by the Federal Reserve were rapidly increasing the amount reserves when banks were borrowing more than usual from the discount window.

Section 3.5.2 Differences across banks of different sizes

We next consider whether the responsiveness of banks to interest rates and the reserves preference measure differ by bank size. We divide banks into three size categories: Small banks have less than $1 billion in assets; mid-sized banks have between $1 billion and $10 billion in assets; large banks have more than $10 billion in assets.

For the most part, banks of different sizes behave similarly. We do find that medium sized banks appear to be the most sensitive to how their reserves compare to the average level of reserves they have maintained over the past 120 days (i.e. the marginal effect on the reserve preference ratio is larger for medium banks than for other banks). Medium-size banks also appear to be the most sensitive to the pricing of the discount rate relative to the overnight FHLB advance rate. Larger banks are not especially sensitive to this rate, but the larger banks have better access to wholesale funding markets and are thus likely to have more options for raising funds quickly. Interestingly though, larger banks are more sensitive to the spread between the primary credit rate and the 3-month FHLB advance rate.

All banks borrow more during stress. The marginal effect at the means is largest for the large banks. That finding is consistent with the idea that stigma constrains borrowing behavior and that there is less stigma associated with borrowing during stress events that are the result of events well beyond the control of the bank, such as the onset of Covid-19.

Section 3.5.3 Differences between FHLB members and non-members

We have compared the primary credit rate to FHLB advance rates because the FHLBs are an important source of private funding for banks. However, to be eligible to receive an FHLB advance, the bank must be an FHLB member; in the sample, 70 percent of banks are FHLB members. As another extension, we explore whether FHLB membership affects the impact of our different interest rate measures.

The results are presented in Table 8. We find differences in the responsiveness to the interest rate differentials between FHLB member banks and non-member banks. FHLB members are more responsive to the spread between the primary credit rate and the 3-month FHLB advance rate than non-member member banks.

Interestingly, we do find that FHLB members are more responsive to their reserve-to-preference ratio in their use of the discount window than non-FHLB members. That may indicate that, even for FHLB member banks, the discount window is important for obtaining reserves to meet frictional issues.

Section 3.5.4 Role of the condition of the bank

The health of a bank may influence its decision to borrow. In this next extension, we consider whether the condition of the bank as measured by their capital ratios influences the independent variables. We do so, similar to early extensions, by estimating a separate regression for different groups of banks based on their tier-1 capital ratio, total risk based capital ratio, and the leverage ratio. The first group, the vast majority of banks, consists of banks that are well capitalized according to all three measures. The second group consists of banks that are not well capitalized by all three measures but are adequately capitalized.

The results are shown in Table 9. All banks are responsive to their levels of reserves, although we see that the reserve to preference has a larger effect on banks that are adequately capitalized than on those that are well-capitalized. That might suggest that banks that are adequately capitalized are more sensitive to having a low level of reserves. Adequately capitalized banks are also more likely to borrow during periods of stress than are well capitalized banks. The estimated effect of the spread between the primary credit rate and the overnight FHLB advance rate is about the same for both groups of banks, although only significant for the well capitalized banks. That might simply be due to the larger number of observations. Borrowing by well capitalized banks appears to be more responsive to the spread between the primary credit rate and the three-month FHLB rate; that may suggest a greater willingness by well capitalized banks to take advantage of an attractive discount window rate.[12]

Section 3.5.5 Term versus overnight borrowing

Our last extension considers whether reserve positions and interest rate spreads shape decisions to borrow overnight versus term (conditional on borrowing from the discount window). We focus on the part of the sample period when term borrowing (up to 90 days) was authorized in addition to overnight borrowing. Indeed, over one-third of borrowing activity in this period is associated with term borrowing. In this analysis, only banks that borrowed are included and we study whether the banks borrowed overnight or term; i.e. the dependent variable remains 0 and 1, but now 1 represents term borrowing.

The results of this analysis are in Table 10. The marginal effect on reserve to preference ratio is now positive with a one standard deviation increase in a bank's reserve to preference ratio associated with a 2 percent increase in the likelihood of borrowing term. This result is consistent with term borrowing being used for cash management purposes other than covering an immediate liquidity shortfall. Of the two interest-rate-spread variables, only the primary credit rate to the overnight FHLB rate was negative and significant. Our results here indicate that a higher interest rate spread strongly discouraged banks from taking term discount window loans. (This result is also suggestive of the idea that there might have been an opportunistic approach to the use of term primary credit.)

[12] This result would also be consistent with somewhat more hesitancy about using the discount window at less well capitalized banks and is in line with findings of Ennis and Klee (2024).

## Section 4. Building an aggregate picture

The bank level analysis is helpful in assessing the extent to which bank-level reserves (as well as how the primary credit rate compares with other interest rates) affect borrowing decisions. It is also useful to understand how the level of reserves, as well as the interest rate, affect borrowing at a more aggregate level. To investigate this, we first look at whether the aggregate level of reserves is related to the likelihood that banks are below their preferred level of reserves. We find that this is indeed the case. Having confirmed a link between the aggregate level of reserves and a higher likelihood that banks are below their preferred level of reserves, we test whether the aggregate level of reserves, along with the relative attractiveness of the primary credit rate, influences the number of borrowers at the discount window in a particular week.

### *Section 4.1 Aggregate reserves and the likelihood banks are below their preferred level of reserves*

To test whether the level of aggregate reserves influences the likelihood that an individual bank borrows, we first check whether banks are more likely to end up with reserve holdings being below the amount that they might prefer when aggregate reserves are relatively scarce. We look at the distribution of the reserve-to-preference ratios across all banks for all weeks to get a sense of whether individual bank reserves on any given Wednesday are low. A bank is considered to have a "low" level of reserves if the bank reserves-to-preference ratio is in the bottom 10 percent of the distribution. As a measure of the scarcity/plentifulness of aggregate reserves, we consider the ratio of reserves (from the Federal Reserve's H.4.1 statistical release) to banking system deposits (from the Federal Reserve's H.8 statistical release).

The relationships between the ratio of the aggregate level of reserves relative to banking system deposits and the likelihood that an individual bank has a low reserves-to-preference ratios are shown in Table 11. The relationships are estimated for all banks and for different size groupings of banks.

The results indicate that when the aggregate level of reserves is higher compared to deposits, individual banks are less likely to have a ratio of reserve holdings relative to average reserve holdings that is in the bottom quartile of the distribution of the ratios. In particular, a one percentage point decrease in the ratio of aggregate reserves to banking system deposits increases the probability of having low reserves by 0.5 percentage points.[13] Since the baseline probabilities of having those levels of reserves is 10 percent, these changes are small but meaningful.

[13] Evaluating the marginal effect at the mean.

*Section 4.2. Aggregate reserves, interest rates, and discount window borrowing*

If the aggregate level of reserves affects the likelihood that banks have lower than preferred level of reserves and having a lower than preferred level of reserves affects the likelihood of borrowing, then it should follow that the aggregate level of reserves relative to deposits should affect the number of banks that borrow in a particular week. (The ratio is measured in percentage points for ease of interpretation.) In particular, we estimate the regression:

$$\begin{aligned}\text{Number of banks borrowing in a week}_t = \text{function of (constant} \\ + \beta 1 * \text{reserves to banking system deposits}_t \\ + \beta 2 * (\text{primary credit rate}_t - \text{overnight FHLB rate}_t) \\ + \beta 3 * (\text{primary credit rate}_t - \text{90 day FHLB rate}_t) \\ + \beta 4 * \text{financial stress}_t).\end{aligned} \tag{3}$$

Since the dependent variable is a count of the number of banks that borrow in week *t*, we estimate a Poisson regression.[14] The analysis period is, as before, from January 2016 to March 2024.

The results from the preferred specification are in Table 12. Consistent with our hypothesis, we find that more banks borrow when the ratio of reserves to bank deposits is lower (i.e., reserves are relatively scarce). A one percentage points decrease in this ratio (about one-third of a standard deviation) is estimated to increase the number of borrowing banks by about one bank.[15] For further comparison, the prevailing ratio declined by 9 percentage points between the first half of 2016 to the first half of 2019. As, on average, about 20 banks borrow in any given week during the sample period our analysis suggests that between 2016 and 2019 the reduction in reserves amid a growing banking sector notably boosted the number of borrowing banks.

Also as expected, fewer banks borrow from the discount window when the primary credit rate is higher relative to the FHLB rate. A 10-basis point widening of this spread (about one-third of a standard deviation) increases the number of borrowers by a bit more than one bank. Unsurprisingly, the coefficient on the stress dummy is positive and significant, indicating more banks borrow during stress periods versus non-stress periods.

To assess how well this regression works, Figure 2 presents actual versus predicted borrowings for the entire sample period. The prediction (solid line) follows the path of actual borrowing (dashed line) quite closely except during late 2022 and in the second half of 2023 when there is notably more borrowing than expected.

[14] As this is a non-linear regression specification scaling has some influence on the size of the estimated impact. For the ratio of reserves to deposits, this is expressed in terms of percentage points. The spread between the primary credit rate and the FHLB advance rate is expressed in terms of 10s of basis points.

[15] The functional form of the Poisson regression means that the coefficient can be interpreted as the effect of the independent variable on the log of the expected number of counts. Typical interpretations are then to consider a one unit change in the independent variable.

## Section 5. Conclusion

This paper explores the role of two key Federal Reserve policy variables—the level reserves and the level of the primary credit rate—in influencing discount window borrowing. We document that the discount window borrowing is responsive to the level of reserves in the banking system. That finding holds even in periods when reserves are quite abundant; indeed, we find that the effects of current reserve holdings relative to a backward-looking average level of reserves mattered slightly more post-2020 than during the period before 2020, when reserves were not as abundant. We also find that the setting of the primary credit rate in relation to other possible sources of funds matters for discount window use. We further find evidence that the level of reserves is particularly important for medium sized banks (those with between $1 billion and $10 billion in assets), FHLB members, and adequately capitalized banks. Interest rate spreads had larger effects for medium and large (those with assets greater than $10 billion) banks, FHLB members, and well-capitalized banks.

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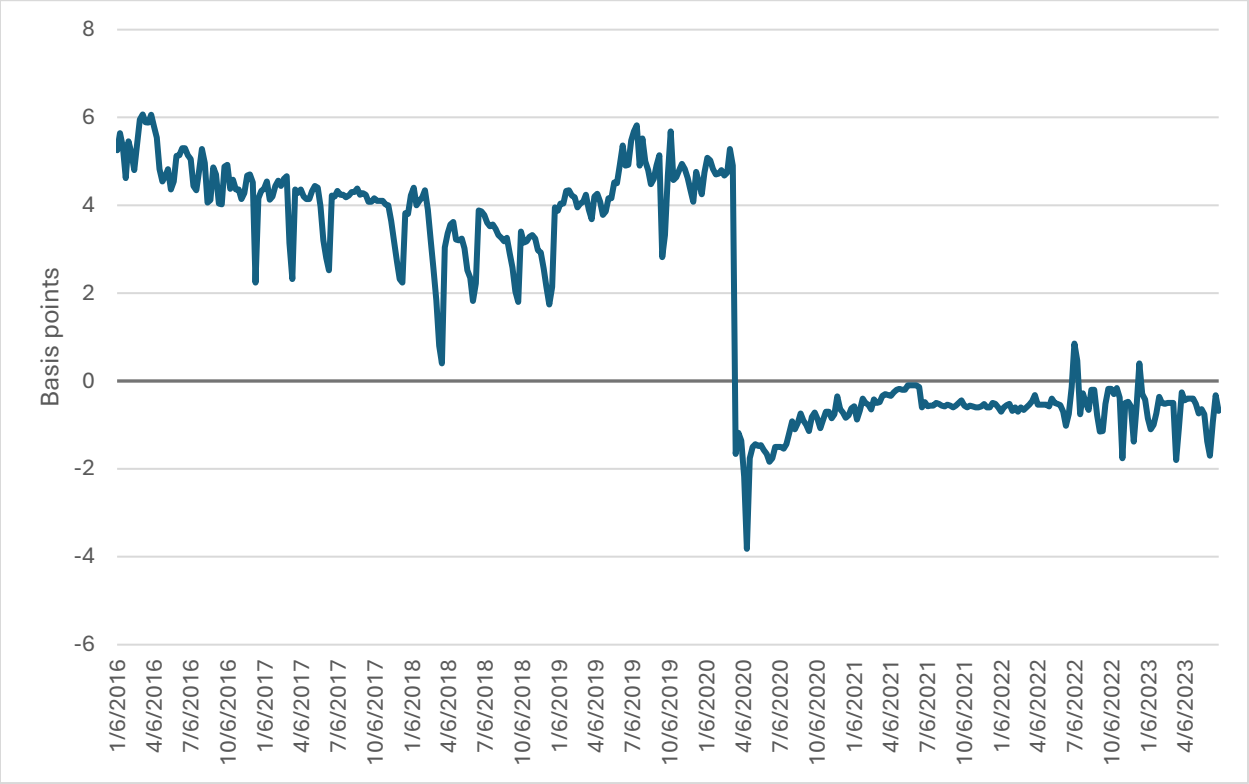
Figure 1

Spread between the primary credit rate and the overnight FHLB advance rate

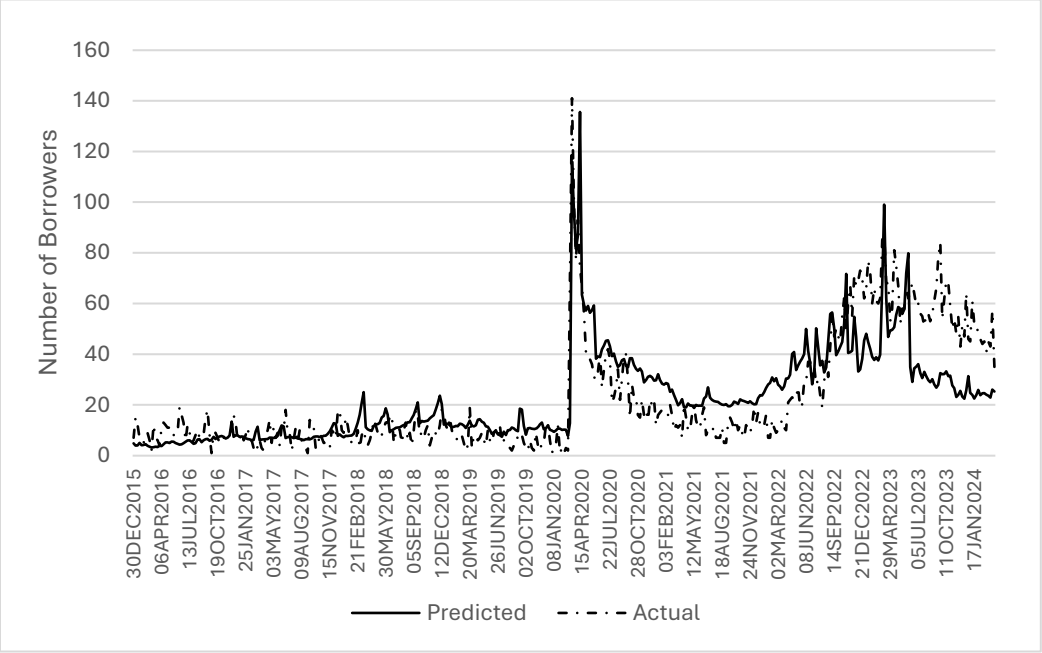
(Primary credit rate – FHLB advance rate)




Source. Author calculations based on data from Federal Reserve Economic Data | FRED | St. Louis Fed (DPCREDIT) and FHLB Des Moines (https://www.fhlbdm.com/products-services/advances/rate-history-tool/).

Figure 2

Aggregate Number of Borrowers: Actual versus Predicted




Source: Actual values based on internal Federal Reserve data records. Predicted values based on regression results from table 12.

Table 1
Summary statistics

| | Mean | Std. |
|---|---|---|
| **Overall** | | |
| PC borrowing dummy | 0.006 | 0.075 |
| Reserve to preference ratio | 1.021 | 0.648 |
| Spread between PC rate and overnight FHLB rate | 0.195 | 0.250 |
| Spread between primary credit and the 3-month FHLB rate | 0.067 | 0.329 |
| Stress period dummy | 0.058 | 0.235 |
| **Before March 2020** | | |
| PC borrowing dummy | 0.002 | 0.046 |
| Reserve to preference ratio | 1.016 | 0.655 |
| Spread between PC rate and overnight FHLB rate | 0.411 | 0.103 |
| Spread between primary credit and the 3-month FHLB rate | 0.311 | 0.138 |
| Stress period dummy | 0.008 | 0.091 |
| **After March 2020** | | |
| PC borrowing dummy | 0.010 | 0.100 |
| Reserve to preference ratio | 1.028 | 0.641 |
| Spread between PC rate and overnight FHLB rate | -0.063 | 0.050 |
| Spread between primary credit and the 3-month FHLB rate | -0.225 | 0.243 |
| Stress period dummy | 0.118 | 0.323 |

Source: Author calculations using data from internal Federal Reserve data records, Federal Reserve Economic Data | FRED | St. Louis Fed (DPCREDIT), and FHLB Des Moines (https://www.fhlbdm.com/products-services/advances/rate-history-tool/).

Table 2
Individual bank reserves, spread, and the likelihood of borrowing

| | All Banks |
|---|---|
| Reserve to preference ratio | -0.003*** |
| | (0.000) |
| Spread between PC rate and overnight FHLB rate | -0.009*** |
| | (0.000) |
| Spread between primary credit and the 3-month FHLB rate | -0.002*** |
| | (0.000) |
| Stress period dummy | 0.003*** |
| | (0.000) |
| Observations | 1,715,819 |
| Borrowed | 9,679 |

Note. Logistic regression; marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in parentheses.

Table 3

Analysis during different time periods

| | Before and after March 2020 | | During stress and non-stress periods | |
|---|---|---|---|---|
| | Before | After | Stress | Non-stress |
| Reserve to preference ratio | -0.001*** | -0.007*** | -0.006*** | -0.003*** |
| | (0.000) | (0.000) | (0.001) | (0.000) |
| Spread between PC rate and overnight FHLB rate | -0.010*** | -0.016*** | 0.006 | -0.009*** |
| | (0.001) | (0.002) | (0.006) | (0.000) |
| Spread between primary credit and the 3-month FHLB rate | 0.005*** | -0.003*** | -0.005 | -0.001*** |
| | (0.000) | (0.000) | (0.003) | (0.000) |
| Observations | 934,536 | 781,283 | 100,252 | 1,615,567 |
| Borrowed | 1,956 | 7,723 | 1,803 | 7,876 |

Note. Logistic regression; marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in parentheses.

Table 4
Sensitivity of borrowing to the overnight spread

| | Marginal Effects | S.E. |
|---|---|---|
| Reserves to preference ratio | -0.0029*** | 0.0001 |
| ON spread, decile 1 | 0.0030*** | 0.0002 |
| ON spread, decile 2 | 0.0020*** | 0.0002 |
| ON spread, decile 3 | 0.0015*** | 0.0002 |
| ON spread, decile 4 | 0.0034*** | 0.0002 |
| ON spread, decile 5 | 0.0039*** | 0.0002 |
| ON spread, decile 6 | *omitted* | |
| ON spread, decile 7 | -0.0009*** | 0.0002 |
| ON spread, decile 8 | -0.0018*** | 0.0002 |
| ON spread, decile 9 | -0.0024*** | 0.0003 |
| ON spread, decile 10 | -0.0012*** | 0.0002 |
| 3-month spread | -0.0021*** | 0.0002 |
| Stress period dummy | 0.0030*** | 0.0001 |
| | | |
| Observations | 1,715,819 | |
| Borrowed | 9,679 | |

Note. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in second column.

Table 5
Sensitivity of borrowing to the 3-month spread

| | Marginal Effects | S.E. |
|---|---|---|
| Reserves to preference ratio | -0.0029*** | 0.0001 |
| ON spread | -0.0041*** | 0.0008 |
| Term spread, decile 1 | 0.0037*** | 0.0003 |
| Term spread, decile 2 | 0.0034*** | 0.0004 |
| Term spread, decile 3 | 0.0031*** | 0.0003 |
| Term spread, decile 4 | 0.0017*** | 0.0003 |
| Term spread, decile 5 | 0.0035*** | 0.0003 |
| Term spread, decile 6 | *omitted* | |
| Term spread, decile 7 | -0.0002 | 0.0003 |
| Term spread, decile 8 | -0.0003 | 0.0003 |
| Term spread, decile 9 | -0.0006** | 0.0003 |
| Term spread, decile 10 | -0.0007** | 0.0003 |
| Stress period dummy | 0.0026*** | 0.0001 |
| | | |
| Observations | 1,715,819 | |
| Borrowed | 9,679 | |

Note. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in second column.

Table 6
Individual bank reserves, interest rates, and the likelihood of borrowing

| | Marginal Effects | S.E. |
|---|---|---|
| Reserve to preference, decile 1 | 0.0054*** | 0.0002 |
| Reserve to preference, decile 2 | 0.0038*** | 0.0002 |
| Reserve to preference, decile 3 | 0.0023*** | 0.0002 |
| Reserve to preference, decile 4 | 0.0012*** | 0.0002 |
| Reserve to preference, decile 5 | *omitted* | |
| Reserve to preference, decile 6 | -0.0032*** | 0.0003 |
| Reserve to preference, decile 7 | -0.0008*** | 0.0002 |
| Reserve to preference, decile 8 | -0.0007*** | 0.0002 |
| Reserve to preference, decile 9 | 0.0001 | 0.0002 |
| Reserve to preference, decile 10 | 0.0018*** | 0.0002 |
| ON spread | -0.0082*** | 0.0002 |
| 3-month spread | -0.0009*** | 0.0001 |
| Stress period dummy | 0.0018*** | 0.0001 |
| | | |
| Observations | 1,715,819 | |
| Borrowed | 9,679 | |

Note. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in second column.

Table 7
Comparison across bank size

| | Small banks | Medium banks | Large banks |
|---|---|---|---|
| Reserve to preference ratio | -0.0023*** | -0.0073*** | -0.0016*** |
| | (0.0001) | (0.0004) | (0.0006) |
| Spread between PC rate and overnight FHLB rate | -0.0060*** | -0.0252*** | -0.0012 |
| | (0.0003) | (0.0010) | (0.0019) |
| Spread between primary credit and the 3-month FHLB rate | -0.0011*** | -0.0014** | -0.0078*** |
| | (0.0002) | (0.0006) | (0.0011) |
| Stress period dummy | 0.0017*** | 0.0051*** | 0.0110*** |
| | (0.0001) | (0.0004) | (0.0008) |
| Observations | 1,366,225 | 290,894 | 58,700 |
| Borrowed | 5,407 | 3,777 | 495 |

Note. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in parentheses.

Table 8
Individual bank reserves, spread, FHLB status, and the likelihood of borrowing

| | Non-FHLB member | FHLB member |
|---|---|---|
| Reserve to preference ratio | -0.0011*** | -0.0036*** |
| | (0.0002) | (0.0001) |
| Spread between PC rate and overnight FHLB rate | -0.0051*** | -0.0103*** |
| | (0.0005) | (0.0003) |
| Spread between primary credit and the 3-month | -0.0006 | -0.0018*** |
| FHLB rate | (0.0004) | (0.0002) |
| Stress period dummy | 0.0018*** | 0.0029*** |
| | (0.0002) | (0.0001) |
| Observations | 397,019 | 1,318,800 |
| Borrowed | 1,222 | 8,457 |

Note. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in parentheses.

Table 9
Individual bank reserves, spread, financial condition, and the likelihood of borrowing

| | Financial Condition | |
|---|---|---|
| | Well Capitalized | Adequately Capitalized |
| Reserve to preference ratio | -0.0032*** | -0.0065*** |
| | (0.0001) | (0.0012) |
| Spread between PC rate and overnight FHLB rate | -0.0090*** | -0.0129 |
| | (0.0003) | (0.0102) |
| Spread between primary credit and the 3-month FHLB rate | -0.0016*** | 0.0022 |
| | (0.0002) | (0.0032) |
| Stress period dummy | 0.0026*** | 0.0065*** |
| | (0.0001) | (0.0018) |
| Observations | 1,587,775 | 18,759 |
| Borrowed | 9,096 | 142 |

Note. Data only includes domestic banks, not branches and agencies of foreign banks. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in parentheses.

Table 10
Individual bank reserves, spread, and the likelihood of borrowing term

| | Conditional on borrowing where 0 = ON and 1 = Term |
|---|---|
| Reserve to preference ratio | 0.0240*** |
| | (0.0063) |
| Spread between PC rate and overnight FHLB rate | -0.7055*** |
| | (0.1063) |
| Spread between primary credit and the 3-month FHLB rate | 0.0829*** |
| | (0.0229) |
| Stress period dummy | 0.0120 |
| | (0.0150) |
| Observations | 7,723 |
| Borrowed | 2,684 |

Note. Logistic regression. Marginal effects at the means. The symbols ***, **, and * indicates statistical significance at the 1 percent, 5 percent, and 10 percent levels respectively. Standard errors are in parentheses.

Table 11
Banking system reserves and the likelihood of "low" reserve levels

| | All banks | Large banks | Medium banks | Small banks |
|---|---|---|---|---|
| Aggregate reserves to banking system deposits | -0.0049*** | -0.0084*** | -0.0082*** | -0.0041*** |
| | (0.0001) | (0.0005) | (0.0002) | (0.0001) |
| Stress period dummy | -0.0160*** | -0.1157*** | -0.0277*** | -0.0092*** |
| | (0.0015) | (0.0081) | (0.0034) | (0.0017) |
| Observations | 1,715,819 | 58,700 | 290,894 | 1,366,225 |
| Number w/ very low reserves | 445,397 | 11,378 | 80,795 | 353,224 |

Note. Logistic regression. Marginal effects at the means. The symbol *** indicates statistical significance at the 1 percent level. Standard errors are in parentheses.

Table 12
Aggregate reserves, interest rate spreads, and the number of banks that borrow during a week

| | Effect on number of banks borrowing during the week |
|---|---|
| Reserves to banking system deposits | -0.08*** |
| | (0.00) |
| Spread between PC rate and overnight FHLB rate | -0.27*** |
| | (0.01) |
| Spread between primary credit and the 3-month FHLB rate | -0.04*** |
| | (0.00) |
| Stress period dummy | 0.53*** |
| | (0.03) |
| Intercept | 4.81*** |
| | (0.09) |
| Observations | 431 |

Note. Poisson regression. Raw coefficients reported. The symbol *** indicates statistical significance at the 1 percent level. Standard errors are in parentheses.