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Standing Facilities and Interbank Borrowing: Evidence from the Federal Reserve's New Discount Window

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Abstract

Standing facilities are designed to place an upper bound on the rates at which financial institutions lend to one another overnight, reducing the volatility of the overnight interest rate, typically the rate targeted by central banks. However, improper design of the facility might decrease a bank's incentive to participate actively in the interbank market. Thus, the mere availability of central bank provided credit may lead to its use being *more* than what would be expected based on the characteristics of the interbank market. By contrast, however, banks may perceive a stigma from using such facilities, and thus borrow *less* than what one might expect, thereby reducing the facilities' effectiveness at reducing interest rate volatility. We develop a model demonstrating these two alternative implications of a standing facility. Empirical predictions of the model are then tested using data from the Federal Reserve's new primary credit facility and the US federal funds market. A comparison of data from before and after recent changes to the discount window suggests continued reluctance to borrow from the Fed.

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1. Introduction

Modern central banks implement monetary policy primarily by setting a target for some short-term rate of interest that is consistent with its ultimate objective of price stability. Because central banks pursue their goals operationally by periodically intervening in financial markets to affect the level of bank reserves, overnight rates of interest on loans between financial institutions are typically chosen as a central bank's intermediate target. Excessive volatility in interbank rates, if viewed by market participants as an inability of the central bank to achieve its intermediate goals, is potentially damaging to the central bank's reputation and its ability to stabilize market expectations.

To address their common concern over interbank interest rate volatility, central banks in industrialized countries have used a variety of tools to reduce interest rate volatility (Laurens (1994)). Since short-term interest rate volatility is largely determined by volatility in reserve demand, interest rate stability was historically achieved through high statutory reserve requirements that provided a predictable demand for reserves. Over the past two decades, however, largely due to pressure from the banking industry that argued that reserve requirements place it at a competitive disadvantage relative to unregulated financial intermediaries, reserve requirements have been reduced or eliminated in industrialized countries. Therefore, attention has once again focussed on the volatility of short-term interest rates and the implications of this volatility for achieving the goals of monetary policy.[1]

One approach that central banks have taken in response to lower (non-zero) reserve requirements has been to operate under a regime of lagged reserve accounting.[2] Under such

[1] In the US, this has been a popular theme in both the popular press and academic research. See, for example, Clouse and Elmendorf (1997), Naroff (1997), and VanHoose and Humphrey (2001).

[2] The Federal Reserve returned to such a system effective July 30, 1998.

accounting practices, institutions know how much they must hold in reserves in advance of the period over which the reserves must be held. Such a system reduces volatility in interbank interest rates that would otherwise be caused by banks having to make large and rapid adjustments to their reserves (through interbank transactions) due to late and unexpected changes in reservable liabilities.[3]

A more direct method that some central banks use to limit interbank interest rate volatility is to provide credit to and accept deposits from market participants directly through so-called standing facilities. For example, the central banks in Canada, Australia, and New Zealand operate standing facilities where the rates offered by these central banks are 25 basis points above and below these central banks' target rate. Thus, overnight interest rates are expected to remain in a relatively tight corridor around its desired level. The European Central Bank (ECB) also maintains standing facilities, accepting deposits and making loans at rates 100 basis points away from its target level. Thus, the ECB's facilities implicitly tolerate a greater amount of interest rate volatility.

Until recently, the Federal Reserve did not operate a standing facility. Loans made through the Fed's discount window were offered at below-market rates, necessitating intense supervisory scrutiny and moral suasion to limit the market's use of such loans. In recent years, the fraction of required reserves that were borrowed from the Fed's discount window fell dramatically (see Figure 1). Peristiani (1998) argues that this may be due to market participants refraining from requesting discount loans because of the perception that it would send a negative signal to the

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[3] Whether lagged reserve accounting reduces interest rate volatility remains an open question. Lasser (1992) finds that when the Fed abandoned lagged reserve accounting in favor of contemporaneous reserve accounting (CRA), interest rate volatility rose only for a short time period before returning to the earlier lower levels. In fact, Lasser (1992) argues that the Fed's reason for going towards CRA was to "allow the Fed to conduct a more effective monetary policy." The 1998 return to LRA in the US was motivated by the belief that "it has become increasingly

Fed, bank supervisors, and eventually the market at large. In response to the perception that banks were unwilling to borrowing from the discount window, the Federal Reserve drastically changed its discount window policy and began the operation of a standing facility (see Madigan and Nelson (2002)). This facility offers banks in good financial condition "primary credit" from the central bank at 100 basis points above the FOMC's target federal funds rate. "Secondary credit" would be offered at a slightly higher rate.[4]

The Fed's new facility became operational on January 9, 2003. Like other central bank standing facilities, the above market price of funds serves as a rationing mechanism that dramatically reduces the need for much, if any, supervisory review of the potential borrower. Thus, as designed, use of the new primary credit facility should not necessarily imply anything negative about an infrequent borrower, and therefore, banks should be willing to make occasional use of the facility if market conditions warrant. Unlike prior lending from the discount window, the Fed's new primary credit facility attempts to offer commercial banks a guilt-free alternative to borrowing in traditional interbank markets. As a result, the mere existence of the new facility might be expected to eliminate all market transactions that would otherwise be conducted at rates 100 or more basis points over the target funds rate.[5]

In this paper, we develop a model of a bank's decision to borrow from a central bank standing facility. The model emphasizes two aspects that affect the bank's decision to borrow in addition to the stated interest rate of the facility. First, we suggest that despite the assertions of the central bank, banks may remain reluctant to borrow. That this might hold true is suggested by

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difficult to estimate the quantity of balances that depositories must hold at the Reserve Banks …" (Federal Reserve (1998)). It remains to be tested whether interest rate volatility has fallen since LRA was reinstated in the US.

[4] Unlike the aforementioned central banks, the Fed did not implement a standing facility to pay interest on overnight deposits from banks.

the results of Furfine (2001). He demonstrates that when the Fed implemented a temporary Special Lending Facility (SLF) surrounding Y2K and combined this implementation with written assurances that the Fed would not look unfavorably upon a bank that borrows from the SLF, banks were still very reluctant to borrow. This conclusion was reached after observing that banks were willing to pay higher interest rates in the federal funds market rather than borrow from the SLF.

Second, the model in the paper also suggests how the introduction of a standing facility may actually lead to greater borrowing from the central bank than would be warranted by interbank interest rates alone. Specifically, if the interest rates on central bank standing facilities are set too close to rates that occasionally occur in the market, interbank market participants may have less of an incentive to actively seek the best possible market outcome.[6] Thus, the interbank market may not allocate funds as well as it would in the absence of the standing facility competitor. One result of this would be that standing facilities might witness more activity than would be warranted solely by the characteristics of the interbank market.

A simple example illustrates these two alternative possibilities. Suppose participants in an interbank market without access to standing facilities offer overnight loans uniformly over the range 4.0% to 6.0%. This implies that 25% of the interbank market transacts between 5.5% and 6.0%. Suppose that a standing facility is then introduced offering to lend funds at 5.5%. Ex ante, one would expect 25% of the interbank market to move to the standing facility. However, the

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[5] These overnight loans from the Fed require collateral, so the relevant cost of collateral must be added to the stated interest rate charge.

[6] Since market rates, i.e. those measured by the daily effective federal funds rate, rarely rise to 100 basis points over target, one might believe that individual federal funds transactions also only rarely rise to this level. However, variation in average rates does not consider variation in transaction rates across banks on any given day. For instance, Furfine's (2004) analysis of federal funds borrowers from the first half of 1998 documents that average interest rates paid varied by 70 basis points across banks. Cross-bank variation in rates on any given day, therefore,

model developed in this paper suggests two reasons why the observed borrowing from the central bank may be more or less than 25% of the market. First, borrowing from the central bank might carry a stigma, suggesting that less than 25% of the market might move to the Fed. Second, the mere existence of the standing facility may change the behavior of market participants. In particular, banks may have a lesser incentive to participate actively in the interbank market due to the certainty of transacting at the standing facility. As a result, one might find that more than 25% of the market ultimately uses the standing facility.

The paper then tests the implications of the model using data from the Fed's new primary credit facility and the overnight federal funds market. Our results indicate strongly that borrowing from the Fed's new primary credit facility is far lower than could have been expected given the cross-sectional variation in interest rates paid in the federal funds market. Further, the amount of borrowing from the Fed is dwarfed by the amount of interbank borrowing at less attractive rates of interest. Taken together, the results suggest that stigma remains an important influence in banks' decision to borrow from the Fed.

The remainder of the paper is organized as follows. The model of an interbank market with and without standing facilities is developed in Section 2. Section 3 provides some institutional details of the interbank market in the United States and describes the data used in this paper. Section 4 conducts tests of the implications of the model. Section 5 concludes.

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could reasonably be expected to be much wider, making it likely that certain banks may face market rates of more than 100 basis points over the Fed's target.

2. Model

2.1 Baseline model without standing facilities

This section develops a simple search model of an interbank market.[7] Consider a bank that needs to borrow a fixed amount.[8] We assume that the bank is risk neutral and thus its objective is to pay the lowest interest rate possible for its loan. There exists an interbank market in which the bank can participate. For simplicity, it is assumed that the existing environment allows the bank to obtain, at zero cost, one loan offer from a counterparty. We define this first interest rate offer as i_1. This initial rate might be the one available from a bank's regular correspondent or counterparty. It might also represent the prevailing quote from an overnight money broker.

In response to receiving this first offer, the bank has two options, accept the offer or decline the offer and find another offer from the market. If it solicits another offer from the market, it must pay a cost of c. In its simplest interpretation, c represents the search costs of finding another suitable counterparty willing to lend funds to the bank. Intuitively, search costs c may be greater than zero because a bank acquiring funds in an atypical manner might lose the value of its relationship with its normal correspondent or broker. More practically, if c were not greater than zero, the bank would literally search forever until it found the lowest available rate possible. Should the bank decide to seek an additional market offer, i_2, it must then accept either market offer.

The key choice the bank faces is whether or not to seek a second market offer. This decision logically depends on the tradeoff between the costs of searching and the benefits of a

[7] An in-depth description of search models can be found in Diamond (1989).

[8] Anticipating the empirical analysis using US data, we focus on a bank that needs to borrow funds. The analysis is symmetric in case the bank needs to lend.

potential improvement in borrowing terms.[9] To analyze this choice more formally, we assume that a bank's initial offer, i_1, is drawn from a fixed and known distribution with cumulative distribution function $G(.)$ and probability function $g(.)$. Should the bank make an investment of c, we assume for simplicity that the bank gets another draw from the same distribution.[10] The function $G(.)$ is assumed to be continuous and monotonically increasing.

Economically, the function $G(.)$ represents the distribution of offers that a bank can hope to receive each time it participates in the interbank market. For example, one might think that a bank with a relatively stable risk profile and an established relationship would have a fairly narrow window of expected initial offer rates i_1. Bad draws from the distribution might nevertheless occur. For example, a bank may experience an unexpected outflow late in the business day when it can no longer arrange a loan from one of its normal counterparties. Similarly, a bank's typical counterparty may experience a sudden demand for liquidity itself and may not easily lend funds as it typically would do.[11]

Given the above assumptions regarding the operation of a representative borrower in the overnight interbank market, it is possible to examine the choice of whether a bank finds it worthwhile to make the investment c in return for a second offer from the interbank market. Suppose a bank chooses not to seek a second offer. This choice costs i_1. Alternatively, if the

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[9] As the model presented is static, the fixed cost c can be interpreted as a cost per unit of borrowing. In a dynamic version of the model, the fixed cost c would be balanced against the present discounted value of future benefits arising from the ability to get improved terms. While adding some analytical complexity, the intuition delivered by the model remains the same. Thus, the simpler exposition is presented.

[10] This assumption is without loss of generality. The results of the model hold even if the distribution of second offers is different than that of the first offer, as long as there is some probability that the second offer will be better than the first.

[11] Systemwide reasons may also cause a change in the underlying distribution function. For instance, the Fed may have supplied too few reserves to the banking system suggesting that the entire market will be paying higher rates for overnight funds.

bank seeks a second offer, it will pay a total cost of $c + \min(i_1, i_2)$. The decision to pay the search costs and receive a second offer depends on the first offer received i_1. This decision is shown in Figure 2.

The x-axis represents the initial offer i_1 and the y-axis represents values relating to the expected accepted offer. Note, if banks could only receive the first offer, the accepted interest rate would equal i_1. This is represented by the 45-degree line in Figure 2. The relationship between first offers and expected accepted offers is depicted by the solid line in Figure 2. Note that because a bank can search a second time, its expected accepted rate will always be below i_1 as long as there is any possibility of receiving a better offer. For very high first offers, the bank's expected accepted rate will simply be the expected value of another draw from the distribution $g(.)$, labeled $\overline{g}$ in Figure 2. The dotted line in Figure 2 adds the search cost c to the expected accepted interest rate to depict the expected total cost of conducting a search at all levels of initial offers. The intersection of the dotted line with the 45-degree line gives the value of i_1 above which the bank finds it worthwhile to conduct a search. Defining this cutoff value as $i^*(c)$, it is straightforward to show that $i^*(c)$ is the rate at which the cost of conducting a search c equals the expected interest rate savings from doing so.

The bank's decision rule in the absence of a standing facility is as follows. Accept all initial offers i_1 that are less than $i^*(c)$. This is depicted by the ray from point **a** to point **b** in Figure 2. For first offers above $i^*(c)$, draw again, pay the search cost c and expect to have a total funding cost depicted by the curve drawn from point **b** to point **c**.

2.2 Adding standing facilities

Now suppose that in addition to the interbank market, the central bank offers a standing facility at which the bank can borrow at a fixed standing facility rate of i_{CB}. No search costs are incurred when a bank decides to borrow from the central bank, but we allow for the possibility that borrowing from the central bank may impose a non-price stigma cost *s*. The interaction of standing facilities and the bank's choice to obtain a second offer is depicted in Figure 3. Suppose the central bank chooses a standing facility rate such that $i^*(c) \le i_{CB} + s$. In this case, depicted as point X in Figure 3, the existence of the facility does not affect a bank's decision to undertake a search. Intuitively, this is because if the bank's first offer $i_1 \ge i_{CB} + s$, the first offer is treated as if it was an offer of $i_1 = i_{CB} + s$, and at this level, the bank still chooses to undertake a search.

Suppose, by contrast, that the central bank chooses a standing facility rate such that $i^*(c) > i_{CB} + s$, depicted by point Y in Figure 3. In this case, banks will never conduct a search. This is because all first offers above $i^*(c)$ are treated as if $i_1 = i_{CB} + s$, and at this lower level, banks do not find it in their interest to search.

The influence that standing facilities have on the interbank market therefore depends crucially on whether $i_{CB} + s$ is greater than or less than $i^*(c)$. We know from Figure 2 that $i^*(c)$ is less than the expected market interest rate $\overline{g}$ (e.g. central bank target) plus the search cost *c*. Thus, for standing facilities to influence search decisions, it must be the case that $i_{CB} + s < \overline{g} + c$. Given that central banks typically choose i_{CB} to be some distance above their target rate (near $\overline{g}$), standing facilities will typically only deter search if stigma costs are much less than search costs *c*. Further, it is reasonable to believe that in the presence of any significant stigma, the existence of a standing facility will not influence a bank's decision to search.

In the case of standing facilities, the bank's decision rule depends on whether or not the standing facility rate is chosen such that $i_{CB} + s$ is at a point such as X or Y in Figure 3. If the cost of the standing facility and stigma is at point X, the bank's decision is to accept all initial offers i_1 that are less than $i^*(c)$. This is depicted by the ray from point **a** to point **b** in Figure 3. For first offers above $i^*(c)$, but below X, draw again, pay the search cost *c* and expect to have a total funding cost traced by the curve drawn from point **b** to point **e**. For all first offers above X, draw again, pay *c*, and expect to have total costs be those drawn at point **e.** The standing facility will only be used if both draws are above X.

By contrast, if the standing facility and stigma costs are at point Y, the bank's decision is more straightforward. The bank will accept all first offers less than Y. This is drawn as the ray from point **a** to point **d** in Figure 3. If the first offer is greater than Y, borrow from the standing facility and pay the cost drawn at point **d**, which is equal to Y.

2.3 Empirical implications

The model described in the previous two subsections delivers two predictions regarding interest rates paid by banks in an interbank market when a standing facility is introduced. The predictions depend on the rate chosen by the central bank and the significance of stigma costs. These are listed here.

Prediction 1: The introduction of a standing facility with the characteristic $i^*(c) > i_{CB} + s$ will deter banks from searching for better interest rates. Thus, the amount of borrowing from the standing facility will be greater than the amount of interbank borrowing conducted at rates above $i_{CB} + s$ before the introduction of the facility.

Prediction 2: The introduction of a standing facility with the characteristic $i*(c) \leq i_{CB} + s$ does not affect bank behavior, but simply truncates the observation of interbank interest rates above $i_{CB} + s$. The amount of borrowing from the standing facility will equal the amount of borrowing conducted at rates above $i_{CB} + s$ before the introduction of the facility. Further, there should be no observations of interbank transactions at rates above $i_{CB} + s$. Finally, if we observe banks transacting at rates greater than i_{CB}, it must be because $s > 0$.

3. Institutional details and data

The empirical tests conducted below will examine the use of the Federal Reserve's primary credit facility and the interest rates paid in the federal funds market. Before conducting such tests, this section provides some important institutional details about the operation of the Fed and the federal funds market.

In its operation of monetary policy, the Fed announces a target rate for federal funds. However, as a practical matter, achieving this target is accomplished by regular interventions in the reserves market in an effort to have the volume-weighted *average* rate on federal funds transactions (a.k.a. the effective federal funds rate) be close to the target rate *over some horizon*, typically one reserve maintenance period. In other words, the Fed does not have much of a concern with small deviations of the effective rate from target and has even less concern with the fact that individual federal funds transactions may take place at an interest rate far from the target rate. In particular, the federal funds market exhibits cross-bank variation in interest rates paid for funds. In this paper, we exploit the fact that rates paid for federal funds do vary across banks to determine whether the distribution of rates paid by banks seems to have changed since the introduction of the Fed's new standing facility.

In the following section, we will compare the amount of borrowing of primary credit from the Fed to the volume that one would have predicted in advance, given the historical (pre-facility) empirical distribution of cross-bank interest rates paid. This will allow us to determine which empirical prediction is most consistent with the Fed's introduction of its primary credit facility. To examine which prediction is most consistent with the data, we require data on interbank market transactions both before and after the policy change. In particular, we require information regarding the distribution of interest rates on individual interbank market transactions. These data were constructed from payment flow information.

To be precise, federal funds transactions are settled over Fedwire, the real-time gross settlement system owned and operated by the Federal Reserve. For this study, a record of every Fedwire funds transfer was collected between January 9, 2002 and March 31, 2002 (Period 1) and also between January 9, 2003 and March 31, 2003 (Period 2). Using identical days in the two years helps to mitigate any seasonal patterns to interbank lending that may be present. These funds transfers were then searched for those related to the federal funds market. For instance, if Bank A agrees to lend $10 million to Bank B on a Tuesday at an interest rate of 5.50%, the Fedwire transaction data will contain a payment from Bank A to Bank B for $10 million on Tuesday and also a payment from Bank B to Bank A for $10,001,527.78 on Wednesday. Based on anecdotal evidence presented by Stigum (1990), payments whose amounts were greater than $1 million, ended in five zeros, and had a payment the following business day in the opposite direction in an amount that could reasonably be construed as the initial payment plus interest were identified as federal funds transactions.[12] Once the underlying transaction data have been uncovered, calculating the value transacted over certain interest rate ranges is straightforward.

For Period 2, we also utilize data from the Federal Reserve's H.3 release on the dollar volume of lending done at the Fed's primary credit facility, augmented by similar confidential data collected by the Fed at a daily frequency.

4. Empirical tests

The empirical question is whether or not the use of the primary credit facility has been used more or less than what one would predict, given the characteristics of the federal funds market. For each day during Period 1, we calculate the fraction q_{1t} of the interbank market that takes place on day t of Period 1 at 100 or more basis points above the target federal funds rate, which during Period 1 was 1.75%. We can similarly calculate q_{2t} as the total amount of primary credit borrowed divided by the total volume of interbank loans on day t during Period 2. Thus, our first empirical test is whether the distribution of q_{1t} is the same as the distribution of q_{2t}. Intuitively, this corresponds to the "25% of the market" example given in the introduction.

Summary statistics for q_{1t} and q_{2t}, shown in Table 1, indicate that borrowing at the primary credit facility is far lower than what could have been expected. As Table 1 indicates, the mean fraction of the interbank market that borrowed at or above 100 basis points above target during Period 1 is slightly less than one percent. This fraction, however, is 140 times larger than the average fraction of the market that borrowed from the primary credit facility in Period 2. On one day during Period 1, over 2.1% of the interbank market trading at 100 or more basis points

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[12] Because we are particularly interested in finding transactions somewhat far from the Fed's target rate, we allow interest rates to range from a low rate of 0.5% to a high of 250 basis points above the target rate.

above target. The largest single day of borrowing from the primary credit facility during Period 2 amounted to less than eight hundredths of a percent of total market volume.

Although the simple sample statistics indicate that the borrowing at the primary credit facility has been lower than what we might have expected given the distribution of interest rates paid in the market during Period 1, we test this formally by calculating both Kolmogorov-Smirnov and Wilcoxon rank statistics.[13] The Kolmogorov-Smirnov statistic tests the null hypotheses that q_{1t} comes from a smaller or larger distribution than q_{2t}. The Wilcoxon statistic tests the null hypothesis that both q_{1t} and q_{2t} were drawn from the same distribution. These results are shown in Table 2. As should be no surprise after seeing Table 1, the results presented in Table 2 indicate overwhelmingly that the fraction of the interbank market that has borrowed from the primary credit facility is lower than the fraction of the interbank market that would seem to benefit from doing so.

One possible explanation to the low level of borrowing from the primary credit facility is that during Period 2, the range of interest rates paid in the federal funds market was much smaller than the range paid during Period 1. This possibility is outside the scope of our model, but needs to be considered in the empirical tests. A narrower range of interest rates would suggest less of a benefit from borrowing directly from the Fed and would not have been accounted for in the univariate results discussed above. Table 1 also indicates summary statistics on data from the federal funds brokers that is published each day by the Federal Reserve Bank of New York. According to these data, the market did seem to have a wider range of interest rates

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[13] The Kolmogorov-Smirnov test uses the maximum distance between two cumulative distribution functions as the test statistic D. Details of tests of this type are given in Conover (1999). The Wilcoxon ranksum test first orders all observations, regardless of which distribution the observation was drawn from. Then, each observation is ranked and then summed separately for each distribution. The test statistic is based upon the difference between the actual sum and the expected sum of the ranks of all the observations. Details are given in Wilcoxon (1945). The results from the Wilcoxon test are equivalent to those from a Mann-Whitney test described in Mann and Whitney (1947).

during Period 1. The mean standard deviation of interest rates paid in the brokered market was 13 basis points in Period 1 but only 4 basis points in Period 2. This difference in mean, however, may be overstated because of the occurrence of a very large and outlying value for this variable during Period 1. A more informative comparison is the difference in the median standard deviation. During the first period, the median standard deviation of interest rates was 6 basis points but only 3 basis points in Period 2. Thus, by this measure, the dispersion of interest rates was twice as wide during the first period. Table 1 also reports summary statistics on the highest rate reported by the brokers during the two periods. These data, too, indicate a wider range of interest rates paid during Period 1.

We then try to determine whether or not the lower dispersion of rates paid in the market can explain the observed low level of borrowing from the primary credit facility. Using data from Period 1, we fit a series of regression models to estimate the fraction of the market that trades at 100 or more basis points above target. The dependent variable is q_{1t}. In some specifications, we include a lagged dependent variable. We consider the broker-reported standard deviation of interest rates and the spread between the broker-reported high rate and the target rate as independent variables. These two variables are expected to be correlated with higher fractions of market activity conducted at higher rates. In some specifications, we include volatility measures from other financial markets to investigate whether federal funds rate volatility may be related to financial market volatility more generally. We proxy for market volatility by using absolute values of the daily return on the S&P 500 stock index and the daily yield change on the 10-year Treasury note.[14]

[14] In regression results not reported, we have additionally considered calendar-related variables such as month-end and quarter-ends, reserve settlement days, and days before and after holidays. Coefficients on these additional variables were never statistically significantly different from zero.

The results from these regression equations are shown in Table 3. The coefficients reported generally have the expected signs. In particular, the spread between the broker-reported highest rate in the market and the target funds rate enters with a positive sign. Higher standard deviations of interest rates paid are also generally correlated with higher fractions of the market transacted at 100 or more basis points over target. However, the coefficient on the standard deviation does not enter significantly when measures of market volatility enter the regression, although these variables are jointly significant at standard significance levels. Also, movements in the broker-reported average rate (effective federal funds rate) do not seem to have additional significant explanatory power.

Using the estimated coefficients, we then create predicted values $\hat{q}_{2t}$ of the fraction of the market that should be expected transact over this range of interest rates using data from Period 2. These predicted shares are then compared to the actual shares q_{2t} and additional equality of distribution tests are conducted. The final row of Table 3 reports analogous findings to those reported in Table 2. Specifically, even after controlling for differences in market conditions between Period 1 and Period 2, we overwhelmingly reject the null hypothesis that the quantity of borrowing from the primary credit facility is what would be expected given the variation in interest rates in the market in favor of the alternative that primary credit usage is abnormally low.

The results of the above analysis suggests that borrowing from the primary credit facility has been lower than one might have expected given the distribution of interest rates paid in the federal funds market. A further indication of this fact can be found in the third row of Table 1, which reports the fraction of the federal funds market that either borrows from the primary credit facility or borrows in the funds market at 100 or more basis points over target. A comparison of the second and third lines of Table 1 indicates that an average of more than 57 times more activity occurs in the federal funds market at rates equal to or higher than the rate offered by the primary credit facility. Within the context of the model, the evidence is consistent with our second empirical prediction, namely that a positive stigma is attached to central bank borrowing.

5. Conclusion

This paper develops a model of the interaction between a bank's borrowing in an interbank market and a bank's decision to borrow from a central bank standing facility. In an environment of low and declining reserve requirements, standing facilities are becoming a more central component in the operating framework of many central banks. The model demonstrates that a standing facility may or may not influence the degree to which commercial banks participate in the private interbank market. The model incorporates that (a) the mere presence of a standing facility may inhibit a bank's incentive to solicit attractive market offers and (b) there may be a stigma attached to borrowing from the central bank instead of the interbank market. These two effects have opposite predictions regarding the likelihood that a bank will borrow from the central bank.

We then conduct an empirical comparison of the US federal funds market during periods with and without a standing facility. After controlling for other differences between the two periods, we find that borrowing from the Fed's new primary credit facility is far lower than could have been expected given the cross-sectional variation in interest rates paid in the federal funds market. Further, the amount of borrowing from the Fed is dwarfed by the amount of interbank borrowing at less attractive rates of interest. These empirical results suggest that strong reluctance to borrow from the Fed remains.

The need for future research on bank willingness to borrow from their central bank seems clear. In countries other than the United States, borrowing from central bank standing facilities is perceived to be routine. One explanation of this difference across countries is that marketwide variables influence individual bank decisions. For instance, banks may be willing to borrow from facilities that other banks use regularly. In this case, an individual bank's choice to use the facility likely conveys no information to the central bank and thus there are no stigma costs. By contrast, if facilities are little used, banks may be unwilling to be one of the few to borrow out of concern that the central bank would think that the borrower was in some way unique. This would lead to positive stigma costs. This suggests that the ultimate use of standing facilities may have both a high-use and low-use equilibrium. If so, the Fed may face a challenge convincing large numbers of banks to change their behavior so that the facility can perform its intended role.

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Table 1: Summary statistics

This table reports summary statistics for various measures of interbank market activity. Period 1 consists of 56 trading days from January 9, 2002 through March 29, 2002. Period 2 consists of 56 trading days from January 9, 2003 through March 31, 2003.

Variable	Mean	Standard Deviation	Minimum	Median	Maximum
Fraction of market trading at or above target+100 during Period 1.	.0097635	.0040487	.0011751	.0095214	.0218257
Fraction of market borrowing primary credit during Period 2.	.0000697	.0001421	0	.0000206	.0007724
Fraction of market trading at or above target+100 or borrowing primary credit during Period 2.	.0040602	.002413	.0003974	.0037616	.010511
Brokered reported daily standard deviation of interest rates paid in the funds market during Period 1.	0.13	0.32	0.03	0.06	1.77
Brokered reported daily standard deviation of interest rates paid in the funds market during Period 2.	0.04	0.02	0.02	0.03	0.11
Brokered reported daily highest rate paid in the funds market less the target rate during Period 1.	0.33	0.87	0	0.13	6.25
Brokered reported daily highest rate paid in the funds market less the target rate during Period 2.	0.16	0.14	0	0.13	0.75

Table 2: Tests for Equality of Distribution

This table reports test statistics for univariate comparisons of the fraction of the interbank market transacting at or above 100 basis points over target during Period 1 with the fraction of the interbank market transacting at the primary credit facility during Period 2. Period 1 consists of 56 trading days from January 9, 2002 through March 29, 2002. Period 2 consists of 56 trading days from January 9, 2003 through March 31, 2003.

Null hypothesis	Kolmogorov-Smirnov equality of distributions	Wilcoxon rank-sum tests
Fraction of market trading at or above target+100 during Period 1 is **greater** than fraction of market borrowing primary credit during Period 2.	D=0.000 p-value 1.000	
Fraction of market trading at or above target+100 during Period 1 is **less** than fraction of market borrowing primary credit during Period 2.	D=1.000 p-value 0.000	
Fraction of market trading at or above target+100 during Period 1 is **the same as** the fraction of market borrowing primary credit during Period 2.		Z=-9.125 p-value 0.000

Table 3: Regression models

This table reports coefficient estimates (and robust standard errors) for various regression specifications. The dependent variable in all specifications is the fraction q_{1t}, which measures the fraction of the interbank market that transacted at rates 100 or more basis points above the target funds rate of 1.75% during Period 1.

	1	2	3	4	5	6
Lagged dependent variable	0.285 (0.116)*	0.276 (0.120)*	0.283 (0.107)*			
Broker-reported high rate less target rate	0.001 (0.000)**	0.001 (0.000)**	0.001 (0.000)**	0.002 (0.000)**	0.002 (0.000)**	0.002 (0.000)**
Broker-reported standard deviation	0.001 (0.001)*	0.001 (0.001)*	0.001 (0.001)	0.002 (0.001)**	0.001 (0.001)*	0.001 (0.001)
Broker-reported average rate less target rate	-0.006 (0.010)		-0.008 (0.011)	-0.004 (0.010)		-0.006 (0.011)
Abs. val. of the return on the S&P 500			0.097 (0.060)			0.106 (0.065)
Abs. val. of the 10-year T-note yield change			0.012 (0.014)			0.012 (0.015)
Constant	0.006 (0.001)**	0.006 (0.001)**	0.005 (0.001)**	0.009 (0.001)**	0.009 (0.001)**	0.008 (0.001)**
Observations	55	55	55	56	56	56
R-squared	0.22	0.21	0.26	0.14	0.14	0.19
Robust standard errors in parentheses * significant at 5%; ** significant at 1%						
K-S test statistic comparing distribution of predicted values with actual primary credit borrowing	D=1.000 p-value 0.000	D=1.000 p-value 0.000	D=1.000 p-value 0.000	D=1.000 p-value 0.000	D=1.000 p-value 0.000	D=1.000 p-value 0.000
Wilcoxon test statistic comparing distribution of predicted values with actual primary credit borrowing	Z=-9.083 p-value 0.000	Z=-9.083 p-value 0.000	Z=-9.083 p-value 0.000	Z=-9.125 p-value 0.000	Z=-9.129 p-value 0.000	Z=-9.125 p-value 0.000

Figure 1: Borrowing from the discount window

This figure plots the ratio of borrowed reserves to required reserves since January 1959. Source: Federal Reserve H.3.

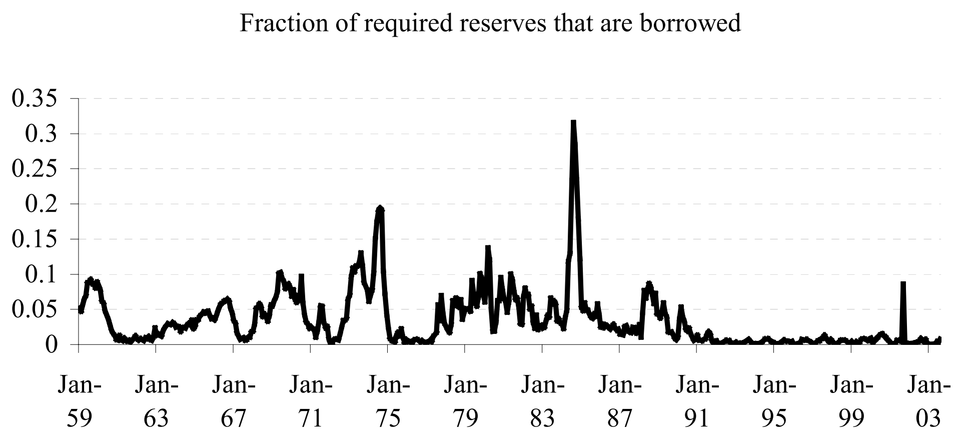


Figure 2: The bank's decision to search for a better rate in the interbank market

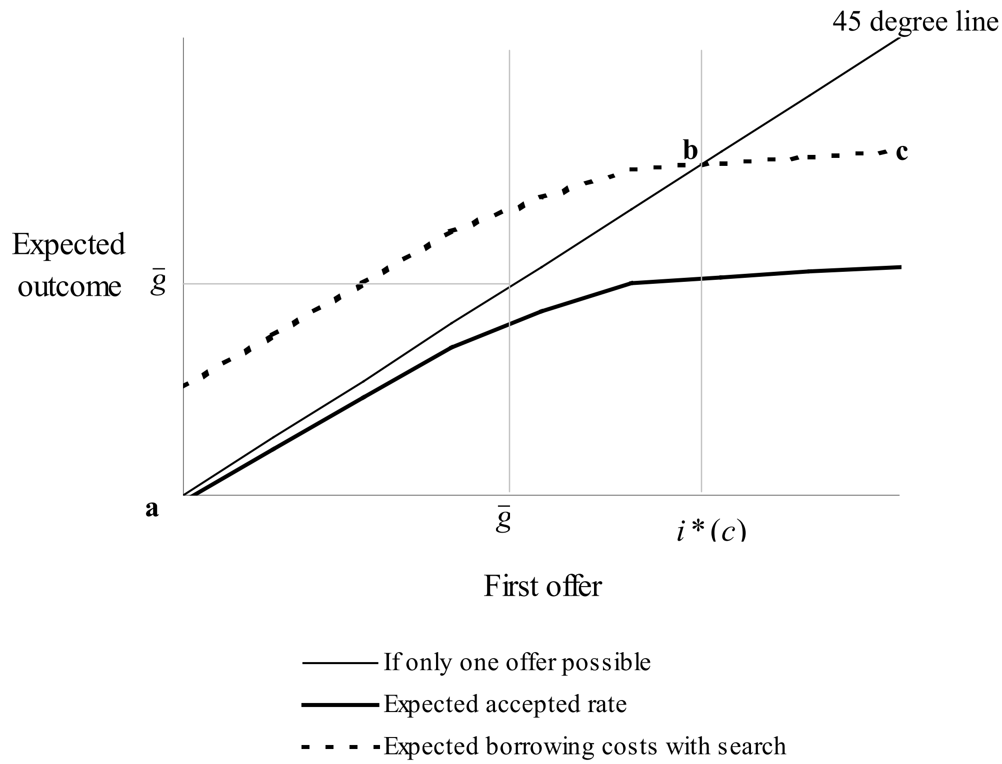
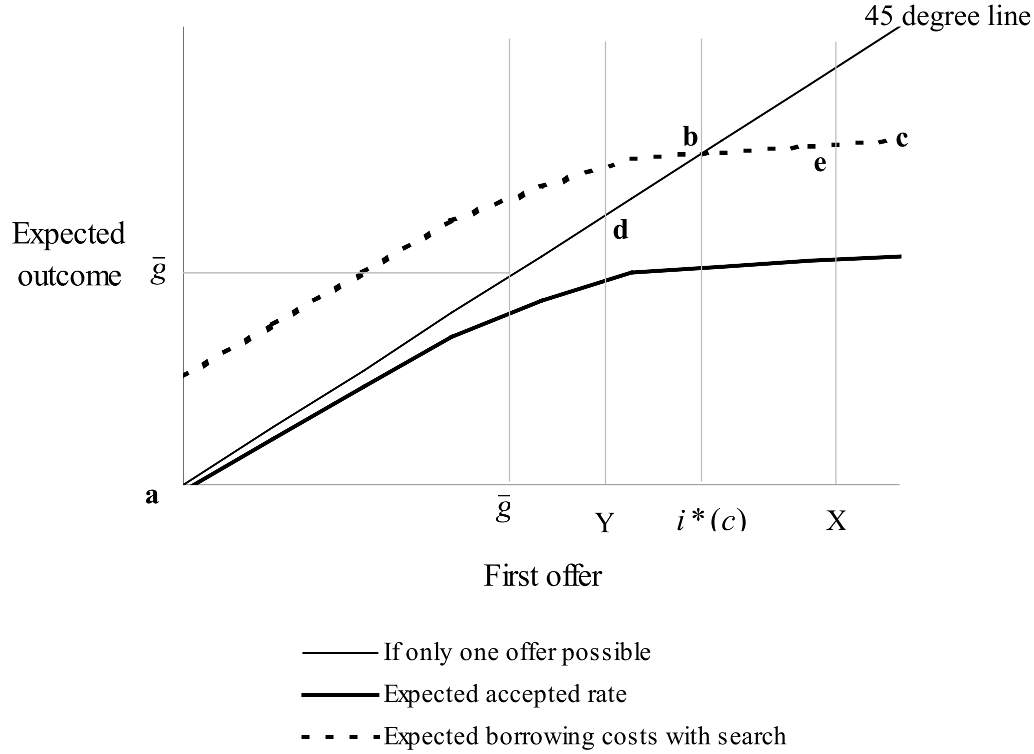


Figure 3: The influence of standing facilities



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