# The Discount Rate: Experience Under Reserve Targeting

*By Gordon H. Sellon, Jr., and Diane Seibert*

Since the change in Federal Reserve operating procedures from interest rate to reserve targeting in October 1979, the discount rate—the interest rate charged to depository institutions when they borrow from a Federal Reserve Bank—has had a more visible role in the implementation of monetary policy. In addition to changes in the basic discount rate, the Federal Reserve has at times imposed a surcharge rate on large banks that borrow frequently.

The purpose of this article is to examine the impact of the basic discount rate and the discount rate surcharge on interest rates and borrowing since the implementation of reserve targeting.[1] The article is divided into three sections. The first two contain analyses of the short-run effects of the basic discount rate and the discount rate surcharge on interest rates and borrowing under reserve targeting. The final section provides empirical evidence on the impact of discount rate changes since October 1979 and on the behavior of surcharge borrowing.

## THE BASIC DISCOUNT RATE

The basic discount rate is the interest rate charged for short-term borrowing from the Federal Reserve, which is primarily intended to allow depository institutions time to make more basic adjustments in their portfolios in response to unexpected changes in their assets and liabilities. The directors of the regional Federal Reserve Banks make recommendations concerning changes in the discount rate, which are subject to approval by the Board of Governors.[2]

Borrowing at the discount window plays an important part in the determination of short-term interest rates and in the growth of money and credit in the economy. Generally speaking, depository institutions have a need for reserves to support the growth of money and credit. This demand for reserves can be met in two ways: through reserves supplied by the Federal Reserve using open market operations and by

[1] Borrowing at the discount window can occur under a variety of programs: adjustment credit, seasonal credit, and other extended credit. For the purposes of this article, borrowing consists of adjustment and seasonal credit. Borrowing under the other extended credit program is treated as part of nonborrowed reserves.

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[2] Two recent studies of the role of discount policy under reserve targeting are P. Keir, "The Impact of Discount Policy Procedures on the Effectiveness of Reserve Targeting" in *New Monetary Control Procedures,* Federal Reserve Staff Study—Volume I, Board of Governors of the Federal Reserve System, February 1981, and G. H. Sellon, Jr., "The Role of the Discount Rate in Monetary Policy: A Theoretical Analysis," *Economic Review,* Federal Reserve Bank of Kansas City, June 1980.

reserves provided through the discount window. By varying the discount rate, the price of borrowed reserves, the Federal Reserve can influence the use of the discount window as a source of funds and so cause depository institutions to undertake balance sheet adjustments that affect market interest rates and the growth of money and credit.

## Analytical Framework

The impact of changes in the basic discount rate on discount window borrowing and interest rates can be analyzed by means of the following simple model of the demand and supply of borrowed reserves:

(1) $BR^D = \overline{BR} + b\,(rF - rD)$

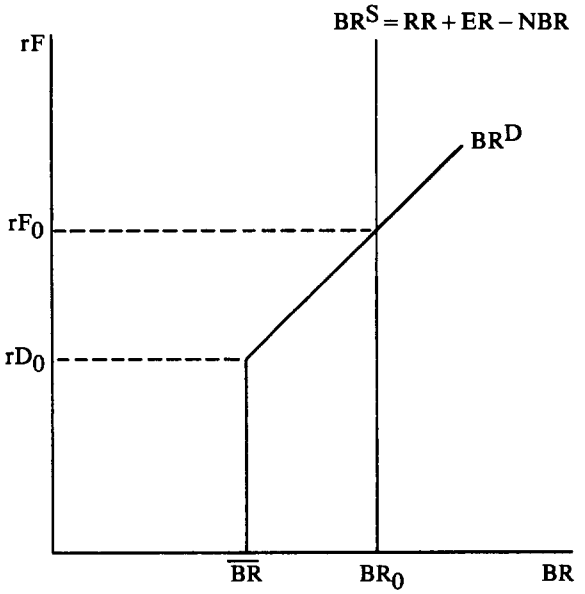
(2) $BR^S = RR + ER - NBR$

In equation (1), depository institutions' demand for borrowed reserves can be broken down into two parts. The term $\overline{BR}$ represents that part of borrowing that is insensitive to interest rates. This is a frictional level of borrowing that would occur even with the federal funds rate, rF, equal to or below the discount rate, rD.

The second term in equation (1) represents that part of the demand for borrowing that is sensitive to the positive spread between the funds rate and the discount rate. The higher the funds rate relative to the discount rate, the more incentive there is to borrow from the Federal Reserve rather than in the federal funds market. Changes in the discount rate can affect the demand for borrowed reserves to the extent that these changes alter the spread between the funds rate and the discount rate. Thus, if the discount rate is increased relative to the funds rate, borrowing will tend to be reduced. Alternatively, if the discount rate is lowered relative to the funds rate, borrowing will tend to increase.

The major factors influencing the supply of borrowed reserves are shown in equation (2).

**Figure 1**




Other things equal, an increase in required reserves, RR, or excess reserves, ER, tends to increase the need for institutions to use the discount window. In contrast, a greater quantity of nonborrowed reserves, NBR, supplied by the Federal Reserve through open market operations, tends to reduce the need for discount window borrowing.

A graphic illustration of this model is shown in Figure 1. When the funds rate, rF, is below the discount rate, $rD_0$, institutions have little incentive to use the discount window so that the demand for borrowing, $BR^D$, consists only of interest-insensitive borrowing, $\overline{BR}$. As the funds rate rises above the discount rate, however, the discount window becomes more attractive as a source of funds so that the demand for borrowed reserves increases. Thus, for example, with a funds rate of $rF_0$ and discount rate, $rD_0$, total borrowing, BR, rises to $BR_0$.

Unlike the demand for borrowed reserves, the supply of borrowed reserves is not sensitive to interest rates. Thus, in Figure 1, it is shown

**Figure 2**

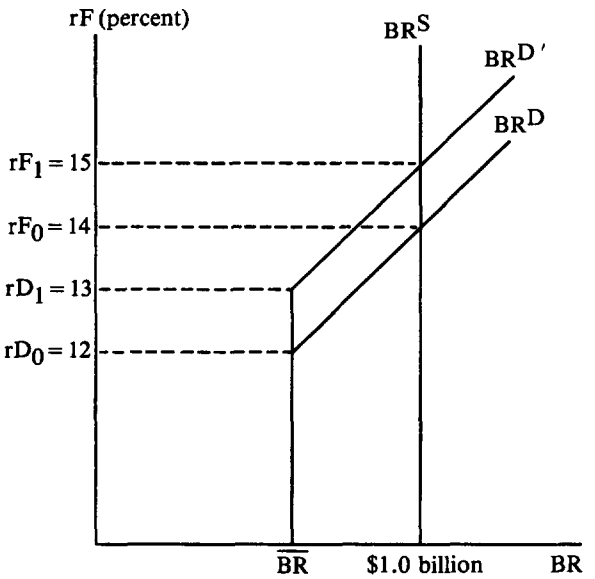
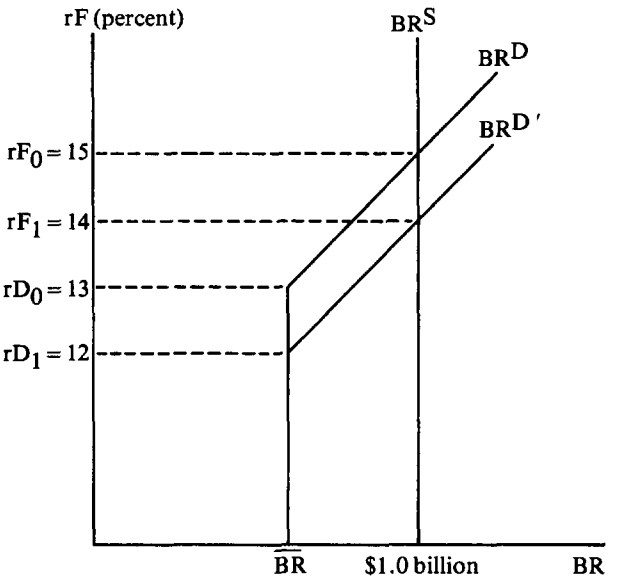



**Figure 3**




as a vertical line $BR^S$. The interest insensitivity of the supply curve results from several important assumptions. First, it is assumed that a system of lagged reserve accounting is in effect so that required reserves in a given week do not depend upon deposits or interest rates in that week.[3] Second, excess reserves are taken to be unresponsive to interest rate changes. Finally, the Federal Reserve is considered to be using a nonborrowed reserves operating target so that the quantity of nonborrowed reserves is given and is not varied in response to interest rate changes.

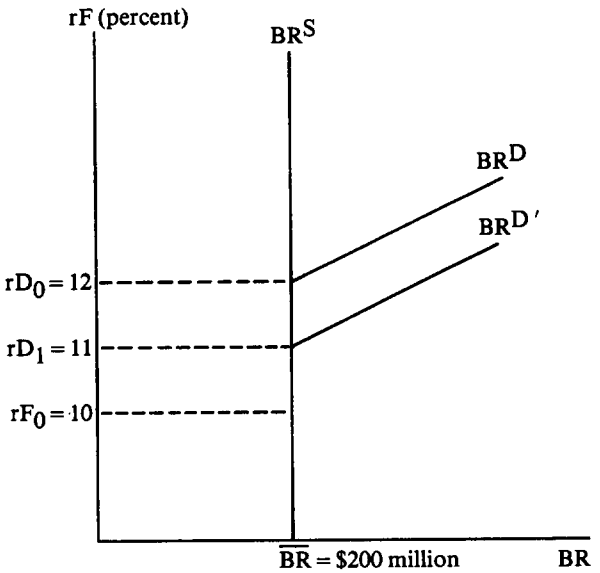
## The Impact of Discount Rate Changes

This framework can be used to examine the impact of changes in the basic discount rate. In general, the most important determinant of whether discount rate changes can have an effect on market rates is the existence of a positive spread between the funds rate and the discount rate. If the funds rate is above the discount rate, some interest-sensitive borrowing will occur. In this situation, discount rate changes affect market rates by altering the demand for borrowed reserves. In contrast, if the funds rate is below the discount rate, so that the discount rate is a penalty rate, discount rate changes have no impact on market rates. The reason is that with a penalty discount rate, there is no interest-sensitive borrowing. As a consequence, discount rate changes have no effect on the demand for borrowed reserves and, hence, no impact on market interest rates.[4]

[3] Under a lagged reserve accounting system, changes in deposits in the current week have no effect on banks' required reserves. This reduces the responsiveness of the demand for total reserves to market interest rates, since interest rate effects on money demand are not transmitted to required reserves in the current statement week.

[4] Under lagged reserve accounting, the existence of a penalty discount rate may make it difficult for the Federal Reserve to employ a nonborrowed reserve operating procedure. For a more detailed discussion, see J. A. Cacy, B. Higgins, and G. H. Sellon, Jr., "Should the Discount Rate be a Penalty Rate?" *Economic Review,* Federal Reserve Bank of Kansas City, January 1981.

**Figure 4**




A more detailed analysis of discount rate changes is shown in Figures 2-4. Consider, first, the implications of an increase in the basic discount rate. In Figure 2, initially the discount rate, $rD_0$, is 12 percent, the federal funds rate, $rF_0$, is 14 percent, and discount window borrowing is $1.0 billion. An increase in the discount rate to 13 percent reduces the demand for borrowed reserves so that the $BR^D$ curve shifts to $BR^{D'}$. As a result of this shift, the funds rate increases to 15 percent, and the amount of discount window borrowing remains unchanged at $1.0 billion. Thus, under the conditions shown in Figure 2, a 1 percent increase in the basic discount rate results in a 1 percent rise in the federal funds rate but no change in total discount window borrowing.

The results depend importantly on the assumptions of lagged reserve accounting and the use of a nonborrowed reserve targeting procedure.[5] With these assumptions, the supply of borrowed reserves in a given week is essentially fixed. That is, in the aggregate, depository institutions must borrow the quantity that is supplied. When the discount rate is increased, some banks are initially discouraged from using the discount window as a source of funds. Instead, they attempt to meet their reserve needs in the federal funds market. However, with a fixed supply of reserves, their actions bid up the funds rate until the original spread between the funds rate and discount rate is restored, leaving aggregate borrowing unchanged. Thus, with lagged reserve accounting and a fixed quantity of nonborrowed reserves, discount rate increases have an immediate one-for-one effect on the funds rate but no immediate impact on the quantity of discount window borrowing.[6]

The impact of a reduction in the basic discount rate is somewhat more complicated. In

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5 Alternatively, under a contemporaneous reserve accounting system, changes in deposits in the current week would affect required reserves in that week. As a result, the demand for total reserves in the current week would be responsive to interest rates as would the supply of borrowed reserves in equation (2). In this environment, discount rate changes would have less than a one-for-one impact on the funds rate and would affect the quantity of reserves borrowed. Similar results would be obtained if excess reserves were interest sensitive. Furthermore, if the Federal Reserve targeted interest rates instead of nonborrowed reserves, discount rate changes would not have any effect on market rates but would affect the amount of reserves borrowed. In this situation, discount rate changes would be offset by changes in nonborrowed reserves, so that there would not be a net effect on market rates. For a further discussion of discount rate changes under different operating targets, see G. H. Sellon, Jr., "The Role of the Discount Rate in Monetary Policy." Additional information on the distinction between lagged and contemporaneous reserve accounting can be found in D. S. Jones, "Contemporaneous vs. Lagged Reserve Accounting: Implications for Monetary Control," *Economic Review,* Federal Reserve Bank of Kansas City, November 1981.

6 The results of discount rate increases differ considerably when the discount rate is a penalty rate. As indicated above, in this situation discount rate increases would have no impact on market rates. However, as this situation is unlikely to arise in practice, it is not afforded a detailed examination.

practice, the Federal Reserve has cut the discount rate in both a penalty rate and a nonpenalty rate situation. Thus, two cases must be distinguished, depending on whether the discount rate is below or above the funds rate when the discount rate is lowered. In Figure 3, initially the discount rate is 13 percent, the funds rate is 15 percent, and borrowing is $1.0 billion. A decrease in the discount rate to 12 percent shifts the demand for borrowed reserves from $BR^D$ to $BR^{D'}$, resulting in a reduction of the funds rate to 14 percent with borrowing at $1.0 billion. In this situation, the effects of a reduction in the discount rate are symmetrical with those of a discount rate increase. A 1 percentage point cut in the discount rate lowers the funds rate by a full percentage point but leaves aggregate discount window borrowing unchanged.

Different results are obtained, however, if the discount rate is above the funds rate when the discount rate is reduced. In Figure 4, the discount rate is initially at 12 percent while the funds rate is 10 percent. Since the funds rate is below the discount rate, there is no incentive for institutions to use the discount window, so that borrowing is at a frictional level of $200 million. In these circumstances a cut in the basic discount rate from 12 percent to 11 percent shifts the demand for borrowed reserves from $BR^D$ to $BR^{D'}$. However, since there is no interest-sensitive borrowing, the reduction in the discount rate has no impact on the funds rate or the frictional level of borrowing. Thus, if the discount rate is above the funds rate so that the discount rate is a penalty rate, discount rate reductions have no impact on interest rates or borrowing.[7]

[7] Even in a penalty rate environment, a discount rate reduction may affect interest rates to the extent that the reduction is perceived as a signal of future Federal Reserve policy.

## THE DISCOUNT RATE SURCHARGE

In March 1980, the Federal Reserve introduced a discount rate surcharge which applied to large banks that made frequent use of the discount window. The purpose of the surcharge was to prevent large banks with access to the money markets from borrowing excessively without imposing a higher cost on small banks with limited access to alternative sources of funds. The surcharge was applied to banks with deposits over $500 million that borrowed for two consecutive weeks or for more than four weeks in a calendar quarter.[8]

When introduced on March 17, 1980, the discount rate surcharge was 3 percent. Thus, large banks subject to the surcharge would pay the basic discount rate of 13 percent plus the 3 percent surcharge, or a total of 16 percent. The surcharge was removed on May 8, 1980. Subsequently, the surcharge was reintroduced on November 17, 1980, and remained in effect until November 17, 1981. During this time, the surcharge rate ranged from 2 to 4 percent.

The use of a discount rate surcharge can be expected to affect both the pattern of discount window borrowing and the level of short-term interest rates. The behavior of large banks depends on whether they are potentially subject to the surcharge and on the relative price of funds obtained in the market as compared to the price at the discount window.[9] For example,

[8] The formula for applying the surcharge was changed from a calendar quarter to a moving 13-week period on October 1, 1981.

[9] The behavior of large banks under a surcharge depends crucially on the frequency criteria used in applying the surcharge. Thus, banks which do not see themselves as being seriously constrained by a surcharge may behave very differently from banks that are so constrained. Furthermore, frequency criteria may alter banks' decisions as to when to use the discount window, leading to unpredictable week-to-week changes in borrowing demand. These considerations highlight the complexity of modeling bank behavior when a surcharge is in effect.

when the funds rate is less than the basic discount rate plus the surcharge, large banks potentially subject to the surcharge will tend to avoid the discount window and will attempt to meet their reserve needs in the federal funds market. In contrast, when the federal funds rate exceeds the discount rate plus surcharge, large banks would be expected to return to the discount window, since the price of reserves borrowed from the Federal Reserve, including the surcharge, is less than the cost of federal funds.

Even though they are not subject to the surcharge, small banks are indirectly affected when a surcharge is in effect. To the extent that large banks avoid the discount window and attempt to fund their reserve needs in the market, they place upward pressure on the federal funds rate. Small banks which borrow reserves are affected in two ways. First, if small banks choose not to borrow at the discount window, they must pay the higher market rate. Second, small banks actually have an incentive to make more use of the discount window since a higher market rate increases the attractiveness of reserves borrowed at the basic discount rate. Indeed, given a fixed supply of borrowed reserves in a particular week, to the extent that the surcharge induces large banks to reduce their borrowings, the higher market rate will cause small banks to borrow an offsetting amount, leaving the total amount of discount window borrowings unchanged.

## The Surcharge and the Demand for Borrowing

The impact of the discount rate surcharge on the demand for borrowing can be analyzed by dividing the total demand for borrowed reserves into the demands for borrowed reserves by large banks and small banks, respectively.

$$\text{(3a)}\quad BR_L^D = \overline{BR}_L + b_L(rF - rD - S)$$

$$\text{(3b)}\quad BR_S^D = \overline{BR}_S + b_S(rF - rD)$$

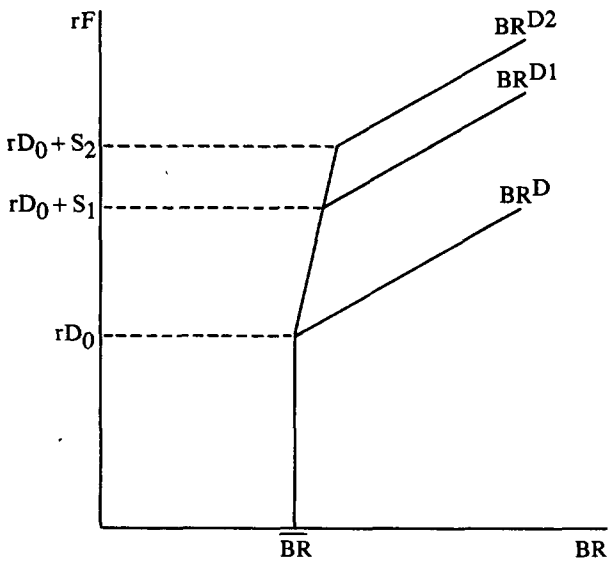
Equation (3a) describes the demand for borrowing by large banks subject to the surcharge.[10] Borrowing by large banks is made up of an interest-insensitive amount, $\overline{BR}_L$, plus an amount which depends upon the spread between the funds rate, rF, and the basic discount rate, rD, plus the surcharge rate, S. When the funds rate is below the basic discount rate plus surcharge, large banks are assumed to undertake only interest-insensitive borrowing.

Equation (3b) describes the demand for borrowing by small banks. Borrowing by small banks is made up of an interest-insensitive amount, $\overline{BR}_S$, plus an amount that depends upon the spread between the basic discount rate and the funds rate. Small banks are not directly affected by the surcharge rate.

The impact of the introduction of a surcharge on the total demand for borrowed reserves is shown in Figure 5. In the absence of a surcharge, the total demand for borrowed reserves, $BR^D$, is the sum of the separate demands by large and small banks. The introduction of a surcharge on large banks causes a change in their behavior. With a surcharge, $S_1$, when the funds rate is between the basic rate, $rD_0$, and the basic rate plus surcharge, $rD_0 + S_1$, there is no interest-sensitive borrowing by large banks. The total demand for bor-

[10] In order to simplify the analysis in light of the problem of modeling the impact of frequency criteria on surcharge borrowing, it is assumed that all large banks are subject to the surcharge in a given week. To the extent that all large banks are not subject to the surcharge, the interest rate implications of the surcharge are attenuated. Furthermore, frequency criteria may cause the demand for borrowed reserves by large banks to undergo considerable week-to-week variations.

**Figure 5**




rowing consists of the interest-insensitive borrowing by both large and small banks plus the interest-sensitive borrowing by small banks. When the funds rate rises above the basic discount rate plus surcharge, $rD_0+S_1$, interest-sensitive borrowing by large banks is restored. Thus, with a surcharge, $S_1$, the total demand for borrowed reserves is shown as the curve $BR^{D1}$.[11] With a larger surcharge, $S_2$, the demand for borrowed reserves is given by $BR^{D2}$. That is, the higher the surcharge, the greater the range over which large banks tend to avoid the discount window.

[11] Without a surcharge, the total demand for borrowed reserves is given by:

$$BR^D = \overline{BR}_L + \overline{BR}_S + (b_L+b_S)(rF-rD).$$

With a surcharge and with the funds rate below the discount rate plus surcharge, the total demand for borrowed reserves is given by:

$$BR^D = \overline{BR}_L + \overline{BR}_S + b_S(rF-rD).$$

With a surcharge and with the funds rate above the discount rate plus surcharge, the total demand for borrowed reserves is given by:

$$BR^D = \overline{BR}_L + \overline{BR}_S + b_L(rF-rD-S) + b_S(rF-rD).$$

Thus, the steeper slope of the borrowing demand curve, $BR^{D1}$, in Figure 5 when the funds rate is between the basic discount rate and the basic rate plus surcharge corresponds to the second case where only small banks have interest-sensitive borrowing.

## The Surcharge and Interest Rates

The discount rate surcharge has a number of important implications for the level of market interest rates. The main points are summarized first and are then discussed in more detail below.

1. For a given supply of borrowed reserves, a discount rate surcharge raises market interest rates as compared to a situation of no surcharge. Moreover, a surcharge can affect market interest rates even if no borrowing occurs at the surcharge rate.
2. The impact on market rates of a given surcharge is not uniform but depends upon the quantity of borrowed reserves supplied. In general, a surcharge of a given amount has a larger impact on market rates at higher levels of borrowing.
3. The imposition of a surcharge has a smaller impact on market rates than an equal increase in the basic discount rate.
4. Changes in the surcharge rate may or may not have an impact on market rates depending on the position of the market rate relative to the surcharge.

Generally speaking, a discount rate surcharge affects market interest rates by changing the relative cost of funds obtained via the discount window versus funds obtained in the market. Suppose that the funds rate is between the basic discount rate and the discount rate plus surcharge. In this situation, large banks subject to the surcharge have an incentive to reduce their discount window borrowing and to increase their borrowing in the funds market. These actions cause the funds rate to be bid up relative to the basic discount rate. Small banks, initially unaffected by the imposition of the surcharge,

**Figure 6**

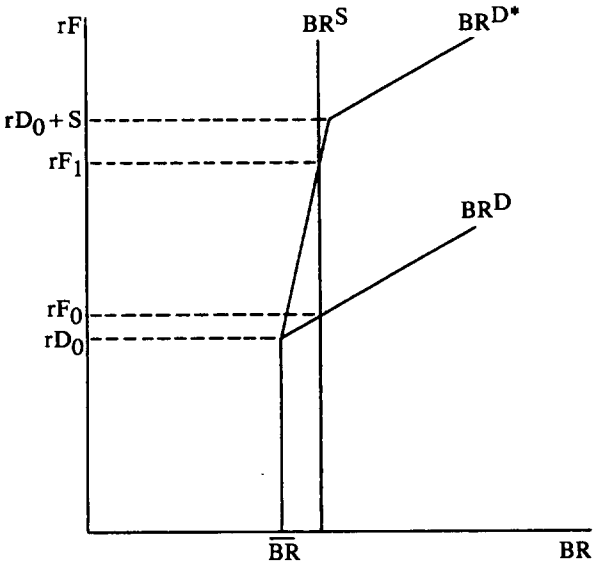
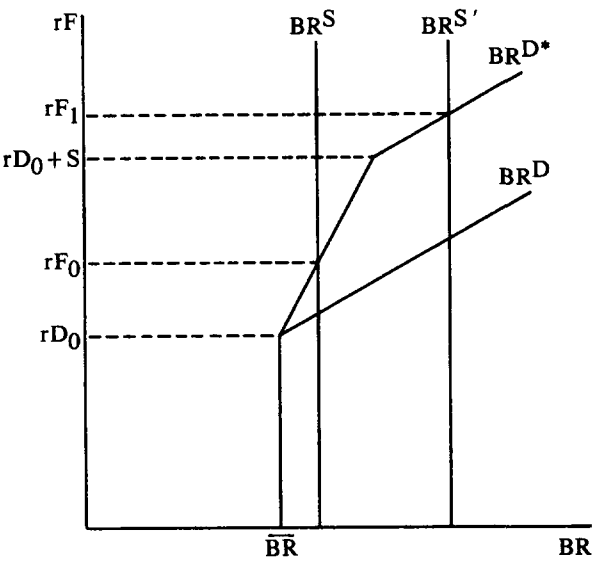



**Figure 7**



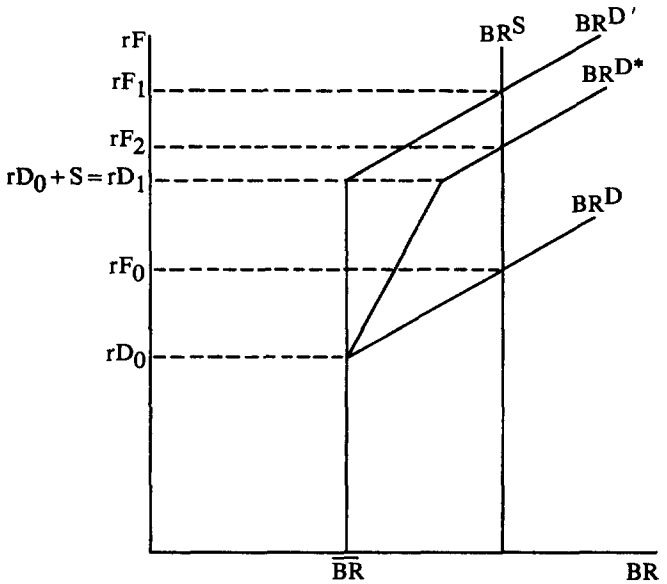

tend to increase their discount window borrowing in response to the widening spread between the funds rate and the basic discount rate. It is important to note that the increase in the funds rate occurs in response to large banks' attempts to avoid paying the surcharge. Thus, the rise in the funds rate can occur even if no large banks actually borrow at the surcharge rate.

These points are illustrated in Figure 6. In the absence of a surcharge, the demand for borrowed reserves is given by $BR^D$. With the supply of borrowed reserves, $BR^S$, the initial funds rate, $rF_0$, is above the basic discount rate, $rD_0$. In this situation, some interest-sensitive borrowing by both large and small banks would occur. With a surcharge, however, the demand for borrowed reserves is given by $BR^{D*}$, and the funds rate rises from $rF_0$ to $rF_1$ in order to induce small banks to absorb the borrowed reserves that are no longer demanded by large banks subject to the surcharge. Moreover, since the funds rate is between the discount rate and the discount rate plus surcharge, there would be no interest-sensitive borrowing by large banks.

While a surcharge tends to raise market interest rates, the size of the impact on market rates varies with the level of borrowing. In general, a given surcharge has a larger effect at higher levels of borrowing. The reason is that for a relatively small supply of borrowed reserves, the funds rate does not have to rise by much in order to induce small banks to offset the reduction in borrowing by large banks caused by the surcharge. In contrast, with a relatively large supply of borrowed reserves, the funds rate has to rise by a greater amount in order for banks to borrow the quantity supplied. In fact, the funds rate may rise above the basic discount rate plus surcharge, giving both large banks and small banks an incentive to use the discount window.

Figure 7 shows how the impact of a surcharge on interest rates may vary depending on the level of borrowing. With a surcharge of a given amount, S, the demand for borrowed reserves is given by $BR^{D*}$. If the supply of borrowed

**Figure 8**




reserves is $BR^S$, the equilibrium funds rate is $rF_0$. Since the funds rate is between the basic discount rate, $rD_0$, and the basic rate plus surcharge, $rD_0 + S$, all interest-sensitive borrowing is done by small banks. In contrast, with borrowing supply curve $BR^{S'}$, the funds rate, $rF_1$, is above the basic rate plus surcharge, $rD_0 + S$, so that both large and small banks borrow at the discount window. Comparison of the two cases shows that the surcharge has a larger impact on the spread between the funds rate and basic discount rate for higher levels of borrowing.

A third property of a discount rate surcharge is that a surcharge has a smaller impact on market rates than an equal change in the basic discount rate. That is, a 1 percent surcharge has less of an impact on market rates than a 1 percent increase in the basic rate. Moreover, since an increase in the basic rate generally raises market rates on a one-for-one basis, a discount rate surcharge increases market rates by only a fraction of the surcharge.

The reason for this difference is that a change in the basic discount rate makes the discount window less attractive to both large banks and small banks. In contrast, a discount rate surcharge directly alters the behavior only of large banks subject to the surcharge. Thus, for an equal increase in the two rates, the demand for borrowed reserves is reduced by a greater amount in the case of the basic rate. As a consequence, the market rate must rise by more in the case of a change in the basic rate to induce banks to return to the discount window and absorb the fixed supply of borrowed reserves.

A comparison of changes in the basic discount rate and the discount rate surcharge is shown in Figure 8. Initially, for a basic discount rate of $rD_0$, the demand for borrowed reserves is given by $BR^D$. With a fixed supply of borrowed reserves, $BR^S$, the initial funds rate is $rF_0$. A 1 percent increase in the basic discount rate causes a reduction in the demand for borrowed reserves by both large and small banks so that the $BR^D$ curve shifts to $BR^{D'}$ and the funds rate increases to $rF_1$. In contrast, a 1 percent discount rate surcharge leads to a reduction in the demand for borrowed reserves by large banks only. In this situation, the borrowing demand curve shifts from $BR^D$ to $BR^{D*}$ and the funds rate rises to $rF_2$. Thus, an increase in the basic discount rate results in a larger increase in the funds rate than does an equal increase in the surcharge.

While a discount rate surcharge generally has an impact on market interest rates, there are important circumstances in which changes in the surcharge may not affect market rates. Specifically, a discount rate surcharge only affects market rates to the extent that it alters the behavior of banks subject to the surcharge. Thus, for example, if a surcharge is in effect and the funds rate is currently lower than the basic discount rate plus surcharge, large banks do not have an incentive to use the discount

**Table 1**
**DISCOUNT RATE HISTORY: POST OCTOBER 1979**

| Date* | Basic Rate (in percent) | Surcharge (in percent) |
|---|---|---|
| **1980** | | |
| February 15 | 13 | — |
| March 17 | — | 3 |
| May 8 | — | 0 |
| May 30 | 12 | — |
| June 13 | 11 | — |
| July 28 | 10 | — |
| September 26 | 11 | — |
| November 17 | 12 | 2 |
| December 5 | 13 | 3 |
| **1981** | | |
| May 5 | 14 | 4 |
| September 22 | — | 3 |
| October 12 | — | 2 |
| November 2 | 13 | — |
| November 17 | — | 0 |
| December 4 | 12 | — |
| **1982** | | |
| July 20 | 11½ | — |
| August 2 | 11 | — |
| August 16 | 10½ | — |
| August 27 | 10 | — |

*Effective date of rate changes at the Federal Reserve Bank of New York. NOTE: The discount rate was 12 percent at the time of the October 1979 operating procedure switch.

window. In this situation, an increase in the surcharge would not be expected to have an impact on market rates, since it would not induce any further reduction in discount window usage by large banks.

In a similar manner, a reduction in a discount rate surcharge may not affect market interest rates. To be effective in reducing market rates, a cut in the surcharge would have to be large enough so that large banks would have an incentive to return to the discount window. That is, under circumstances in which large banks are avoiding the discount window because of the presence of a surcharge, a cut in the surcharge would have to be large enough to place the basic discount rate plus surcharge below the funds rate. Only then would large banks have an incentive to return to the discount window.

## EMPIRICAL ANALYSIS

This section contains a variety of empirical evidence on the role of the basic discount rate and the discount rate surcharge in the period since October 1979. The analysis is divided into two parts. In the first part, the effects of changes in the basic discount rate and the discount surcharge on market interest rates are examined. The second part contains a more detailed discussion of the impact of the surcharge on the behavior of large banks and on the demand for borrowed reserves.

### The Impact of Discount Rate Changes

A history of recent changes in the basic discount rate and discount rate surcharge is shown in Table 1. In the post-October 1979 period the basic rate has been changed 14 times and has ranged from 10 to 14 percent. A 3 percent surcharge was imposed in March 1980 and removed in May 1980. The surcharge was reimposed in November 1980 at a rate of 2 percent and was subsequently raised to 3 percent in December 1980 and to 4 percent in May 1981. The surcharge was then lowered to 3 percent in September 1981, to 2 percent in October 1981, and was removed in November 1981.

The previous analysis suggests that both the basic discount rate and the discount rate surcharge can have a significant impact on market interest rates when the Federal Reserve employs a nonborrowed reserve operating procedure. In order to measure these effects, a simple weekly model of the reserves market was estimated over the period from October 1979 to May 1982. The model, shown in Table 2, is a reduced form of the model of the demand and

**Table 2**
**THE IMPACT OF DISCOUNT RATE CHANGES**

I. Model

$$\Delta rF = a_0 + a_1 \cdot D1 \cdot \Delta rD + a_2 \cdot D2 \cdot \Delta rD + a_3 \cdot \Delta S + a_4 \cdot \Delta NBR + a_5 \cdot \Delta RR + a_6 \cdot \Delta NETCO$$

where

| | |
|---|---|
| rF | = federal funds rate |
| rD | = basic discount rate |
| D1 | = dummy variable for discount rate increases (=1 for increases, =0 otherwise) |
| D2 | = dummy variable for discount rate decreases (=1 for decreases, =0 otherwise) |
| S | = discount rate surcharge |
| NBR | = nonborrowed reserves |
| RR | = required reserves |
| NETCO | = potential net carryover of excess reserves |

II. Estimation

$$\Delta rF = \underset{(-0.1766)}{-0.0119} + \underset{(2.3405)}{1.1598} \cdot D1 \cdot \Delta rD + \underset{(0.3385)}{0.1629} \cdot D2 \cdot \Delta rD$$

$$+ \underset{(3.8445)}{0.6452} \cdot \Delta S - \underset{(-2.5326)}{0.0003} \cdot \Delta NBR + \underset{(2.3678)}{0.0006} \cdot \Delta RR - \underset{(-2.9673)}{0.0016} \cdot \Delta NETCO$$

Sample period: weekly, October 17, 1979 to May 5, 1982

$\bar{R}^2 = .2240$ Standard Error of Regression = 0.7476

Durbin-Watson Statistic = 1.84

NOTE: The federal funds rate, the basic discount rate, and the surcharge rate are measured in percentage points and are based on seven-day averages for the statement week ending Wednesday. Nonborrowed reserves, required reserves, and potential net carryover of excess reserves are measured in millions of dollars.

supply of borrowed reserves presented earlier. In this reduced form, changes in the federal funds rate, rF, are related to changes in the basic discount rate, rD, changes in the discount rate surcharge, S, changes in nonborrowed reserves, NBR, changes in required reserves, RR, and changes in the net carryover of excess reserves, NETCO.[12]

The theoretical analysis suggests that the impact of discount rate changes differs according

[12] Under present reserve accounting procedures, depository institutions are allowed to carry forward into the following settlement period excess reserves or a reserve deficiency of up to 2 percent of reserve requirements. Thus, this carryover provision affects the net supply of borrowed reserves in a given week.

to whether the funds rate is above or below the basic discount rate. In fact, it is possible to distinguish four cases: (1) a basic discount rate increase without a penalty rate, (2) a discount rate increase with a penalty rate, (3) a discount rate decrease without a penalty rate, and (4) a discount rate decrease with a penalty rate. As a practical matter, however, 10 of the 11 discount rate changes during the sample period fell into categories (1) and (4). Thus, two dummy variables were created in order to distinguish the effects of increases versus decreases in the basic discount rate. The coefficient $a_1$ measures the impact on the funds rate of an increase in the basic rate. Because all basic discount rate increases during the sample period occurred in a nonpenalty rate setting, the coefficient $a_1$ would be expected to have a value close to one. In contrast, the coefficient $a_2$ measures the impact on the funds rate of a decrease in the basic discount rate. Since most cuts in the basic discount rate occurred in a penalty rate environment, $a_2$ would be expected to have a value close to zero.[13]

The empirical results in Table 2 strongly support the view that discount rate increases can have a significant effect on market rates under a nonborrowed reserves operating procedure. The value of the coefficient $a_1$ indicates that an increase in the basic discount rate by 1 percentage point leads to a rise in the funds rate of approximately 1.16 percentage points. Thus, increases in the basic discount rate have approximately a one-for-one effect in raising market rates in an environment of lagged reserve accounting and a nonborrowed reserve operating procedure.

In contrast, the coefficient on basic rate reductions, $a_2$, is small and not statistically different from zero. Thus, during the sample period, reduction in the basic discount rate had little or no independent effect on market rates. The explanation of this result is that most of the cuts in the basic rate occurred when the funds rate was below the discount rate. Under these circumstances, the previous analysis suggests that discount rate reductions do not have an impact on market rates.

The reaction of market rates to changes in the discount rate surcharge also is consistent with the theoretical discussion. The surcharge coefficient, $a_3$, is significant and indicates that a 1 percent surcharge raises the funds rate by approximately 65 basis points. That is, while changes in the surcharge affect market rates, these changes have a smaller impact than changes in the basic discount rate. Moreover, a surcharge of 3 percent increases market rates by approximately 2 percentage points, a result similar to that obtained in the Federal Reserve System study of the impact of the new operating procedures.[14]

## Surcharge Borrowing and Interest Rates

While the empirical analysis confirms the importance of discount rate changes on market interest rates, a more detailed analysis is necessary to gauge the impact of the discount rate surcharge on the behavior of large banks and on the total demand for borrowed reserves. Some information can be obtained by dividing the sample period, October 1979-May 1982, into weeks in which a surcharge was in effect and weeks without a surcharge. This procedure shows that large banks' borrowing as a percent of total borrowing averaged 60 percent in weeks without a surcharge compared with an average

[13] It should be noted that over a sample period that contained more observations in categories (2) and (3), it might be useful to develop additional dummy variables. While in principle it might be possible to extend this type of categorization to surcharge changes, in practice collinearity between basic discount rate changes and surcharge changes prevented its application.

[14] P. Keir, p. A-6.

## Table 3
## SURCHARGE BORROWING

| Surcharge Rate (percentage points) | Weeks in Effect | Amount Borrowed at the Surcharge ($ millions) | | Number of Institutions Paying the Surcharge | | Surcharge Borrowing as a Percent of Total Borrowing by Large Institutions | | Surcharge Borrowing as a Percent of Total Borrowing | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| 2 | 8 | 174 | 0-669 | 8 | 0-30 | 15 | 0-45 | 10 | 0-31 |
| 3 | 33 | 81 | 0-395 | 5 | 0-29 | 11 | 0-53 | 5 | 0-26 |
| 4 | 20 | 96 | 0-494 | 5 | 0-14 | 9 | 0-48 | 5 | 0-20 |

of 52 percent in weeks with a surcharge. Thus, there was a tendency for large banks to borrow relatively less and small banks to borrow relatively more in weeks in which a surcharge was in effect.

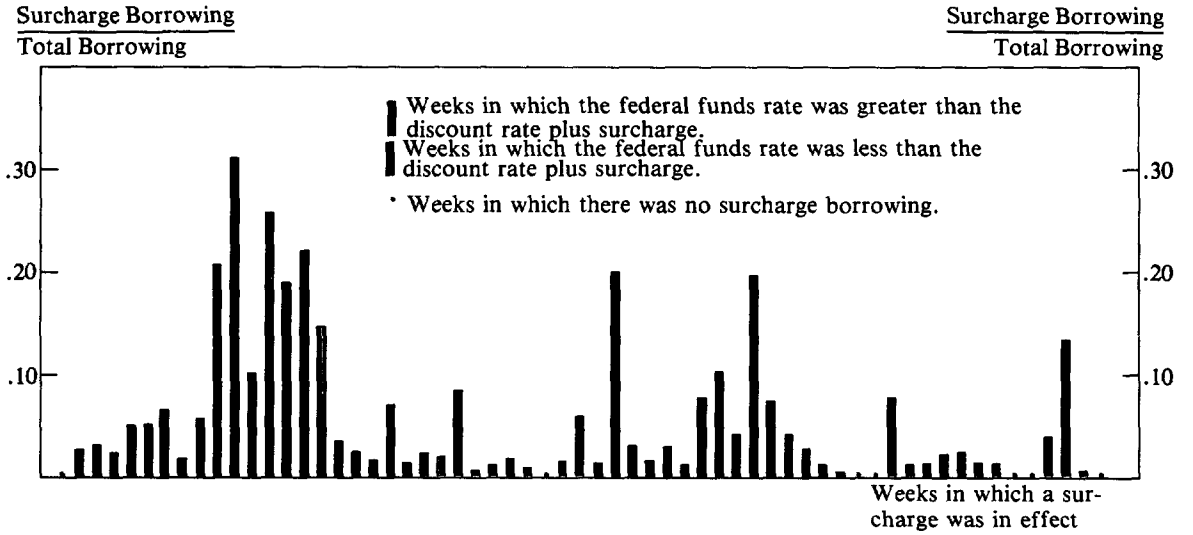
A more detailed picture of surcharge borrowing is provided in Table 3. These data indicate that, at times, surcharge borrowing comprised as much as 50 percent of the total borrowing of large banks and as much as 30 percent of total borrowing by all institutions. The table also provides evidence on the relationship between the size of the surcharge and the number of institutions borrowing at the surcharge rate. While as many as 30 institutions paid the surcharge in a given week in which a 2 or 3 percent surcharge was operative, this number was reduced by half in the presence of a 4 percent surcharge. Furthermore, regardless of the surcharge rate in effect, the amount of surcharge borrowing varied over a wide range, highlighting the difficulty of forecasting the demand for borrowing in weeks in which a surcharge was in effect.

The theoretical analysis presented earlier suggested that the behavior of large banks under a surcharge should depend on the relationship of the funds rate to the basic discount rate plus surcharge. In particular, when the funds rate is below the discount rate plus surcharge, one would expect relatively little usage of the discount window by large banks potentially subject to the surcharge. In contrast, with a funds rate above the discount rate plus surcharge, the discount window becomes a more attractive source of funds to large banks.

This analysis is supported by the data presented in Chart 1, which shows the amount of surcharge borrowing as a percent of total borrowing in weeks in which a surcharge was in effect. The blue bars indicate those weeks in which the funds rate is below the discount rate plus surcharge, while the black bars identify weeks in which the funds rate is above the discount rate plus surcharge. There is a clear tendency for the proportion of surcharge borrowing to increase in weeks in which the funds rate is above the basic discount rate plus surcharge. Thus, the proportion of surcharge borrowing to total borrowing appears to be related to the relative prices of reserves obtained in the market versus reserves obtained at the discount window.

The previous theoretical analysis suggests there are two important ways in which the surcharge affects the demand for borrowing. First, a surcharge tends to reduce the demand for borrowing at any given spread between the funds rate and the basic discount rate. This relationship is examined in Chart 2, which compares the spread to total borrowing. The black dots depict weeks in which no surcharge was in effect while the blue dots correspond to weeks in which a surcharge was in effect. In general, the

## Chart 1
## INTEREST SENSITIVITY OF SURCHARGE BORROWING




## Table 4
## SPREAD BETWEEN FEDERAL FUNDS RATE AND DISCOUNT RATE AT ALTERNATIVE BORROWING LEVELS

(Percentage Points)

| Borrowing (millions of dollars) | No Surcharge | Surcharge = 2 Percent | Surcharge = 3 Percent | Surcharge = 4 Percent |
|---|---|---|---|---|
| 1,000 | 1.04 | 1.61 | 2.00 | 2.49 |
| 1,500 | 1.71 | 2.65 | 3.29 | 4.09 |
| 2,000 | 2.44 | 3.77 | 4.69 | 5.83 |
| 2,500 | 3.21 | 4.96 | 6.17 | 7.67 |

**Estimated Equation**

$$\ln(\text{Spread}) = \underset{(-9.6728)}{-8.4576} + \underset{(6.7905)}{0.2178} \bullet S + \underset{(10.1316)}{1.2296} \bullet \ln(BR)$$

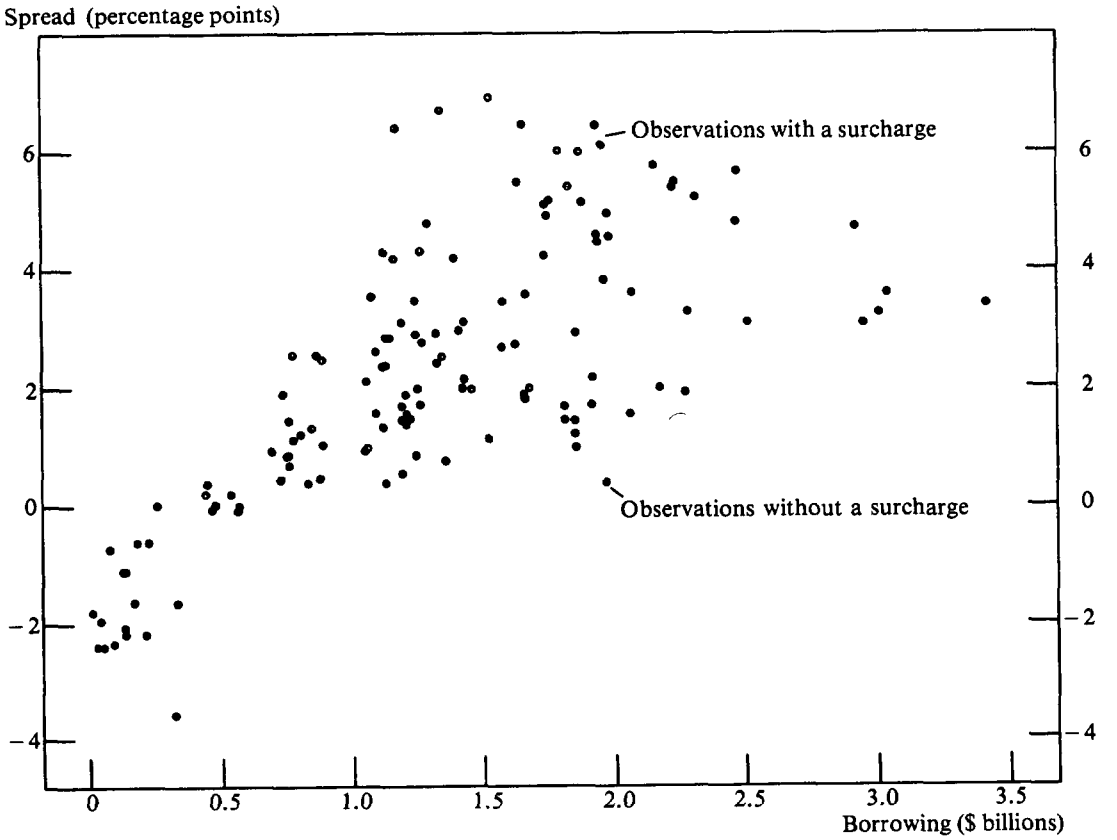
where

ln = natural logarithm
Spread = federal funds rate − basic discount rate
S = discount rate surcharge
BR = borrowed reserves

Sample period: weekly, October 17, 1979 to May 5, 1982
$\bar{R}^2$ = .5883 Standard Error of Regression = 0.5674
Durbin-Watson Statistic = 0.83

NOTE: The discount rate surcharge and the spread between the federal funds rate and the basic discount rate are measured in percentage points and are based on seven-day averages for the statement week ending Wednesday. Borrowed reserves are measured in millions of dollars.

**Chart 2**
**BORROWING AND THE SPREAD BETWEEN THE FEDERAL FUNDS RATE AND THE BASIC DISCOUNT RATE: POST OCTOBER 1979**




blue dots occur higher and to the left of the black dots. That is, the presence of a surcharge appears to reduce the demand for borrowing so that a higher spread is required to induce a given level of borrowing when a surcharge is in effect than when no surcharge is in effect.

Second, the surcharge does not uniformly affect the demand for borrowing. That is, at higher levels of borrowing, any given surcharge will have a greater impact on the spread than at lower levels of borrowing. This relationship, as well as the impact of the surcharge on the demand for borrowing discussed above, is clearly illustrated in Table 4. The information in this table was obtained from a simple log linear regression of the spread as a function of borrowing and the discount rate surcharge shown in Table 4.[15] For each surcharge rate, this equation was used to calculate the spread that would result at the indicated levels of borrowing. With this nonlinear borrowing function, the spread

15 The sample period excluded weeks in which the spread between the funds rate and the basic discount rate was negative.

between the funds rate and the basic discount rate is 1.04 percentage points when borrowing is $1 billion but 2.44 percentage points when borrowing is $2 billion. The imposition of a 2 percent surcharge has the effect of raising the spread by 0.57 percentage points with borrowing at $1 billion. In contrast, the 2 percentage surcharge raises the initial spread by 1.33 percentage points at a borrowing level of $2 billion. Similarly, a 3 or 4 percent surcharge raises the spread at each level of borrowing, but an increasing amount at higher levels of borrowing. Thus, while the discount rate surcharge generally reduces the demand for borrowing, its impact increases with the size of the surcharge and with the level of borrowing.

## SUMMARY AND CONCLUSIONS

This article has examined the short-run implications of the basic discount rate and discount rate surcharge for market interest rates and discount window borrowing under reserve targeting. The analysis shows that when the basic discount rate is not a penalty rate, changes in the basic rate have a one-for-one impact on market rates but no immediate effect on discount window borrowing. In contrast, with a penalty discount rate, discount rate changes have no direct impact on interest rates or borrowing.

The analysis of the discount rate surcharge is more complex. While the surcharge may not immediately affect the total amount of discount window borrowing, it tends to reduce the proportion of borrowing done by large banks and to increase the proportion done by small banks. Moreover, while a surcharge generally raises market rates by an amount less than an equal increase in the basic rate, its impact is variable and difficult to predict. In general, the effect of the surcharge depends both on the factors determining which large banks are subject to the surcharge and on the level of borrowing that must be done by all institutions. Finally, changes in the surcharge may or may not have an impact on market rates depending on the relationship of market rates to the cost of funds at the discount window.

The empirical evidence presented generally supports the theoretical analysis. In the period since the adoption of reserve targeting, increases in the basic discount rate have generally had a one-for-one effect on market rates. In contrast, reductions in the basic rate have had little influence on market rates. On average, the discount rate surcharge also appears to have had a significant effect on market rates. However, the impact of the surcharge on large bank behavior and on the demand for borrowing seems to have been quite variable.