FUNDAMENTAL REAPPRAISAL OF THE DISCOUNT MECHANISM

AN EVALUATION OF SOME DETERMINANTS OF MEMBER BANK BORROWING

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The following paper is one of a series prepared by the research staffs of the Board of Governors of the Federal Reserve System and of the Federal Reserve Banks and by academic economists in connection with the Fundamental Reappraisal of the Discount Mechanism.

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The major focus of this paper is to identify the determinants of member bank borrowing and to measure certain relationships which exist among these determinants. Regression analysis is used to contrast various forms of borrowing from the Federal Reserve with borrowing from sources other than the Federal Reserve. This methodology was selected so that it would be possible to assign measurable weights to the causal factors felt to be most responsible for borrowing and then compare these factors as they differ in their ability to explain variations in borrowing from the Federal Reserve as distinct from other sources.

It is becoming increasingly clear that the distribution of financial assets throughout the banking system can materially affect the speed and efficiency with which a given monetary policy takes hold. Banks of various sizes may be expected to respond differently over the business cycle to changes in financial variables such as liquidity and interest rates. To the extent that banks react to fluctuating credit conditions by adjusting their liquidity positions, they can affect to a significant degree the amount of borrowing and credit expansion that takes place. Consequently, both bank size and liquidity are examined in this paper and tested for their significance in explaining different types of borrowing.

Insofar as the structural characteristics of banks which borrow from the Federal Reserve influence the degree to which they borrow, sensitivity to interest rates has traditionally been a popular determinant. The literature has from time to time reflected discussions, both theoretical and empirical, on the influences of interest-rate spreads on banks' sensitivity to borrowing. Interest rates are examined closely for their influence upon borrowing per se, as well as for their degree of interaction with other determinants of borrowing.

A discussion dating back only a few years centers around the effects on member bank borrowing of possible differences in the administration of the discount window among the various Federal Reserve districts. In order to facilitate a closer look at this problem an attempt is made to distinguish between supply and demand factors in determining borrowing among several Federal Reserve districts.

The variables tested for their significance in explaining borrowing from the Federal Reserve and borrowing from other sources were: (a) a liquidity ratio, designed to reflect the banks' ability to meet loan demands and unexpected deposit withdrawals out of internally generated short-term assets; (b) an interest-rate differential between the discount rate and 3-month Treasury bill rate, to reflect the impact of banks' response to least-cost considerations; (c) the size of bank, to indicate differences in the likelihood that some banks--say, those associated with financial centers--might be less reluctant than others to borrow from the Federal Reserve; and (d) Federal Reserve district, to shed light on the problem of alleged differences in the administration of the discount window.

To lessen the degree to which the statistical results would be affected by problems associated with aggregated data, the initial part of the study examined the borrowing behavior of individual banks. Tests were made on weekly reporting member banks for six Federal Reserve districts during the period July 1959 to October 1961.

The tests were divided into two parts: cross-section analyses and time-series analyses. The cross sections estimated the relationship between the likelihood of a borrowing by a particular bank and factors associated with its indebtedness. Additional cross sections estimated the relationship between the frequency of borrowing from the Federal Reserve and the postulated determinants of borrowing.

The time-series regressions estimated the relationship between borrowing and the independent variables--liquidity, size, and district--and then with the addition of the temporal variable, the interest-rate differential.

I. Summary of Findings and Conclusions

The results of the cross sections and the time-series regressions suggest that the liquidity condition of a bank's short-term asset portfolio as well as the interest differential between the discount rate and the bill rate contributed significantly toward explaining variations in borrowing from the Federal Reserve. Of the two factors, liquidity had the greater impact on borrowing in all of the periods studied; but in those periods when the discount rate was less than the bill rate, the importance of

liquidity as an explanatory factor diminished somewhat in favor of the interest-differential factor.

The behavior of the liquidity and interest-differential variables supports the least-cost hypothesis--that banks, in general, are sensitive to interest-rate differentials to the extent that they will borrow from the least expensive source even when that source is the Federal Reserve. In the period when the bill rate exceeded the discount rate, the explanatory power of the bank liquidity variable in explaining the likelihood of indebtedness to the Federal Reserve was not quite half that made as when the discount rate exceeded the bill rate. This suggests that banks are less reluctant to borrow from the Federal Reserve when it is the least expensive alternative source of funds.

Banks borrowed more often when it was profitable to do so. The frequency of borrowing from the Federal Reserve was negatively associated with liquidity, corroborating the results of the conditional probability estimates. Banks were more likely to borrow, and borrowed more often, from the Federal Reserve with relatively higher levels of liquidity when the bill rate exceeded the discount rate. The cross sections demonstrated that in the period when the bill rate exceeded the discount rate ($rb > rd$) banks were less willing to use Treasury bills as a secondary source of reserves and shifted instead to the Federal Reserve.

The time-series regressions supported the inferences made from the cross sections. When the interest-rate differential was explicitly included in the regressions, banks were found to be sensitive to variations

in the interest-rate spread as well as to variations in liquidity levels. Inasmuch as aggregate data can sometimes mask the effects of microrelations, it is not immediately clear whether the variations in relative amounts of borrowing were being caused by the same number of banks borrowing greater amounts, the same number of banks borrowing the same amounts but more often, or fewer banks borrowing greater amounts. To distinguish between these effects, an estimate was made of the proportion of banks in each Reserve District that were borrowing over time. The results indicated that the number of banks per district as well as the relative amounts of borrowing from the Federal Reserve increased when the discount rate was the least-cost alternative.

On the basis of the regression results, it was concluded that for the period studied the incentive of banks to borrow stemmed from the liquidity condition of their short-term assets as well as, and to a lesser extent, the "profitability" of borrowing. It cannot be concluded from the results that banks borrow from the Federal Reserve to reinvest in short-term Government securities. It was demonstrated that Treasury bills were liquidated in periods when the bill rate exceeded the discount rate. The results would have been the reverse if banks had been engaged in "profiteering."

Among the other determinants, size of bank was shown to have a significant, though uncertain, effect on borrowing from the Federal Reserve. Although considerable differences were found to exist among banks of varying sizes with respect to their likelihood, as well as to their frequency, of

borrowing, no discernable pattern emerged among size groups. Borrowing from other sources, however, was found to be an increasing function of size, a result which was not unexpected.

There was variation among Federal Reserve districts in relative amounts of borrowing from the Federal Reserve, in the proportion of banks borrowing, and in the frequency of borrowing per bank. These results suggest the existence of other causal factors not explicitly considered, such as those with characteristics of demand or supply.

If nonuniformities in the administration of the discount function were, in fact, responsible for the disparate patterns of borrowing among districts, these patterns would be expected to differ substantially from those markets in which nonprice rationing was nonexistent. Banks are not precluded from borrowing elsewhere--for example, Federal funds markets--on grounds other than price constraints or smallness of transaction. Therefore, the patterns of ex post borrowing among districts between that market and the discount window would differ to the extent that funds were more accessible at some discount windows by virtue of easier lending policies. Although the six districts differed substantially with respect to borrowing from the Federal Reserve after liquidity and cost were taken into account, there was a similarity in the borrowing for each district by type of borrowing. The cross-section findings showed that roughly the same patterns of borrowing existed among Federal Reserve districts for borrowing from the Federal Reserve and borrowing from other soures. The time-series analysis indicated that the patterns of borrowing were precisely

the same after taking into account the liquidity condition of the district as a whole and the interest-rate differential.

This does not prove that supply factors are of no importance in the determination of differences in borrowing among districts--rather that for the period of time covered and the districts involved, differences in demand explained to some degree the importance of the Federal Reserve district as a determinant of borrowing.

II. Design of the Study

A. Data

The sample consisted of nearly all weekly reporting member banks in six Federal Reserve districts: Boston, Richmond, St. Louis, Minneapolis, Dallas, and San Francisco. These were the districts for which adequate data were available. Banks for which complete records were not available for one reason or another were dropped from the sample. The Bank of America was dropped because it was believed that this bank was not of the same nature as the other banks in the sample and, because of its size, might bias the results.

Each bank was checked for changes in structure. Banks which merged during the period July 1959 to October 1961 were deleted. When the sample of banks was finally completed, the raw data from the weekly balance sheets were averaged for 2-week periods giving 35 biweekly observations for each of the 143 banks.

Information on interest rates was obtained from the Federal Reserve Bulletin and from Section 12 of the Supplement to Banking and Monetary Statistics, 1966. Special calculations required for weekly averages of daily figures on 3-month Treasury bill rates were made available by the Government Finance Section of the Board's Division of Research and Statistics.

B. Description of the Explanatory Variables

The variables used to explain the various forms in which borrowing is presented include the following:

a) LQ - measure of a bank's liquidity

where LQ = the ratio of: (Loans to domestic commercial banks + Loans to brokers and dealers for purchasing or carrying other securities + Treasury bills + Currency and coin + Balances in banks in the United States - Borrowing from the Federal Reserve - Lagged borrowing from others) to (Demand deposits adjusted + Time deposits - Required reserves).

The approach taken in this study is to regard the maintenance of good banker-customer relationships as the deciding factor in assessing the short-run "needs" or liquidity of the bank. Accordingly, bankers will alter their optimum asset portfolio in order to accommodate customers who they feel have long-run profit potentials outweighing current considerations.

b) P - measure of the cost of borrowing from the Federal Reserve in contrast to borrowing from other sources,

where P = (rd - rb), rd = the discount rate, and rb = Treasury bill rate. When (rd - rb) is negative, there is a negative cost associated with borrowing from the Federal Reserve.

c) L_i - measure of the bank's demand deposit size

where L_1 = under \$25 million; L_2 = \$25 million - \$50 million; L_3 = \$50 million - \$100 million; L_4 = \$100 million - \$300 million; L_5 = over \$300 million.

In the regressions, the L_i's are represented by dummy variables.

d) C - dummy variable indicating the bank's reserve classification. Reserve city banks were assigned a value of 1 for variable C, country banks were given a value of 0.

e) D_i - dummy variables representing the six Federal Reserve districts

where D_1 = Boston; D_5 = Richmond; D_8 = St. Louis; D_9 = Minneapolis; D_{11} = Dallas; D_{12} = San Francisco.

III. Results

A. Cross-section Analysis

Ordinary least-square regressions were used to ascertain if, and to what extent, a relationship existed between a bank's borrowing from the Federal Reserve and such characteristics as size of bank, Federal Reserve district, and the liquidity position of the asset portfolio. The conditional probability estimates predicted the likelihood of nonzero borrowing. In addition, they served to indicate the nature of the relationship between

the independent variables and the likelihood of borrowing, that is, would banks in one particular district be more likely to borrow than those in another?

1. Likelihood of Indebtedness

Four cross sections were taken: two for dates when the Treasury bill rate was greater than the discount rate--August 19, 1959, and December 23, 1959--and two for dates when the bill rate was less than the discount rate, July 22, 1959, and March 16, 1960. Estimates were made for the likelihood of borrowing from the Federal Reserve ($\bar{B}_f$) and from other sources ($\bar{B}_o$). The final equations for the conditional probability estimates were:[1/]

July 22, 1959

$$(1)\quad \bar{B}_f = \underset{(.439)}{.549} - \underset{(.141)}{.353(D_1)}* - \underset{(.140)}{.203(D_8)} + \underset{(.160)}{.039(D_9)} - \underset{(.137)}{.115(D_{11})} - \underset{(.141)}{.224(D_{12})}$$

$$+ \underset{(.107)}{.256(L_2)}* + \underset{(.121)}{.108(L_3)} + \underset{(.116)}{.194(L_4)} + \underset{(.161)}{.015(L_5)} - \underset{(.000)}{.001(LQ)}*$$

$R^2 = .203$, $F = 3.352$**

August 19, 1959

$$(2)\quad \bar{B}_f = \underset{(.370)}{.195} - \underset{(.119)}{.110(D_1)} - \underset{(.118)}{.088(D_8)} + \underset{(.136)}{.208(D_9)} + \underset{(.116)}{.017(D_{11})} - \underset{(.121)}{.084(D_{12})}$$

$$+ \underset{(.090)}{.224(L_2)}* + \underset{(.100)}{.126(L_3)} + \underset{(.093)}{.153(L_4)} - \underset{(.145)}{.074(L_5)} - \underset{(.000)}{.001(LQ)}*$$

$R^2 = .152$, $F = 2.360$*

1/ In all of the equations
* indicates significant at .05 level of confidence and
** indicates significant at .01 level of confidence.

December 23, 1959

$$(3)\quad \bar{B}_f = \underset{(.402)}{.313} - \underset{(.128)}{.105(D_1)} - \underset{(.129)}{.031(D_8)} - \underset{(.144)}{.001(D_9)} - \underset{(.125)}{.066(D_{11})} - \underset{(.130)}{.129(D_{12})}$$

$$+ \underset{(.097)}{.073(L_2)} + \underset{(.111)}{.030(L_3)} + \underset{(.400)}{.147(L_4)} - \underset{(.149)}{.154(L_5)} - \underset{(.000)}{.001(LQ)^*}$$

$R^2 = .079$, $F = 1.126$

March 16, 1960

$$(4)\quad \bar{B}_f = \underset{(.465)}{.624} - \underset{(.149)}{.236(D_1)} - \underset{(.150)}{.154(D_8)} - \underset{(.170)}{.058(D_9)} - \underset{(.147)}{.038(D_{11})} - \underset{(.154)}{.184(D_{12})}$$

$$+ \underset{(.110)}{.052(L_2)} + \underset{(.130)}{.087(L_3)} - \underset{(.117)}{.065(L_4)} + \underset{(.206)}{.122(L_5)} - \underset{(.000)}{.002(LQ)^*}$$

$R^2 = .113$, $F = 1.674$

July 22, 1959

$$(5)\quad \bar{B}_o = \underset{(.422)}{.399} - \underset{(.135)}{.054(D_1)} - \underset{(.135)}{.099(D_8)} + \underset{(.155)}{.180(D_9)} - \underset{(.132)}{.024(D_{11})} - \underset{(.137)}{.235(D_{12})}$$

$$+ \underset{(.102)}{.226(L_2)^*} + \underset{(.116)}{.251(L_3)^*} + \underset{(.112)}{.493(L_4)^{**}} + \underset{(.155)}{.533(L_5)^*} - \underset{(.000)}{.002(LQ)^*}$$

$R^2 = .317$, $F = 6.121^{**}$

August 19, 1959

$$(6)\quad \bar{B}_o = \underset{(.392)}{.388} + \underset{(.126)}{.033(D_1)} - \underset{(.125)}{.022(D_8)} + \underset{(.143)}{.207(D_9)} + \underset{(.123)}{.024(D_{11})} - \underset{(.128)}{.175(D_{12})}$$

$$+ \underset{(.095)}{.273(L_2)^*} + \underset{(.106)}{.279(L_3)^*} + \underset{(.099)}{.595(L_4)^{**}} + \underset{(.154)}{.609(L_5)^*} - \underset{(.000)}{.002(LQ)^*}$$

$R^2 = .404$, $F = 8.934^{**}$

December 23, 1959

$$(7)\quad \overline{B}_o = \underset{(.384)}{.144} - \underset{(.123)}{.022(D_1)} + \underset{(.123)}{.122(D_8)} + \underset{(.137)}{.236(D_9)} + \underset{(.120)}{.020(D_{11})} + \underset{(.126)}{.077(D_{12})}$$

$$+ \underset{(.093)}{.374(L_2)^{**}} + \underset{(.103)}{.189(L_3)} + \underset{(.094)}{.680(L_4)^{**}} + \underset{(.153)}{.491(L_5)^{*}} - \underset{(.000)}{.001(LQ)^{*}}$$

$R^2 = .407$, $F = 9.071^{**}$

March 16, 1960

$$(8)\quad \overline{B}_o = \underset{(.379)}{.365} - \underset{(.121)}{.106(D_1)} - \underset{(.121)}{.017(D_8)} + \underset{(.138)}{.004(D_9)} - \underset{(.121)}{.008(D_{11})} - \underset{(.123)}{.098(D_{12})}$$

$$+ \underset{(.091)}{.260(L_2)^{**}} + \underset{(.104)}{.409(L_3)^{**}} + \underset{(.095)}{.572(L_4)^{**}} + \underset{(.157)}{.706(L_5)^{**}} - \underset{(.000)}{.002(LQ)^{*}}$$

$R^2 = .442$, $F = 10.484^{**}$

Of the eight regressions, six revealed the presence of debt as being significantly related to the three characteristics: size, district, and liquidity. On each date the reason for borrowing from other sources was more fully explained than borrowing from the Federal Reserve. This was to be expected, however, as certain unobservable variables would affect borrowing from the Federal Reserve in a different way than borrowing from other sources. For instance, an ostensibly important factor, the profit spread, has not been considered explicitly. The differences in availability of funds from the discount window and other sources would also affect the ability of the independent variables to explain borrowing. It is inferred, therefore, that the relatively lower R^2's for borrowing from the Federal Reserve are explained at least in part by factors that constrain borrowing from the Federal Reserve

but not borrowing from other sources, that is, reluctance to borrow and availability of supply.

For the two equations that showed a significant relationship between borrowing from the Federal Reserve and the factors determining the likelihood of borrowing, each of the factors was tested to determine its net contribution to the total explained variation in indebtedness. The partial relationships for borrowing from the Federal Reserve and borrowing from other sources are given in Table 1. These partial relationships indicate the amount of explanation contributed by the addition of the factor considered.

All three factors--liquidity, district, and size--were found to contribute to the explanation of borrowing. Worth noting are the differences in impact of the independent factors on borrowing from the Federal Reserve in contrast to those on borrowing from other sources.

In terms of the size of the partial coefficient of determination, the Federal Reserve district made the largest contribution to the explained variation in borrowing from the Federal Reserve. In contrast, the district played a much smaller role in borrowing from other sources, while size explained most of the variations in such borrowing. On August 19, 1959, when the bill rate was greater than the discount rate, indicating that banks could borrow more cheaply at the discount window, the partial correlation coefficient for the liquidity variable dropped more than 50 per cent of the value which it attained when the bill rate was less than the discount rate.

Table 1

Partial Relationships of Conditional Probability Estimates of Borrowing from the Federal Reserve and from Other Sources 1/

Variables in regression	Added variable	Partial coefficient of determination	
		Federal Reserve	Other sources
July 22, 1959			
D_i	L_i	.065 (2.32)*	.214 (9.04)**
L_i	D_i	.010 (2.66)**	.092 (2.69)**
D_i	LQ	.083 (12.29)**	.163 (26.38)**
L_i	LQ	.082 (12.18)**	.011 (16.55)**
D_i,LQ	L_i	.052 (1.82)	.146 (5.60)**
L_i,LQ	D_i	.080 (2.28)*	.071 (2.00)*
D_i,L_i	LQ	.070 (9.93)**	.089 (12.94)**
August 19, 1959			
D_i	L_i	.061 (2.16)*	.272 (12.40)**
L_i	D_i	.079 (2.28)*	.095 (2.79)**
D_i	LQ	.029 (4.06)**	.186 (31.02)**
L_i	LQ	.041 (1.57)	.168 (27.70)**
D_i,LQ	L_i	.062 (2.19)*	.232 (9.96)**
L_i,LQ	D_i	.068 (1.93)*	.066 (1.86)
D_i,L_i	LQ	.030 (6.08)**	.014 (21.70)**

1/ F-ratios are in parentheses.
* indicates significant at 0.05 level of confidence.
** indicates significant at 0.01 level of confidence.

Lending support to the least-cost hypothesis is the finding that less importance is attributed to liquidity considerations when borrowing from the Federal Reserve is "profitable."

Borrowing from other sources was influenced very little by liquidity when the bill rate was greater than the discount rate. This indicates that banks are sensitive to changes in interest-rate differentials. During this period, the bill rate was also greater than the rate on Federal funds, and so it is likely that banks tended to absorb Treasury bills during this time by meeting liquidity considerations through the Federal funds market. This hypothesis is supported by the behavior of the size variable. During the period when the bill rate was relatively low, the partial coefficient for size was 0.146 and significant at the 1 per cent level. When the bill rate was high in relation to other rates, the larger banks were less reluctant to borrow, as indicated by the increase in the partial correlation coefficient to 0.232, significant at the 1 per cent level.[2/]

2. Comparisons by Reserve Districts between Borrowing from the Federal Reserve and from Others

The most interesting finding with respect to the determinants of borrowing was the behavior of the variables for Federal Reserve districts. It has been argued that there are differences in borrowing among districts and that these differences reflect nonuniformities in the administration of the discount window. If the different borrowing patterns that emerge among

2/ The assertion that borrowing from other sources is functionally related to size is explained more fully later.

districts could be attributed to nonuniform administration of the discount window, the patterns of borrowing from the Federal Reserve would differ among districts from borrowing from other sources. On the other hand, if differences in demand were responsible for the borrowing patterns which emerge, as distinct from differences in supply, the patterns of borrowing among districts would be similar for both borrowings.

In Table 2, the districts have been ranked in order of the likelihood of borrowing by their banks from the Federal Reserve and from other sources. The order was obtained from the regressions and derived from the coefficient attached to the district variables. A negative district coefficient in the regressions places the district below D_5 (Richmond was the base district in the regression) in Table 2. Banks located in the district with the largest negative value on a given date show the least probability of borrowing. Banks in the district with the largest positive value show the greatest probability of being in debt.

The comparative likelihoods of borrowing from the Federal Reserve ($\bar{B}_f$) and of borrowing from other sources ($\bar{B}_o$) are roughly similar.

For July 22, 1959, only D_1 differed in its ranking among the six districts borrowing from the Federal Reserve and borrowing from other sources. On August 19, 1959, D_1 and D_{12} changed position while on December 23, 1959, D_5 and D_{12} changed their order of rank. On March 15, 1960, only D_9 changed its rank between $\bar{B}_f$ and $\bar{B}_o$.

Table 2

Federal Reserve Districts Ranked by Likelihood of Banks Borrowing from the Federal Reserve and from Other Sources

Order	Jul. 22, 1959		Aug. 19, 1959		Dec. 23, 1959		Mar. 16, 1960	
	$\bar{B}_f$	$\bar{B}_o$	$\bar{B}_f$	$\bar{B}_o$	$\bar{B}_f$	$\bar{B}_o$	$\bar{B}_f$	$\bar{B}_o$
1	D_1	D_{12}	D_1	D_{12}	D_{12}	D_1	D_1	D_1
2	D_{12}	D_8	D_8	D_8	D_1	D_5	D_{12}	D_{12}
3	D_8	D_1	D_{12}	D_5	D_{11}	D_{11}	D_8	D_8
4	D_{11}	D_{11}	D_5	D_{11}	D_8	D_{12}	D_9	D_{11}
5	D_5	D_5	D_{11}	D_1	D_9	D_8	D_{11}	D_5
6	D_9	D_9	D_9	D_9	D_5	D_9	D_5	D_9

NOTE.--Order is from least likely to most likely to borrow.

Had the patterns of borrowing among districts differed by <u>type</u> of borrowing, one might conclude that some discount windows are more accessible than others. However, since the patterns are roughly the same between borrowing from the Federal Reserve and from other sources, it remains only to explain differences in the demand borrowing among districts. There are, no doubt, a number of conceivable explanations, one of which is the possibility that the liquidity variable does not accurately reflect the demands for credit in the various districts.

A comparison of size of bank was made for borrowing from the Federal Reserve and borrowing from other sources. The order of comparison is shown in Table 3 where the banks by size are listed from least likely to most likely to be in debt.

Table 3

Bank Size by Likelihood of Borrowing from the Federal Reserve and from Other Sources

Order	Jul. 22, 1959		Aug. 19, 1959		Dec. 23, 1959		Mar. 16, 1960	
	$\overline{B}_f$	$\overline{B}_o$	$\overline{B}_f$	$\overline{B}_o$	$\overline{B}_f$	$\overline{B}_o$	$\overline{B}_f$	$\overline{B}_o$
1	L_1	L_1	L_5	L_1	L_5	L_1	L_4	L_1
2	L_5	L_2	L_1	L_2	L_1	L_3	L_1	L_2
3	L_3	L_3	L_3	L_3	L_3	L_2	L_2	L_2
4	L_4	L_4	L_4	L_4	L_2	L_5	L_3	L_4
5	L_2	L_5	L_2	L_5	L_4	L_4	L_5	L_5

NOTE.--Order is from least likely to most likely to borrow.

There is a strong functional relationship between size of bank and borrowing from other sources. For each date except December 23, 1959, the likelihood of a bank's indebtedness was an increasing function of size. These results are not unexpected. As credit tightens, smaller banks draw down balances with their larger correspondent banks--shifting the burden of liquidity to them. The larger, more aggressive banks usually carry smaller relative quantities of excess reserves, and therefore would be expected to borrow more.

In contrast to borrowing from other sources, borrowing from the Federal Reserve showed considerably less association with size of bank. On August 19, 1959, and December 23, 1959, the largest banks were less likely to borrow than the smallest banks, as seen in Table 3. These results are not inconsistent. Borrowing from the Federal Reserve, unlike borrowing from

other sources, is neither anticipated nor orderly. It is more spontaneous and consequently, it would be expected to show a less orderly pattern.

3. Frequency of Borrowing at the Discount Window

Cross section regressions were used to estimate the relationship between the frequency of borrowing from the Federal Reserve and the determinants that had been used to estimate the likelihood of indebtedness, with the addition of a reserve classification variable (C).

The period from July 8, 1959, to November 2, 1960, was divided into three subperiods. The subperiods were chosen to emphasize patterns of borrowing when the relationship between the bill rate and discount rate differed. In particular, all individual bank data were aggregated--providing totals for the first subperiod when the discount rate was above the bill rate. A second aggregation covered the subperiod when the bill rate was greater than the discount rate; the third aggregation covered the entire period.

District, size, class, and liquidity variables were used to explain variations in the frequency of borrowing by bank in each of the designated subperiods. The frequency of borrowing from the Federal Reserve (F_f) represented the number of weeks that a given bank was indebted during the subperiod considered. A weekly average was made of the data within each subperiod.

For the entire period, July 8, 1959, to November 2, 1960, frequency of borrowing from the Federal Reserve was estimated by:

$$(9)\quad F_f = \underset{(8.882)}{14.575} - \underset{(2.950)}{1.398(D_1)} - \underset{(2.872)}{1.767(D_8)} + \underset{(3.288)}{5.194(D_9)} - \underset{(2.817)}{2.337(D_{11})}$$

$$- \underset{(2.950)}{6.611(D_{12})}{}^{*} - \underset{(1.805)}{4.151(C)}{}^{*} + \underset{(2.144)}{5.399(L_2)}{}^{*} + \underset{(2.498)}{4.050(L_3)}{}^{*} + \underset{(2.398)}{2.073(L_4)}$$

$$+ \underset{(3.741)}{2.362(L_5)} - \underset{(.012)}{.030(LQ)}{}^{*}$$

$R^2 = .209$, $F = 3.144$**

In order to examine the effects of holding short-term Treasury bills, the variable T was substituted for LQ in equation 10.

$$(10)\quad F_f = \underset{(8.874)}{9.768} - \underset{(2.984)}{.221(D_1)} - \underset{(3.209)}{1.640(D_8)} + \underset{(2.784)}{7.104(D_9)}{}^{*} - \underset{(2.894)}{2.890(D_{11})}$$

$$- \underset{(2.893)}{5.138(D_{12})}{}^{*} - \underset{(1.801)}{4.110(C)}{}^{*} + \underset{(2.145)}{5.488(L_2)}{}^{*} + \underset{(2.506)}{5.157(L_3)}{}^{*} + \underset{(2.384)}{5.440(L_4)}{}^{*}$$

$$- \underset{(4.351)}{10.371(L_5)}{}^{*} - \underset{(.022)}{.055(T)}{}^{*}$$

$R^2 = .210$, $F = 3.169$*

From August 19, 1959 to March 2, 1960, when the bill rate was above the discount rate, the estimating equation was able to explain to a lesser extent the variation in F_f. In particular:

$$(11)\quad F_f = \underset{(5.009)}{5.649} + \underset{(1.671)}{.444(D_1)} + \underset{(1.616)}{.904(D_8)} + \underset{(1.834)}{3.059(D_9)}{}^{*} + \underset{(1.583)}{.352(D_{11})}$$

$$- \underset{(1.636)}{2.157(D_{12})} - \underset{(1.015)}{1.440(C)} + \underset{(1.223)}{2.852(L_2)}{}^{*} + \underset{(1.364)}{2.326(L_3)}{}^{*} + \underset{(1.334)}{1.335(L_4)}$$

$$+ \underset{(2.149)}{1.498(L_5)} - \underset{(.006)}{.016(LQ)}{}^{*}$$

$R^2 = .153$, $F = 2.149$*

$$(12)\ F_f = \underset{(5.071)}{2.897} + \underset{(1.723)}{.753(D_1)} + \underset{(1.635)}{.769(D_8)} + \underset{(1.830)}{3.954(D_9)^*} - \underset{(1.584)}{.147(D_{11})}$$

$$- \underset{(1.639)}{1.492(D_{12})} - \underset{(1.019)}{1.201(C)} + \underset{(1.240)}{2.995(L_2)^*} + \underset{(1.385)}{2.735(L_3)^*} + \underset{(1.337)}{2.889(L_4)^*}$$

$$+ \underset{(2.433)}{4.984(L_5)^*} - \underset{(.009)}{.019(T)^*}$$

$R^2 = .132$, $F = 1.805$

In the subperiods when rd was greater than rb, the estimating equations that using LQ and T were equations 13 and 14, respecitvely.

$$(13)\ F_f = \underset{(5.046)}{10.257} - \underset{(1.679)}{1.798(D_1)} - \underset{(1.630)}{2.382(D_8)} + \underset{(1.823)}{1.809(D_9)} - \underset{(1.599)}{2.270(D_{11})}$$

$$- \underset{(1.680)}{4.909(D_{12})^*} - \underset{(1.022)}{2.843(C)^*} + \underset{(1.219)}{2.363(L_2)^*} + \underset{(1.420)}{1.971(L_3)} + \underset{(1.362)}{.220(L_4)}$$

$$+ \underset{(2.129)}{.734(L_5)} - \underset{(.007)}{.022(LQ)^*}$$

$R^2 = .241$, $F = 3.792^{**}$

$$(14)\ F_f = \underset{(5.126)}{6.764} - \underset{(1.709)}{1.135(D_1)} - \underset{(1.657)}{2.365(D_8)} + \underset{(1.853)}{3.219(D_9)} - \underset{(1.609)}{2.741(D_{11})}$$

$$- \underset{(1.671)}{3.744(D_{12})^*} - \underset{(1.041)}{2.795(C)^*} + \underset{(1.240)}{2.309(L_2)^*} + \underset{(1.444)}{2.618(L_3)} + \underset{(1.374)}{2.338(L_4)}$$

$$+ \underset{(2.483)}{5.394(L_5)^*} - \underset{(.014)}{.031(T)^*}$$

$R^2 = 2.17$, $F = 3.306^*$

The cross-sectional regressions suggest that the frequency with which a bank borrows from the Federal Reserve is related to its size, Reserve district, portfolio of liquid assets, and perhaps its reserve classification. A compact arrangement of the variable coefficients is presented in Table 4.

Table 4

Relationship Between Frequency of Borrowing from the Federal Reserve and District, Size, Reserve Classification, Liquidity, and Treasury Bills

Period	Equation	Constant	D_1	D_8	D_9	D_{11}	D_{12}	L_2	L_3	L_4	L_5	C	LQ	T	R^2
	(9)	14.575	-1.398	-1.767	5.194	-2.337	-6.611*	5.399*	4.050	2.073	2.362	-4.151*	-.030*		.209**
Entire period		(8.882)	(2.950)	(2.873)	(3.288)	(2.817)	(2.950)	(2.144)	(2.498)	(2.398)	(3.741)	(1.805)	(.012)		(3.144)
	(10)	9.768	- .221	-1.641	7.104*	-2.890	-5.138*	5.488*	5.157*	5.441*	-10.371*	-4.119*		-.055*	.210**
		(8.874)	(2.984)	(2.873)	(3.209)	(2.784)	(2.894)	(2.145)	(2.506)	(2.384)	(4.351)	(1.801)		(.022)	(3.169)
	(11)	5.649	.444	.940	3.059	.352	-2.157	2,852*	2.326	1,335	1.498	-1.440	-.016*		.153*
When rb rd		(5.009)	(1.671)	(1.616)	(1.834)	(1.583)	(1.636)	(1.223)	(1.364)	(1.334)	(2.14?)	(1.015)	(.006)		(2.149)
	(12)	2.897	.753	.769	3.954*	- .147	-1.492	2.995*	2.735	2.889*	4.984*	-1.201		-.019	.132
		(5.071)	(1.723)	(1.635)	(1.830)	(1.584)	(1.639)	(1.241)	(1.385)	(1.337)	(2.434)	(.019)		(.010)	(1.805)
	(13)	10.257*	-1.798	-2.382	1.809	-2.270	-4.909**	2.363	1.971	.220	.734	-2.843**	-.022**		.241**
When rd rb		(5.046)	(1.679)	(1.630)	(1.873)	(1.599)	(1.680)	(1.220)	(1.420)	(1.362)	(2.128)	(1.023)	(.007)		(3.772)
	(14)	6.764	-1.135	-2.365	3.218	-2.741	-3.744*	2.309	2.618	2.338	5.394*	-2.795*		-.031*	.217**
		(5.126)	(1.709)	(1.657)	(1.853)	(1.609)	(1.672)	(1.240)	(1.444)	(1.374)	(2.483)	(1.041)		(.014)	(3.306)

Note: Standard errors are in parentheses under variables. F-ratios are in parentheses under R^2.

* indicates significant at 0.05 level of confidence, and
** indicates significant at 0.01 level of confidence.

In all three subperiods there was a significant association between liquidity and frequency of borrowing from the Federal Reserve. When the bill rate was greater than the discount rate (rb > rd), liquidity became less important as a determinant of frequency. In contrast, when rb was greater than rd, a smaller drop in the level of liquidity prompted an increase in the frequency of borrowing.

The movements in Treasury bills showed much the same pattern as liquidity. Although movements in bills were inversely related to frequency in every subperiod, banks were less willing to reduce holdings of bills when their yield exceeded the cost of funds at the discount window. This finding supports the hypothesis that banks adjust reserves in accordance with the least-cost alternative; banks with low levels of liquidity chose to borrow more often at the Federal Reserve when it was the least expensive source of funds. When the discount rate exceeded the bill rate (rd > rb), the frequency of borrowing was related to larger swings in bills, and banks displayed a greater willingness to liquidate bills rather than borrow from--the more costly--discount window.

The determinants of borrowing were less able to explain the frequency of borrowing when the yield on Treasury bills exceeded the discount rate. Two reasons for this may be cited. First, the exclusion of the price variable reflects its importance when the bill rate is greater than the discount rate. Least-cost considerations demonstrate their impact during this time at the expense of liquidity considerations. It appears, then, that banks are more inclined to borrow from the Federal Reserve when

it is least costly. Consequently, the reduction in importance of liquidity, which has been shown to be a significant factor in determining borrowing, reduces the explanatory power of the equation when the bill rate is greater than the discount rate.

The second reason is the control over borrowing at the discount window. As the bill rate rises relative to the discount rate, discount officers must remain alert to the potential for banks to take advantage of the interest-rate differential. As administrative factors, and therefore, unspecified supply factors increase in importance, the demand factors are less able to explain the variations that occur in the frequency of borrowing from the Federal Reserve.

B. Time-Series Analysis

The inclusion of the price variable P = (rd - rb) substantiated a large part of what was suggested by the cross-section analysis. The results of the test indicate that both liquidity and relative prices play significant roles in the amounts of borrowing that banks, on balance, will wish to undertake and that this relative amount differs among Federal Reserve districts.

The aim of the time series was to observe over time the effect of liquidity, district, and cost on the patterns of borrowing. In order to do this, the cross-sectional variable for the Reserve district had to be pooled with the temporal variable P. The procedure was to aggregate all banks within each district for each date; this provided six district observations for each of the 35 dates, or a total of 210 observations. The districts were represented by dummy variables.

Equations 17 demonstrates that a strong relationship existed between the proportion of banks in each district which borrowed from the Federal Reserve and the explanatory variables. The proportion of banks that borrowed from the Federal Reserve varied inversely with the profit spread and liquidity position. This indicates that the increased amounts of borrowing that took place when the bill rate exceeded the discount rate resulted from an increase in the number of borrowing banks. This finding would seem to demonstrate that the effects of tight money are passed from one bank to another--affecting greater proportions as alternative sources of liquidity dry up.

As in previous equations, there were differences in borrowing among districts. The proportion of banks borrowing from the Federal Reserve is roughly the same as the relative amounts borrowed. The rankings by district for relative amounts and proportions are combined in Table 6.

Equation 18 focusing on the proportion of banks borrowing from other sources, is more difficult to explain. In the first place, the sign of the cost variable P is negative. This suggests that as the cost of discounting becomes greater than the rate on borrowing from other sources, the proportion of banks borrowing from other sources falls. This seems unlikely. The variable P itself, however, was not statistically significant.

As with borrowing from the Federal Reserve, the proportion of banks borrowing from other sources varied noticeably among districts. However, in the former this variation was attributed to demand factors on the

Table 6

Rankings by Districts of the Relative Amounts of Borrowing (B_f/DD_a and B_o/DD_a) and the Proportion of Banks Borrowing (B_{ff} and B_{of})

Order	B_f/DD_a	B_o/DD_a	B_{ff}	B_{of}
1	12	12	1	9
2	1	1	12	8
3	5	5	9	1
4	8	8	8	11
5	9	9	11	12
6	11	11	5	5

NOTE.--Order is from least to most amount of borrowing.

basis that the same patterns of borrowing were prevalent for borrowing from the Federal Reserve as well as borrowing from other sources. The proportion of banks borrowing from other sources varied among districts, but the rankings were not similar to the rankings by district of borrowing from the Federal Reserve. This behavior on the part of district borrowing patterns for the proportion of banks borrowing from other sources is not immediately determinable.