# THE RESPONSE OF BANKS TO CHANGES IN AGGREGATE RESERVES

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THE OBJECTIVE OF THIS ARTICLE is to examine the impact of monetary policy on commercial bank demand deposits. More specifically, we will examine (a) the time lag involved between changes in unborrowed bank reserves and subsequent changes in demand deposits, and (b) the magnitude of the eventual deposit multiplier.

The lagged response of banks to changes in reserves is but one among many time lags that occur between the formulation of monetary policy and its ultimate impact on the economy. In examining the time that it takes for the full effect of changes in reserves to be reflected in the level of demand deposits, we are thus focusing attention only on the first link in the chain of reactions that follow upon the execution of a given monetary policy. A fixed relationship between bank reserves and deposits is regarded as a key factor in the implementation of monetary policy, since only under such conditions are the monetary authorities able to determine with some precision the effect of their actions at the time of making their decisions.

This relationship has been the subject of many studies in the past; the more recent among them are those of George Horwich, Robert Black, Ira Scott, and James Meigs.[1] In general, these authors found a close relationship between changes in bank reserves and changes in deposits (or earning assets), though they also noted a lag in the response. The purpose of this article is to examine this relationship using data for the period 1954-1963.

## I. DETERMINANTS OF CHANGES IN DEMAND DEPOSITS

The hypothesis that is to be tested is that changes in demand deposits of the banking system during any given period are the result of the change in aggregate unborrowed reserves[2] of that period, as well as such changes in earlier periods. The term "period" here refers to an interval of two weeks or half a month. In addition, changes in demand deposits will be conditioned by

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1. George Horwich, "Elements of Timing and Response in the Balance Sheet of Banking, 1953-1955," *Journal of Finance*, XXI (May, 1957), pp. 238-255; Robert P. Black, "An Analysis of the Impacts of the 1953 and 1954 Reductions in Federal Reserve Member Bank Reserve Requirements," Ph.D. dissertation, Graduate Faculty of the University of Virginia, 1955; Ira O. Scott, Jr., "The Regional Impact of Monetary Policy," *Quarterly Journal of Economics*, LXIX (May, 1955), pp. 269-284; A. James Meigs, *Free Reserves and the Money Supply* (Chicago: The University of Chicago Press, 1962).

2. The term "unborrowed reserves" refers to total reserves held by banks less their borrowings from the Federal Reserve. The latter must be subtracted because they are only a temporary source of reserves. Reserves held against time deposits must also be deducted to obtain the unborrowed reserves specifically relevant to changes in demand deposits.

interest rates and borrowings from the Federal Reserve during the given and immediately preceding periods. In its most general form, it is postulated that:

$$\Delta D_t = f(\Delta R_t, \Delta R_{t-1}, \ldots, \Delta R_{t-n}, i, \Delta B_t, B_{t-1})$$

where

$\Delta D$ = change in demand deposits per period
$\Delta R_t$ = change in unborrowed reserves of the given period
$\Delta R_{t-1}$ = change in unborrowed reserves of the preceding period
$i$ = rate of interest
$\Delta B$ = changes in borrowings per period
$B_{t-1}$ = level of borrowing in previous period.

### *A. Aggregate Unborrowed Reserves, Current and Lagged*

Of the explanatory variables, prime importance attaches to changes in unborrowed reserves, current and lagged. Changes in reserves are usually accompanied by simultaneous changes in deposits in the same direction. This, however, may not be the case when, for example, the central bank buys securities directly from the banks. In addition, reserves constitute the base for multiple expansion or contraction of deposits; and, therefore, changes in reserves in any given period are likely to lead to changes in deposits in the same direction in that period. Changes in reserves of the preceding periods are included in the explanatory variables to test the hypothesis that changes in demand deposits are, in part, a delayed response to changes in reserves.

There are many possible reasons for a lag in the expansion of deposits. Reserves flow from one bank to another as a result of spending by a bank's customer of the proceeds from a loan or security purchase. If there is a lag in the use of the funds, the total deposit expansion becomes a delayed response to changes in reserves. In fact, it is generally believed that changes in reserves caused by the actions of the monetary authorities affect banks in the leading financial centers at first, and then part of these changes are transmitted with a delay to country banks. A second reason for the lag in deposit expansion may lie in the attitudes and preferences of banks. Banks prone to be cautious may not act immediately on the receipt of additional reserves. Such a cautious approach is more likely to be characteristic of small banks located some distance from financial centers than of larger city banks.

These considerations suggest that changes in demand deposits will be affected not only by changes in reserves of that period, but also of the preceding periods. But it is difficult to determine *a priori* the number of previous periods that should be included. This can be decided only by experimentation.

### *B. "Dynamic" Elements of Changes in Unborrowed Reserves*

Changes in reserves are initiated by the monetary authorities partly to offset certain seasonal and related influences ("defensive" operations, as they have been called), and partly to implement certain policy objectives ("dynamic" operations).[3] To study the response of the banking system to the

3. This restricted definition of the term "defensive" differs from that of Roosa in that we deal with the net change in unborrowed reserves and thus exclude open market transactions

latter type of operation, seasonally adjusted data will be used. In the case of such policy-related changes in reserves, any lag in response may not be discernible because these changes are likely to be small in any particular time period. The correspondence of deposit changes to policy-related changes in reserves, however, may be expected to be less close than the correspondence to seasonal changes in reserves, because the policy-related changes in reserves are not closely related to changes in the demand for credit and may often be in the opposite direction; banks (especially small ones) may simply adjust their holdings of excess reserves in response to a change in unborrowed reserves that runs counter to the change in demand for credit.

### *C. Seasonal Elements of Changes in Unborrowed Reserves*

It has been suggested that the high correlation noted between changes in demand deposits and changes in reserves of the same period may be due to the fact that reserves are "fed in" by the Federal Reserve as the member banks demonstrate that they are prepared to use them. But during a seasonal increase in demand for credit the Federal Reserve may be expected to provide additional reserves somewhat earlier, in order to avoid creating a temporary credit stringency. Thus banks may not use these reserves until they are actually faced with a demand for increased credit, assuming that the Federal Reserve anticipates this demand by only one period or so. Conversely, during a seasonal decrease in demand for credit the Federal Reserve may wait a short while before decreasing unborrowed reserves, again in order to avoid creating a temporary credit stringency. Bankers could then be expected to contract deposits before their reserves decreased, because they are faced with a decreased demand for credit and because they anticipate the "typical" seasonal pattern of reserve decreases. In testing the response of banks to seasonal changes in reserves, the change in reserves of the following period was also included among the independent variables as a proxy for the Federal Reserve's perception of changes in the demand for credit.

### *D. Interest Rate*

The rate of interest presumably has an influence on banks and on borrowers, but its effects are opposite in direction. For the banker, a rise in the rate of interest is a rise in the opportunity cost of holding reserves and therefore is an added inducement to expand his deposits speedily and to the maximum extent possible. On the other hand, a rise in the interest rate may inhibit borrowing. The function that is being estimated is not strictly defined either as a supply or as a demand function in the i, $\Delta D$ plane. If the demand function were stable and shifts in the supply function were completely explained by variables other than the interest rate, then the shifts in the supply function would "trace out points on the demand curve within the limits imposed by its random shifts."[4]

which simply offset changes in float, currency in circulation, and other operating transactions. See Robert V. Roosa, *Federal Reserve Operations in the Money and Government Securities Markets* (New York: Federal Reserve Bank of New York, 1956), pp. 7-10.

4. Lawrence R. Klein, *An Introduction to Econometrics* (Englewood Cliffs, N.J.: Prentice-Hall, 1962), p. 16.

Conversely, if *explained* shifts in the demand function were dominant, we would have a supply function. Note that identification will be weak or strong depending on the magnitude of the ratio between measures of variability of the demand and supply functions.[5]

### *E. Borrowings*

The level of outstanding borrowings in the preceding period ($B_{t-1}$) may have a negative influence on changes in demand deposits in any given period. A high level of indebtedness to the System, for example, may exercise a restraining influence on banks. On such occasions banks may become cautious in their lending policies because they prefer not to place themselves in a situation where they will be compelled to borrow again in order to meet a reserve drain.

On the other hand, *changes* in borrowings are positively associated with changes in demand deposits. An increase in borrowings is associated with an augmentation of reserves and in turn with an increase in deposits, while repayments reduce reserves and therefore deposits.

### *F. "Own" as Contrasted with Aggregate Reserves*

The hypothesis presented above treats the changes in demand deposits of the banking system as being caused by changes in the aggregate reserves of the banking system. Demand deposits of the banking system can be broken down into deposits of different classes of banks, such as Country and Reserve City banks, and they can be related to changes in aggregate reserves. Also, demand deposits of different classes can be causally related to changes in their "own" reserves, i.e., reserves held by that segment of the banking system. The more useful approach, and the one mainly followed in our empirical investigation, is to link the demand deposits of different classes of banks to changes in *aggregate* reserves, because this approach helps to study the impact of a variable which is directly under the control of the central bank.

## II. Method of Empirical Investigation

The speed and magnitude of deposit changes were measured with the aid of distributed lag regressions. Except for the changes in borrowings ($\Delta B$), all of the other explanatory variables are given so far as the banker is concerned; he cannot influence them in making his decisions. Unborrowed reserves of the banking system are controlled by the Federal Reserve system; the rate of interest is, by and large, given to the banker; and in any particular time period he cannot undo his decision of the previous period to borrow or not to borrow. Thus these variables can be said to cause changes in demand deposits.

The inclusion of changes in borrowing among the explanatory variables raises a problem in terms of statistical estimation. As borrowing is under the control of the individual banker, subject only to disapproval by the Federal

5. Klein, *op. cit.*, p. 17.

Reserve Banks, no cause-and-effect relationship can be maintained.[6] The causation need not always be from borrowings to deposits; it could well happen that borrowings were necessitated by a simultaneous expansion in deposits. This variable must be taken into account, however, in order to neutralize its effects, even if it offends the principle of one-way causation. If this were not done, its effect might be wrongly attributed to some other variable with which it is associated, such as changes in unborrowed reserves.

Equations were computed separately for the periods 1954-59 and 1960-63, because the Federal Reserve system switched in January, 1960, from the use of semi-monthly to bi-weekly periods in presenting data on reserves and deposits.

### *A. Definition of Variables*

*Net demand deposits.* The dependent variables in the equations were net demand deposits of different classes of banks. Net demand deposits are demand deposits subject to reserve requirements. They are equal to gross demand deposits less cash items in the process of collection and demand balances due from banks. Averages of daily figures were used for the appropriate periods.

*Aggregate unborrowed reserves.* Aggregate unborrowed reserves are equal to total reserves held by banks less their borrowings from the Federal Reserve. But two other adjustments were required. First, reserves held against time deposits were subtracted. Second, in order to eliminate the effect of changes in reserve requirements for any class of banks within the period, during 1954-59 reserves were adjusted to a uniform reserve requirement of 20% for Central Reserve City banks, 18% for Reserve City banks, and 12% for Country banks. For the period 1960-63, reserves of Reserve City banks (including New York and Chicago) were adjusted to a uniform reserve requirement of 16½%; reserves of Country banks were adjusted to a uniform requirement of 12%.

*Interest rate.* The interest rate used was that of three-month Treasury bills. For the period 1954-59 weekly auction rates for new issues were used; for the period 1960-63 market yields on outstanding issues were used. (Weekly auction rates were used for the former period because they were also available in seasonably adjusted form.)

*Borrowed reserves.* Averages of daily figures were adjusted to a common reserve requirement basis as indicated for unborrowed reserves.

### *B. Equations Computed*

For the period 1960-63, equations were computed to relate Country and Reserve City banks' net demand deposits to aggregate unborrowed reserves and other explanatory variables discussed above. The results are given in Table I. In addition, the responses of Country and Reserve City banks during

6. The degree of control exercised by the Federal Reserve on member bank borrowings is discussed by C. R. Whittlesey in "Credit Policy at the Discount Window," *Quarterly Journal of Economics*, LXXIII (May, 1959), 207-216. His conclusion was that under normal circumstances "the member bank can assume that its request for loan will not be refused." (p. 211). Thus, except perhaps in occasional instances, borrowings are a variable under the control of the banks themselves.

the same period to changes in their "own" reserves were studied and the resulting equations are given in Table II. For the period 1954-59, the impact of the independent variables on changes in net demand deposits of the three classes of banks (Central Reserve City, Reserve City, and Country) were studied and the results are given in Table III. To study the responses of banks to the "dynamic" elements of changes in reserves, all data for the period 1954-59 were seasonally adjusted, and the equations using this seasonally adjusted data are given in Table IV. Finally, Table V gives the results of an attempt to separate bank responses to changes in reserves during periods of seasonally decreased demand for credit from responses during periods of seasonally increased demand for credit.

TABLE I

REGRESSIONS OF CHANGES IN NET DEMAND DEPOSITS ON AGGREGATE UNBORROWED RESERVES, 1960-63 (n = 99)

Regression coefficient (top line) and standard error (bottom line)

| Variable | Country | Reserve City | Country | Reserve City | Country | Reserve City |
|---|---|---|---|---|---|---|
| $\Delta R_{t+1}$ | .153 | .606* | | | .121 | .739* |
| | (.103) | (.290) | | | (.114) | (.305) |
| $\Delta R_t$ | 1.037* | 3.474* | 1.176* | 3.628* | 1.172* | 3.615* |
| | (.106) | (.286) | (.112) | (.308) | (.112) | (.300) |
| $\Delta R_{t-1}$ | .242* | .196 | .256* | .052 | .272* | .153 |
| | (.102) | (.285) | (.112) | (.305) | (.113) | (.300) |
| $\Delta R_{t-2}$ | .094 | —.458 | .015 | —.559 | .030 | —.458 |
| | (.103) | (.285) | (.112) | (.307) | (.113) | (.302) |
| i | .079 | —.193 | | | | |
| | (.058) | (.201) | | | | |
| $\Delta B^j$ | —5.697* | 3.902* | | | | |
| | (1.172) | (1.054) | | | | |
| $B^j_{t-1}$ | —1.436* | .169 | —.820* | —1.047* | —.848* | —.888* |
| | (.394) | (.622) | (.377) | (.441) | (.378) | (.435) |
| Constant | —109.878 | 463.907 | 71.489 | 84.213 | 71.349 | 49.910 |
| Sum of reserve change coefficients | 1.526 | 3.818 | 1.447 | 3.121 | 1.595 | 4.049 |
| Total deposit multiplier | 5.344 | | 4.568 | | 5.644 | |
| $\bar{R}^2$ | .634 | .682 | .548 | .623 | .549 | .641 |

* Indicates coefficient is significant at the 5% level.

Superscript j indicates variable relevant to the class of banks for which equations are estimated. Interest rates are expressed in thousandths of a percentage point. All other variables are in millions of dollars.

## III. CONCLUSIONS

### A. *Response to Changes in Aggregate Unborrowed Reserves*

1. The equations estimated showed that the reactions of banks to changes in unborrowed reserves were prompt. For all classes of banks, the most im-

portant factor influencing changes in demand deposits in any given period was the change in unborrowed reserves of the same period. Changes in unborrowed reserves of the two preceding periods may also have a positive effect on changes in the demand deposits of a given period in Country and Reserve City banks, indicating a lagged response on their part to changes in reserves. Tests

TABLE II

REGRESSIONS OF CHANGES IN NET DEMAND DEPOSITS ON "OWN" RESERVES, 1960-63 (n = 99)

Regression coefficient (top line) and standard error (bottom line)

| Variable | All observations | | Positive $R_{t+1}$ | | Negative $R_{t+1}$ | |
|---|---|---|---|---|---|---|
| | Country (n = 99) | R. City (n = 99) | Country (n = 59) | R. City (n = 50) | Country (n = 40) | R. City (n = 49) |
| $\Delta R^j_{t+1}$ | .587* | .515 | —.145 | .171 | .829 | .771 |
| | (.243) | (.413) | (.635) | (.901) | (.541) | (1.020) |
| $\Delta R^j_t$ | 3.436* | 5.420* | 3.410* | 6.334* | 3.522* | 4.805* |
| | (.251) | (.395) | (.314) | (.667) | (.447) | (.504) |
| $\Delta R^j_{t-1}$ | 1.039* | .649 | 1.422* | .921 | .836* | .550 |
| | (.252) | (.399) | (.415) | (.658) | (.341) | (.546) |
| $\Delta R^j_{t-2}$ | .007 | —.452 | .012 | .124 | .206 | —1.127 |
| | (.240) | (.415) | (.372) | (.623) | (.337) | (.597) |
| $B^j_{t-1}$ | —.568 | —.996* | —.993* | —.914 | —.017 | —.883 |
| | (.327) | (.409) | (.442) | (.635) | (.503) | (.550) |
| Constant | 54.623 | 100.351 | 131.320* | 171.429 | 22.404 | 152.650 |
| | (31.046) | (81.909) | (56.923) | (162.069) | (61.552) | (158.466) |
| Sum of reserve change coefficients | 5.069 | 6.132 | 4.699 | 7.550 | 5.393 | 4.999 |
| $\bar{R}^2$ | .656 | .680 | .679 | .657 | .615 | .702 |

using periods prior to the second preceding period gave results that were both quantitatively and statistically insignificant.

2. In the case of Central Reserve City banks (analyzed as a separate class for the period 1954-59), the entire positive effect of changes in reserves on deposits was felt in the same period as the change in reserves, i.e., of all the reserve variables, current and lagged, only the coefficient for current period changes in reserves ($\Delta R_t$) was positive (Table III). The coefficients for $\Delta R_{t-1}$ and $\Delta R_{t-2}$ were negative, though not statistically significant. This appears to indicate that Central Reserve City banks expanded their earning assets and therefore their deposits rapidly in response to changes in reserves, but as these deposits were used up in subsequent periods, part of their deposits and reserves were lost to other segments of the banking system. This is an interesting result inasmuch as it throws light on the flow of reserves and deposits through the banking system.

3. Changes in unborrowed reserves of both the current and the preceding periods, i.e., $\Delta R_t$ and $\Delta R_{t-1}$, induced positive changes in demand deposits for the Reserve City category of banks during 1954-59. The coefficients for both the reserve variables were positive and statistically significant (Table III),

implying a lag in the response to changes in reserves. The coefficient for $\Delta R_{t-2}$ was positive though not statistically significant. About 81% of their total reaction to changes in unborrowed reserves occurred in the same period as the change itself, the balance in the following periods. No lagged response was discernible for the period 1960-63. The difference is probably attributable

TABLE III

REGRESSIONS OF CHANGES IN NET DEMAND DEPOSITS ON CHANGES IN TOTAL RESERVES, 1954-59 (n = 144)

Regression coefficient (top line) and standard error (bottom line)

| Variable | Country | Reserve City | C. R. City | Country | Reserve City | C. R. City |
|---|---|---|---|---|---|---|
| $\Delta R_t$ | .477* | 1.259* | 1.147* | .540* | 1.081* | 1.094* |
| | (.082) | (.106) | (.102) | (.073) | (.097) | (.102) |
| $\Delta R_{t-1}$ | .093 | .217* | —.010 | .112 | .218* | —.001 |
| | (.075) | (.098) | (.102) | (.075) | (.100) | (.104) |
| $\Delta R_{t-2}$ | .085 | .053 | —.168 | .103 | .026 | —.219* |
| | (.073) | (.093) | (.100) | (.073) | (.096) | (.100) |
| i | .033 | —.016 | .019 | | | |
| | (.032) | (.041) | (.036) | | | |
| $\Delta B^J$ | —1.458 | 1.325* | .732* | | | |
| | (.810) | (.371) | (.285) | | | |
| $B^J_{t-1}$ | —.285 | .048 | —.302 | .226 | —.131 | —.413* |
| | (.516) | (.250) | (.277) | (.306) | (.155) | (.193) |
| Constant | 2.201 | 42.264 | 1.911 | 8.205 | 60.925 | 67.318 |
| | (49.728) | (62.993) | (67.648) | (44.889) | (52.422) | (43.047) |
| Sum of reserve change coefficients | .655 | 1.529 | .969 | .755 | 1.325 | .874 |
| Total deposit multiplier | | 3.153 | | | 2.954 | |
| $\bar{R}^2$ | .294 | .500 | .481 | .286 | .461 | .457 |

to the fact that banks formerly classified as Central Reserve City and Reserve City banks were brought under one category of Reserve City banks.

4. In the case of Country banks, a lagged response to changes in reserves was noticeable during both 1954-59 and 1960-63. For Country banks during 1954-59, the coefficients for all three reserve change variables were positive (Table III). This indicates that changes in demand deposits were influenced by and in the same direction as changes in reserves of the current and two preceding periods. Only the coefficient for the current-period changes in reserves ($\Delta R_t$), however, was statistically significant, accounting for 65% of the total reaction to changes in reserves.

Though the coefficient for $\Delta R_{t-2}$ was positive in the cases of Reserve City and Country banks, it accounted for a smaller proportion of the total reaction in Reserve City than in Country banks. The positive coefficients for $\Delta R_{t-1}$ and

$\Delta R_{t-2}$ for these two classes of banks tie in with the fact that the coefficients for these variables were negative for Central Reserve City banks. This finding strengthens the point made earlier that in the expansion process the Central Reserve City banks lose part of their reserves to other banks, particularly Country banks.

TABLE IV

REGRESSIONS OF CHANGES IN NET DEMAND DEPOSITS ON AGGREGATE RESERVES, 1954-59; SEASONALLY ADJUSTED OBSERVATIONS (n = 143)
Regression coefficient (top line) and standard error (bottom line)

| Variable | Country | R. City | C. R. City | Country | R. City | C. R. City |
|---|---|---|---|---|---|---|
| $\Delta R_t$ | .306* | .987* | 1.096* | .334* | .843* | 1.073* |
| | (.076) | (.098) | (.111) | (.069) | (.096) | (.112) |
| $\Delta R_{t-1}$ | —.023 | .059 | .020 | —.021 | —.006 | —.018 |
| | (.070) | (.094) | (.111) | (.070) | (.098) | (.112) |
| $\Delta R_{t-2}$ | —.142* | —.081 | —.122 | —.133 | —.145 | —.151 |
| | (.069) | (.093) | (.110) | (.069) | (.096) | (.111) |
| i | —.036 | .019 | —.012 | | | |
| | (.024) | (.025) | (.026) | | | |
| $\Delta B^j$ | —.207 | .902* | .406* | | | |
| | (.670) | (.219) | (.172) | | | |
| $B^j_{t-1}$ | .307 | —.001 | .020 | —.157 | —.204 | —.150 |
| | (.369) | (.143) | (.161) | (.179) | (.091) | (.111) |
| Constant | 85.097 | 70.918 | 11.648 | 62.495 | 91.822 | 17.962 |
| Sum of reserve change coefficients | .141 | .965 | .994 | .180 | .692 | .904 |
| Total deposit multiplier | | 2.100 | | | 1.776 | |
| $\bar{R}^2$ | .148 | .437 | .421 | .145 | .376 | .399 |

During 1960-63 the coefficients for $\Delta R_t$ and $\Delta R_{t-1}$ were positive and statistically significant for Country banks (Table I). About four-fifths of the total reaction to changes in aggregate reserves came in the same period as the change in reserves, and the remainder in the following period.

5. Thus changes in demand deposits in the same period as the changes in unborrowed reserves constitute an overwhelming proportion of the total reaction of banks. The lagged response constituted only about 20% of the total reaction of Country banks, and this lagged positive reaction was at least partly compensated by negative lagged reaction on the part of Reserve City banks (including New York and Chicago banks, classified as Central Reserve City prior to 1962).

6. Next we analyze the *magnitude* of response of banks to changes in reserves. The magnitude of response, otherwise known as the deposit multiplier, is measured by the size of change in demand deposits resulting from a unit change in unborrowed reserves. The size of the deposit multiplier was esti-

mated at 3.153 during the period 1954-59, and 4.568 during the period 1960-63.[7]

7. Three reasons may be suggested for the lower value of the deposit multiplier during 1954-59. First, since all of vault cash can be treated as legal reserves since 1960, the multiplier in the later period becomes larger. But this

TABLE V

REGRESSIONS OF CHANGES IN NET DEMAND DEPOSITS ON CHANGES IN TOTAL UNBORROWED RESERVES FOR SEMI-MONTHLY PERIODS OF EXPANSION AND CONTRACTION SEPARATELY (1954-59)

Regression coefficient (top line) and standard error (bottom line)

| Variable | Positive values of $\Delta R_{t+1}$ (n = 69) | | | Negative values of $\Delta R_{t+1}$ (n = 75) | | |
|---|---|---|---|---|---|---|
| | Country | Reserve City | C. R. City | Country | Reserve City | C. R. City |
| $\Delta R_{t+1}$ | —.136<br>(.157) | .007<br>(.193) | —.011<br>(.222) | .566*<br>(.158) | .800*<br>(.218) | .412<br>(.225) |
| $\Delta R_t$ | .494*<br>(.121) | .899*<br>(.150) | 1.050*<br>(.172) | .692*<br>(.098) | 1.372*<br>(.133) | 1.297*<br>(.137) |
| $\Delta R_{t-1}$ | .161<br>(.117) | .275<br>(.145) | .161<br>(.164) | .153<br>(.097) | .229<br>(.136) | —.111<br>(.138) |
| $\Delta R_{t-2}$ | .204<br>(.114) | .107<br>(.141) | —.121<br>(.158) | .061<br>(.095) | .036<br>(.131) | —.220<br>(.136) |
| $B_{t-1}$ | .209<br>(.449) | —.176<br>(.199) | —.517<br>(.296) | .157<br>(.403) | —.073<br>(.228) | —.372<br>(.252) |
| Constant | 40.047<br>(75.371) | 72.377<br>(82.865) | 125.973<br>(83.076) | 123.336<br>(67.426) | 173.294*<br>(82.193) | 82.203<br>(72.915) |
| Sum of reserve change coefficients | .723 | 1.288 | 1.079 | 1.472 | 2.437 | 1.378 |
| Total deposit multiplier | | 3.090 | | | 5.287 | |
| $\bar{R}^2$ | .192 | .325 | .350 | .411 | .583 | .554 |

cannot contribute much to the difference in the magnitude of the multiplier, since the proportion of any change in deposits that is reflected in holdings of vault cash is a very small proportion of the change in deposits. Second, the reserve requirements were higher during the period 1954-59 than in the later period. As noted in Part II reserves in each period were adjusted to a uniform reserve requirement typical of the period, so that each dollar of adjusted reserves held by any class of banks would serve as backing for the same amount of deposits throughout the given period. But for Reserve City banks reserves were adjusted to a higher reserve requirement in 1954-59 than in the later period (18% for Reserve City banks and 20% for Central Reserve City banks, as opposed to 16½% for all Reserve City banks in 1960-63). Thus

7. The value of the deposit multiplier was calculated by adding the coefficients for $\Delta R_t$, $\Delta R_{t-1}$, and $\Delta R_{t-2}$ for both Reserve City banks and Country banks.

the maximum possible deposit multiplier was larger in 1960-63 than in 1954-59. Third, there was a smaller flow of new reserves to Country banks during 1954-59, contributing again to a lower deposit multiplier in the later period. The equations computed to determine the size and speed of the flow of new reserves to Country banks showed that between 1960 and 1963, 33% of the new reserves went to Country banks, while between 1954 and 1959, 23% of the new reserves went to Country banks. The equations computed are:

(1960-63)

$$\Delta R^c = 6.530 + \underset{(.031)}{0.282}\ \Delta R_t + \underset{(.032)}{0.014}\ \Delta R_{t-1} + \underset{(.033)}{0.039}\ \Delta R_{t-2} \qquad \bar{R}^2 = .45$$

(1954-59)

$$\Delta R^c = 2.264 + \underset{(.021)}{0.153}\ \Delta R_t + \underset{(.028)}{0.044}\ \Delta R_{t-1} + \underset{(.021)}{0.042}\ \Delta R_{t-2} \qquad \bar{R}^2 = .28$$

where $\Delta R^c$ stands for changes in unborrowed reserves of Country banks.

This finding on the changing pattern of distribution of reserves has a bearing on the implementation of monetary policy. Unless closer management of reserve positions by Reserve City banks exactly offsets their higher reserve requirement, a shift of reserves between Reserve City and Country banks will change the potential money supply even though total reserves are constant. Evidence on this point is given in Section F below.[8]

8. Note that in all cases the values of the deposit multipliers obtained were less than the standard theoretical potential multipliers. Of course, this phenomenon may be due simply to banks' changing excess reserves in the same direction as changes in their unborrowed reserves. But a more important explanation may lie in banks' increasing or decreasing their deposits before reserves change, simply as a reflection of a change in the demand for credit. This reaction will be discussed in Section C below.

### *B. Response to "Dynamic" Elements in Unborrowed Reserves*

The response of banks to dynamic elements of changes in unborrowed reserves were studied by using seasonally adjusted data for 1954-59. In all classes of banks, current changes in unborrowed reserves induced statistically significant changes in demand deposits in the same direction, but none of the lagged reserve change variables had statistically significant coefficients; the deposit multiplier was 2.094 (Table IV). Thus, though the response was quick and without discernible lag, it was smaller than that without seasonal adjustment. But note, in this context, that unborrowed reserves, seasonally adjusted, include random changes in addition to policy-related changes. The

8. In an analysis of the operation of the monetary mechanism after World War II, Edward Simmons pointed out that, under a system of differing reserve requirements, shifts in the pattern of reserve flow among the different classes of banks constituted an autonomous factor which thwarted the efforts of the monetary authorities to make desired changes in the aggregate money stock. This, he felt, was one of the factors responsible for the instability of the banking system in the U.S. Though our findings strengthen Simmons' argument, our overall conclusion indicates that his fears were exaggerated. See Edward Simmons, "The Monetary Mechanism Since the War," *Journal of Political Economy*, LVIII (April, 1950), pp. 124-126.

Federal Reserve cannot predict operating transactions with complete accuracy, so it may sometimes need to undo the actions of one period in the next. When banks become aware of this, they may not respond to this part of Federal Reserve actions either in the current period or the succeeding period. In addition, policy-related changes, as noted previously, are not necessarily related to the demand for credit, and therefore the response to such changes may be small.

### *C. Response to Seasonal Changes in Unborrowed Reserves*

As noted in Part I, deposits may contract before reserves contract, as bankers respond to a decrease in the demand for credit with the knowledge that their reserves may soon decline. Given this knowledge, it is unprofitable to attempt to find short-term uses for temporary excess reserves. Since a large part of changes in unborrowed reserves are seasonal in nature, reserve changes of the following period may be largely foreseen by bankers who respond accordingly.

The addition of $\Delta R_{t+1}$ made the deposit multiplier larger in almost all cases (Tables I and V). This indicates that $\Delta R_{t+1}$ helped explain deposit changes independently of the other reserve change variables.[9]

When observations for the two periods were divided into those with positive and negative values of $\Delta R_{t+1}$, positive and significant coefficients were obtained only for observations with negative $\Delta R_{t+1}$. This is to be expected, given the delay of the Federal Reserve system in decreasing reserves.[10]

Thus we see that bank response to seasonal changes in reserves is influenced by seasonal changes in the demand for credit as well as the timing of the Federal Reserve in making offsetting changes in reserves.

### *D. Impact of the Interest Rate*

The interest rate did not appear to influence the response of banks. In no equation in either period was its coefficient statistically significant. Since the coefficient was positive in some equations and negative in others, neither the demand nor the supply plane had *explained* shifts which were considerably larger than the *explained* shifts in the other. Thus the interest rate has no discernible separate effect on deposit expansion when other factors affecting supply of, and demand for, bank credit are taken into account.

9. Because of the very low correlation between reserve changes of successive periods, equations similar to those of Table V but without $\Delta R_{t+1}$ have coefficients for the other variables which are nearly identical to those in the tables.

10. The same equations were also estimated for a portion of the year when reserves and deposits typically decrease. This gave results generally closer to those for all observations than for those with negative values of $\Delta R_{t-1}$. This may be explained by the fact that seasonal factors in the demand for credit include intra-monthly factors; there is a very low correlation between successive reserve changes.

To test whether the reaction to anticipated reserve changes was in fact a seasonal phenomenon, the equations of Table V were also estimated with seasonally adjusted data. The coefficients for $\Delta R_{t-1}$ for Reserve City and Central Reserve City banks were quite small, while that for Country banks was significant but negative. Thus the positive coefficients observed with seasonally unadjusted data are shown to be a seasonal phenomenon.

*E. Impact of Borrowing*

The level of outstanding borrowing ($B_{t-1}$) appears to have a negative influence on demand deposits. Its coefficient was negative in most equations computed, although not statistically significant as a rule. Changes in borrowings are negatively correlated with the level of outstanding borrowings, and when $\Delta B$ is dropped from the explanatory variables the coefficient for $B_{t-1}$ becomes significantly negative in some cases.

Changes in borrowings and in demand deposits were positively associated for Reserve City (including Central Reserve City) banks during both periods studied. But for Country banks the coefficient of $\Delta B$ was negative (and statistically significant), indicating a behavior pattern clearly distinct from that of Reserve City banks. Quantitatively, however, the extent of borrowing by Country banks is small.

The surprising aspect of the result is the difference in the coefficient for $\Delta B$ between the two periods studied. During 1954-59, the coefficients for Central Reserve City and Reserve City banks were .732 and 1.325 respectively (Table III). These values are smaller than the figure of 3.902 for Reserve City banks during the period 1960-63 (Table I). The higher reserve requirement of the earlier period explains the difference only to a small extent. Banks borrowed very heavily during 1954-59 compared to the later years. The average level of outstanding borowings during the period 1954-59 was $632.3 million; the average of semi-monthly changes in borrowings was $17.4 million. For 1960-63, the average level of outstanding borowings was $202.0 million; and the average of bi-weekly changes in borrowings was −$6.8 million, i.e., there was a net reduction in indebtedness. The asymmetry between the responses to expansion and to contraction of reserves may also account for the difference in the coefficient for changes in borrowings between the two periods. Nevertheless, the strikingly different coefficients for the two periods stress the difficulty in establishing a stable relationship between borrowings and deposits.

*F. Response to Changes in "Own" Reserves*

It was pointed out above that changes in demand deposits of different classes of banks could be studied either as a response to changes in aggregate unborrowed reserves or as a response to changes in their "own" reserves, i.e., reserves held by the respective class of banks. The former approach was preferred over the latter for the reason indicated earlier, and the findings discussed so far were based on equations using this approach. But the response of banks to changes in their "own" reserves was studied for the period 1960-63 to see if any additional light could be thrown on the nature of lags.

The reaction of banks to changes in their "own" reserves was similar to their reaction to changes in aggregate reserves, as can be seen by comparing Tables I and II. For Reserve City banks, virtually all the positive effect on demand deposits came by the same period as the change in unborrowed reserves (Table II). For Country banks, 75% of their total response came by the same period as the reserve change, but a lagged response is indicated by

the large and positive coefficient for $\Delta R_{t-1}$. The lag in response to changes in aggregate reserves (which was noted earlier) is partly explained by the time taken for the transmission of reserves from leading financial centers, where changes in reserves occur initially, to Country banks. But the presence of a lagged response even to changes in "own" reserves strengthens the argument that the lag may also be due to the cautious attitude of Country banks in converting their reserves into earning assets and/or to the relatively higher cost of doing so.

The deposit-reserve ratio[11] averaged 6.1 for Reserve City banks and 5.1 for Country banks. Thus, despite their lower reserve requirement, the Country banks' ratio appears to be lower, indicating a greater tendency on their part to maintain excess reserves. Thus we see that closer management of reserve positions by Reserve City banks fully offsets their higher reserve requirement, negating the point raised in section A above regarding the effect of differing reserve requirements.

### *G. Summary*

This investigation has shown that there is virtually no lag in the response of banks to changes in their unborrowed reserves. A lagged response, particularly noticeable only for Country banks, accounts for about 20% of their reaction, and is partially compensated by a lagged decrease in the deposits of Reserve City banks. The former lag appears to be due partly to a delay in the transmission of reserves from leading financial centers to Country banks. Even this short lag is not discernible in the response of banks to policy-related changes in reserves. Thus the Federal Reserve System appears to have excellent control over the timing of changes in the total demand deposits of the American banking system.

There is evidence that the pattern of distribution of reserves among different classes of banks has changed over time. It is unlikely that this change damages monetary control, since Reserve City banks appear to offset the disadvantage of higher reserve requirements by closer management of reserve positions.

The magnitude of the estimated deposit multiplier ranges between 3.2 and 4.6, the latter value in recent years when reserve requirements were lower. Values above this range are obtained when future reserve changes are taken into account; values below this range, when only policy-related changes are considered. Thus the close connection between changes in reserves and in deposits is a result of both reserve supply and demand for credit as they impinge upon the banker.

Changes in borrowings are positively associated with changes in demand deposits, though the magnitude of the relationship differs considerably during the time span studied. At least within the range of variation observed during this time span, the rate of interest is not a decisive separate factor affecting changes in deposits.

11. The use of the term "deposit multiplier" in relation to a class of banks may not be legitimate. Hence the term "deposit-reserve ratio."