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OF EIGHTEEN CLEVELAND TERRITORY,
FOURTH FEDERAL RESERVE DISTRICT
MEMBER BANKS OVER THE PERIOD 1961-1965.

The Ohio State University, Ph.D., 1969
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A STUDY OF THE BORROWING PATTERNS OF EIGHTEEN CLEVELAND TERRITORY,
FOURTH FEDERAL RESERVE DISTRICT MEMBER BANKS OVER
THE PERIOD 1961-1965

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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1969

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CHAPTER I

HYPOTHESES AND THEORETICAL BASES FOR THE STUDY

INTRODUCTION

This study investigates borrowing patterns of 18 individual fourth district member banks during the period 1961 through 1965.

Hypothesis

The major hypothesis is that the banks which borrowed from the Federal Reserve Bank of Cleveland over the period 1961-1965 followed predictable reserve adjustment patterns including borrowing. There are a number of specific hypotheses regarding the variables that are expected to be significant in explaining borrowing. These variables and their related hypotheses are:

1. Interest rates. It is hypothesized that borrowing is positively related to market interest rates and inversely related to the discount rate.
2. Bank size. It is hypothesized that bank size is inversely related to borrowing. It is assumed that bank size is a proxy for transaction costs and that large banks have relatively lower transaction costs than small banks but that for large banks, borrowing at the Federal Reserve is relatively more costly than alternative adjustment mechanisms because large banks enjoy economies of scale in making alternative transactions, but not in borrowing from the Federal Reserve.
3. Unexpected deposit fluctuations of a bank. It is hypothesized that unexpected or random deposit fluctuations are positively related to borrowing and inversely related to bank size.

4. Reserve positions. It is hypothesized that the reserve position is inversely related to borrowing. Reserve position is defined in several ways.
5. Liquidity ratios. It is hypothesized that borrowing is inversely related to bank liquidity. This hypothesis is related to hypothesis 3, insofar as bank asset structures are related to the uncertainty resulting from unexpected deposit fluctuations.
6. Seasonality. It is hypothesized that individual banks have significant seasonal patterns of deposit fluctuations or loan demand changes that affect borrowing.

A sample of 18 Cleveland territory, fourth district banks was chosen for study, and data for these banks were provided by the Cleveland Federal Reserve Bank. The data consist of daily balance sheet figures for the 18 banks. The sample is not necessarily random even of Cleveland territory banks. Sample banks have a variety of sizes and borrowing patterns.

Borrowing and Reserve Adjustment

Each member bank is required to meet its reserve requirement over a settlement period. The reserve requirement is established by regulation. For member banks the required reserves are based on the average daily deposits over a period which includes the opening deposit figure for Thursday through the opening figure for the following Wednesday. Federal Reserve balances, or "maintained" balances, are the reserves held by the individual banks at the Federal Reserve against deposit liabilities. These are averaged for the same period as the required reserves, except that close of business figures are used. The effect of the difference in computation periods is to give banks one day's grace in which

to adjust reserves without penalty. The same procedure is used for country banks except that the settlement period is two weeks rather than one.*

At the end of a given settlement period, an individual bank can have the exact reserves required against deposits or be over or under the requirement. Reserves over the requirement are excess reserves. Reserves less than the requirement are deficient reserves. Deficits must be eliminated by the banks to avoid penalties, although small deficits are not penalized by the Fed. There are several methods open to a bank for adjusting reserves. How an individual bank can make short-run adjustments can be illustrated with the following balance sheet.

Balance Sheet
Any Member Bank

<u>Assets</u>	<u>Liabilities</u>
Cash:	Time deposits
Vault cash	Demand deposits:
Deposits due from other banks	Interbank
Cash items in process of collection	Government
Reserves held at the Federal Reserve	Other
Earning assets:	Borrowing:
Loans	From the Federal Reserve
Securities	From other banks
Miscellaneous assets	Net Worth

Each of the balance sheet items can change or be changed from moment to moment, thus affecting the level of reserves. An important part of this study focuses on the effect of daily changes in the balance sheet and in market conditions in explaining borrowing. Securities,

*Effective September 19, 1968 several changes in computation of required reserves take effect establishing a one week settlement for all banks with requirements based on deposits two weeks earlier.

due-from balances, reserves at the Federal Reserve, borrowing from the Federal Reserve and from other banks are subject to a bank's control for short-run adjustments. Some kinds of loans have been used for adjustment purposes. But the bulk of loans are based on long term customer relations and are seldom called except when serious adjustment problems develop as during the 1920's and 1930's in this country. Time deposits are also responsive to a bank's policies, especially interest rates in the long-run. But they are not particularly responsive in the short-run because of the nature of the contract. Also there are limits on rates that can be offered and perhaps other terms. Vault cash is not well suited to short term adjustment. It is dependent upon the expected pattern of currency and coin demands made on a bank and it is typically kept at a very low level to permit a bank to have deposit balances at the Federal Reserve to draw upon. Cash items in process of collection are checks being collected on other banks and in the short-run are largely outside a bank's control. Miscellaneous assets are buildings, furniture and fixtures, real estate other than premises owned, etc. -- obviously not subject to short term adjustments except at great cost.

The above named fixed assets and semi-fixed assets are generally quite inflexible for short-run adjustment purposes to meet reserve requirements or desired levels of working reserves. On the other hand, borrowing either in federal funds or from the Federal Reserve is a reserve adjustment that is easily accessible to most banks and presumably has been cheaper for borrowing banks than alternative adjustment methods. Balances at other banks, called "due-from balances," are

available to a bank on quick notice and are sometimes used as a reserve adjustment particularly by smaller banks. Besides their use directly by some banks, due-from balances are sometimes a source of funds to loan to the correspondent bank holding the deposits, and are considered federal funds loans by the Federal Reserve Banks.^{1.}

Role of Borrowing in the Monetary Process

Aggregate member bank borrowing plays an important role in the monetary expansion and contraction process. Borrowing is defined as part of Federal Reserve credit, which makes up the largest part of the sources of bank reserves. Because of the nature of the fractional reserve banking system, any increase in bank reserves can lead to a multiple expansion in the money supply. Therefore, borrowing is one of the determinants of the money supply, but it is not subject to control directly by the Federal Reserve.^{2.} The Federal Reserve affects the money supply, interest rates, or the level of prices through its monetary tools. If member bank borrowing and all other factors that influence the effectiveness of monetary policy were predictable by the Federal Reserve, then the effect of policy on goals would be exact. It is toward this fundamental objective that this study of individual bank borrowing is directed. Little is known about individual bank reactions to monetary policy. Moreover, no research to my knowledge has been done

1. Nevins D. Baxter, "Country Banks and the Federal Funds Market," Business Review, Federal Reserve Bank of Philadelphia (April, 1966), p. 3.

2. It was recognition of this fact that led to reliance on open market operations as the major tool of policy early in Federal Reserve history. This is pointed out by A. James Meigs, Free Reserves and the Money Supply (Chicago: University of Chicago Press, 1962), pp. 6-10.

on the daily reserve adjustments of individual member banks or the use of borrowing for this adjustment. Knowledge about the daily influence in bank operations is important if one assumes that daily influences that are not observable in averages are important variables in the decision making of individual banks with respect to borrowing and reserve position management and affect the determination of total reserves. And this requirement to study daily bank behavior is reinforced by the fact that there are day to day monetary policy actions. Something of a mystery is implied in this juxtaposition of daily open market operations by the Federal Reserve and the lack of knowledge of daily reactions of member banks. It is therefore reasonable to conclude that the subject of daily operations of a member bank is an apt topic for research as is recognized in the Federal Reserve.³

There is another important reason for studying individual bank behavior regarding borrowing and/or reserve adjustment in general and this concerns the assumption of homogeneity with respect to deposits. Most aggregate studies assume bank behavior to be homogeneous in dollar magnitudes. There is some evidence in this study, and in a recent study by Bryan and Carleton, that the homogeneity assumption may not be valid for individual bank behavior.⁴

3. Leonall C. Andersen, "A Study of Factors Affecting the Money Stock: Phase One," Staff Economic Studies (Washington: Board of Governors of the Federal Reserve System, 1965), pp. 1-2.

4. William R. Bryan and Willard T. Carleton, "Short-Run Adjustments of an Individual Bank," Econometrica, XXXV (April, 1967), pp. 325-347.

My study is an attempt to focus attention on the individual decision making unit and also on a shorter period of time in which these decisions are made. The distinction of this study lies in its cross sectional approach and examination of daily behavior based on daily bank data. Total borrowing has indeed been studied using time series data and aggregative data. However, individual economic and structural variables may affect individual banks differently. Banks are managed by individuals with diverse philosophies who react to various stimuli in different ways. These individual reactions, however, may be canceled out when aggregate data are studied in a time series. Monetary policy is not directed at individual banks, obviously, but individual bank behavior could possibly lead to success or frustration of policy and in any event is important to our understanding and hence ability to predict the impact of policy.

Most studies have ignored one or other of these points and few previous studies had daily figures available for analysis or individual bank daily figures. Some of these studies will be briefly discussed here and the general framework into which my study falls will be outlined. The sample and methodology are discussed in Chapter II and the empirical results in Chapters III, IV, and V.

Studies of Member Bank Borrowing

Studies of member bank borrowing are numerous and fall into several categories based on the methodology employed. These include (1) multiple equation models in which borrowing is only one part of the

financial sector, e.g., the Brookings model;⁵ (2) multiple equation estimates of the demand and supply of money, e.g., Brunner and Meltzer;⁶ (3) single equation estimates of borrowing, e.g., Goldfeld and Kane;⁷ and (4) descriptive studies of borrowing with little sophisticated quantitative analysis, e.g., McKinney.⁸

The long historical development of the role of money in the economy and the delineation of lines of thought and research are well presented in H. G. Johnson's recent book.⁹ Discussions of the literature on the demand for money and supply of money have recently been published by Federal Reserve staff members.¹⁰ A very recent article by Karl Brunner summarizes the current status of the role of money and monetary policy.¹¹ Member bank borrowing plays a role in the determination of

5. Frank de Leeuw, "A Model of Financial Behavior," in The Brookings Quarterly Model of the United States, edited by J. S. Duesenberry, G. Fromm, L. R. Klein, and E. Kuh (Chicago: Rand McNally & Co., 1965), pp. 465-530.

6. Karl Brunner and Allan H. Meltzer, "Some Further Investigations of Demand and Supply Functions for Money," Journal of Finance, XIX (May, 1964), pp. 240-283.

7. Stephen M. Goldfeld and Edward J. Kane, "The Determinants of Member-Bank Borrowing: An Econometric Study," Journal of Finance, XXI (September, 1966), pp. 499-514.

8. George W. McKinney, The Federal Reserve Discount Window (New Brunswick: Rutgers University Press, 1960).

9. Harry G. Johnson, Essays in Monetary Economics (Cambridge: Harvard University Press, 1967).

10. David M. Jones, "The Demand for Money: A Review of the Empirical Literature," Staff Economic Studies (Washington: Board of Governors of the Federal Reserve System, 1966); Leonall C. Andersen, op. cit., pp. 1-3.

11. "The Role of Money and Monetary Policy," Review, Federal Reserve Bank of St. Louis (July, 1968), pp. 8-24.

member bank reserves and subsequently, through a complex multiplier process affects the money supply. The money supply is interpreted to have an important relationship with economic activity particularly the level of employment and prices.¹² The transmission process relating money to economic behavior is one of the key current topics under examination by monetary economists and the Federal Reserve.

Reserve adjustment management assumes profit maximizing behavior by banks and desired and actual reserves are brought into equilibrium by banks partly by borrowing or repaying borrowing at the Fed. The reductions or increases of excess reserves cause portfolio adjustments in the banking sector which ultimately cause multiple decreases or increases in the money supply and thus in economic activity. The complex transmission which is at the heart of much of current debate is thoroughly discussed in Brunner and Meltzer's study for the Committee on Banking and Currency, and summed up in the third part of the study.¹³

In the light of the above studies borrowing is expected to be related to interest rates, bank reserve positions, lagged borrowed reserves and deposit and loan fluctuations of banks. My study makes no attempt to analyze the complex role of borrowing on ultimate economic activity, but rather the response of individual banks to market opportunities. The study does not employ a simultaneous equation model. It therefore is appropriate to compare this study with those which have

12. Ibid., p. 24.

13. Karl Brunner and Allan H. Meltzer, An Alternative Approach to the Monetary Mechanism, A study prepared for the Subcommittee on Domestic Finance of the Committee on Banking and Currency of the House of Representatives, 88th Congress, 2nd Session, 1964.

used primarily single equation estimates of borrowing and reserve positions (my study estimates reserve positions for cross section data as well as for individual banks in that borrowing and reserve position management are causally related); or with those in which borrowing is part of bank portfolio management such as the borrowing equations in Goldfeld and de Leeuw's models.¹⁴ Only the more recent studies will be reviewed since the history of borrowing and the discussions which appeared over the years concerning borrowing are well summarized in several recent books including Meigs' and Goldfeld's.¹⁵ The descriptive study of McKinney will also be summarized since it presents interesting seasonal patterns for a group of banks.

de Leeuw.¹⁶ In one of the most complete models of the financial sector of the economy, de Leeuw develops a borrowing equation using quarterly data from the beginning of 1943 through the third quarter of 1962. de Leeuw uses a lagged relationship to explain changes in borrowing. He finds interest rates and changes in deposits to be significant in determining changes in aggregate member bank borrowing. de Leeuw concludes that the speed of adjustment for borrowing is fairly rapid and that interest rate differentials are moderately significant in explaining the adjustment.

14. Stephen M. Goldfeld, Commercial Bank Behavior and Economic Activity (Amsterdam: North Holland Publishing Company, 1966), pp. 43-50; de Leeuw, op. cit.

15. A. J. Meigs, op. cit.; Goldfeld, op. cit.

16. de Leeuw, op. cit.

Goldfeld.¹⁷ In his recent study of bank behavior in which a borrowing equation is included, and upon which my study borrows at length as will be noted in Chapter II, Goldfeld estimates the demand for borrowed reserves for both country and reserve city banks. The variables which he finds significant using quarterly data include interest rates, lagged borrowed reserves, lagged excess reserves, changes in potential deposits and several other variables which differ between classes of banks. Goldfeld's borrowing estimates are contained in Appendix 3.

Dewald and Gibson.¹⁸ Dewald and Gibson have examined the uncontrolled factors which influence the effectiveness of monetary policy. One of the uncontrolled factors studied was discounting which was found to be significantly explained by the federal funds rate (given the discount rate) and by Wednesdays. These authors concluded that an aggregative predictive equation for all non-controlled factors which enter into monetary policy gave good results. Aggregate borrowing data on a daily basis were studied in this study, making it the only published study to use daily borrowing to my knowledge.

Goldfeld and Kane.¹⁹ These authors attempt to study borrowing from the point of individual bank decision making and therefore use disaggregated data, consisting of weekly data for the period July, 1953

17. Goldfeld, op. cit.

18. William G. Dewald and William E. Gibson, "Sources of Variation in Member-Bank Reserves," Review of Economics and Statistics, LXXI (May, 1967), pp. 143-150.

19. Goldfeld and Kane, op. cit.

through December, 1963 for each of the four main categories of member banks. Their results show varying speeds of adjustments for different classes of banks and varying elasticities with regard to interest rate influences. Significant variables in explaining borrowed reserves are unborrowed reserves, lagged borrowing and costs variables. An additional test was made by these authors of the Polakoff "reluctance elasticity" for which they find some support.

McKinney.²⁰ The study of fifth district borrowing patterns by McKinney is mainly a descriptive analysis of the seasonal and cyclical patterns of that district. However, his results are based on only two years of data, 1956-1957. He found that reserve city banks and country banks differed sharply in their borrowing patterns. Country banks tend to borrow at the end of the period of reserve computation while reserve city banks borrow at the beginning. Reserve city banks tend to increase borrowings over weekends, reduce them on Monday and Tuesday and increase them again on Wednesday. McKinney includes findings with respect to borrowing by size of bank, how much they borrow and the collateral used by fifth district borrowing banks. A great portion of his study is devoted to the mechanics of borrowing including the kinds of forms used, etc.

The results of my study are compared with the above studies where findings are comparable. This is done in the summary in Chapter VI.

There have been other studies of member bank borrowing one of the most extensive being done by the Board of Governors of the Federal

20. McKinney, op. cit.

Reserve System, the results of which have led to changes in the administration of the discount window.²¹ Several recent studies have looked at member bank free reserves and thus by implication at borrowed reserves. A free reserves equation is contained in the Federal Reserve-MIT econometric model.²² Meigs' study of banks' demand for free reserves concluded that banks seek to maintain certain ratios of excess reserves and free reserves (and thus borrowing) to total deposits and that these ratios are functionally related to market rates of interest, the discount rate, expected deposit movements and other variables.²³ Studies of bank reserve adjustments have incorporated borrowing into the equations as part of the adjustment mechanism. A recent and interesting example of this research is that by Bryan and Carleton in which weekly data of an individual bank were studied.²⁴ They found desired reserves to be functionally related to lagged reserves, lagged borrowing, and interest rates. The study of Bryan and Carleton is one of the first published attempts to use individual bank data and resembles my study in that regard.

In almost every study mentioned above and in many of those not mentioned specifically borrowing was found to be significantly

21. "Federal Reserve Board Proposes to Widen Its Loan Operations for Commercial Banks," Wall Street Journal, July 22, 1968, p. 5, Col. 1.

22. "The Federal Reserve-MIT Econometric Model," Federal Reserve Bulletin (January, 1968), p. 31.

23. Meigs, op. cit.

24. Bryan and Carleton, op. cit.

explained by cost variables, deposit and/or loan fluctuations, reserve positions and seasonality factors. My study follows this tradition and is different primarily because of the daily data for individual banks that are used.

CHAPTER II

SAMPLE, DATA AND PLAN OF ANALYSIS

The sample of banks, data and methodology of the study are considered in detail in this chapter.

Sample

The total number of banks in the Cleveland Federal Reserve district is 530, and the Cleveland territory encompasses 271 of the total. My study is based on data for a sample of 18 member-banks, drawn from a population of 252 of the 271 Cleveland territory, fourth district banks. The sample was chosen with my cooperation and approval, by officials at the Cleveland Federal Reserve Bank, and data which were readily available from a cash management study by the Cleveland Federal Reserve Bank were given to me. For its study, the Cleveland Federal Reserve Bank collected daily figures for numerous asset and liability accounts for 252 of the 271 banks in the territory for the period 1961-1963. The banks in the Cleveland study were arrayed into seven size classes based on average total deposits held by each bank at the beginning, middle and end of the study period. The size classes, the number of banks in the study, and the number of reserve city banks used in the Cleveland Federal Bank study are presented in Table 1.

TABLE 1

SUMMARY OF BANKS IN CLEVELAND BANK STUDY

Size Class	Definition of Class (total deposits in millions)	No. Banks in Study	Reserve City Banks in Study
1	less than \$1	6	0
2	\$1 to \$5	101	0
3	5 to 10	55	0
4	10 to 25	52	0
5	25 to 50	18	0
6	50 to 100	9	0
7	100 and over	<u>11</u>	<u>11</u>
Totals		252	11

With the large amount of data collected for its study, the Cleveland Bank felt that the sample could be selected most economically from the population of banks it had used. The method of selection used by the Cleveland Federal Reserve Bank involved setting up a distribution of the percentage of days each of the 252 banks borrowed over the period October 20, 1960 to December 31, 1965. This selection process eliminated non-borrowing banks from inclusion in the sample. However, the resulting sample of banks included 8 banks which borrowed less than 1 per cent of the time between May 4, 1961, and December 31, 1965, the period of my study. One bank did no borrowing during this period although it borrowed within the period used by the Cleveland Bank in choosing the sample.

A frequency distribution of the number of days each bank borrowed over the period October 20, 1960 to December 31, 1965 was computed and six convenient frequency classifications were selected for the 63 borrowing banks. The highest frequency classification included banks that borrowed 10 per cent or more of the time. Seven of the 63 borrowing banks

borrowed 10 per cent or more of the time. Each of these seven banks was included in the sample. Eleven more banks were chosen for the sample and these were randomly taken from each of the other frequency classifications. The distribution of borrowing banks by size class and the distribution of my sample of banks by size class are as follows:

Size Class	Number in Sample	Number in Population
1 (smallest)	None	None
2	5	14
3	3	11
4	5	18
5	1	7
6	1	3
7 (largest)	3	10
Totals	<u>18</u>	<u>63</u>

The largest size class includes only reserve city banks. My sample includes three banks of this class. Two of these are money market banks, so designated by the Board of Governors because these banks are large, active in the government security market and a source of finance to government security dealers and so on. The other reserve city bank in the sample became a country bank in May, 1965, and its daily figures reflect this change.

Data

The data upon which most of the study is based are daily balance sheet figures for each of the 18 banks for each day of the period May 4, 1961 through December 31, 1965. The data are:

1. Interbank demand deposits
2. Government deposits
3. Other demand deposits
4. Cash items in process of collection
5. Balances due from other banks
6. Net demand deposits
7. Time deposits
8. Vault cash

9. Total daily deposits
10. Balances at the Federal Reserve
11. Required reserves
12. Excess or deficit reserves
13. Accumulated excess or deficit reserves
14. Borrowings from the Federal Reserve

The following quarterly data from each bank's call reports have been compiled:

1. Total earning assets
2. Cash
3. Balances with other banks
4. Securities
5. Loans and discounts
6. Total deposits

Besides the bank data the following interest rate data were available:

1. Treasury bill rate (91 day)
2. Federal Reserve discount rate

Trend and the following seasonal dummy variables were also employed as explanatory variables:

1. Trend
2. Days of the week
3. The first ten days of the month
4. The last ten days of the month
5. Months of the year
6. The second week of the country-bank settlement period

These seasonal variables were included in the equations because other investigators have found significant seasonal patterns in banking statistics. The basis for the expectation that there would be seasonality in borrowing and reserve positions, is discussed later in this chapter and in Chapter V where the daily results are presented. Averages of figures over the entire time span were also used to test hypotheses. Seasonal dummy variables were not used in the cross-sectional

estimates nor were interest rates although both were used in the individual bank estimating equations.

Plan of Analysis

The primary method of analysis used in this study is stepwise linear regression analysis. There are two basic equations. The first is a structural equation. Averages of daily data for each bank for the entire period are used in testing the structural hypotheses. There are as many observations as banks in this case. The second equation is estimated for each individual bank, using daily data. Each day of the study period is an observation. The structural equation in functional form is the following:

$$B = f(DV, S, L, X) + u. \quad (1)$$

where:

- B = ratio of average borrowing to average total deposits
- DV = variability of deposits using the ratio of the standard error of estimated deposits to average total deposits
- S = size class of bank based on average total deposits which serves as a proxy for transaction costs
- L = a measure of liquidity which is the ratio of average loans to average total deposits
- X = reserve position which is the ratio of average excess reserves to average total deposits
- u = an error term which is assumed to be random, normally distributed with expected value of zero, constant variance, not autocorrelated, and independent of other variables

The daily equation in functional form is the following:

$$B = f(Z, i, r, B_{t-1}, AX_{t-1}) + u. \quad (2)$$

where:

- B = daily level of borrowed reserves
- Z = 1) seasonal dummy variables for days, weeks, and months or
2) potential earning assets (total deposits - required reserves) or
3) individual deposit items, interbank, government and other
- i = daily differential between the 91 day Treasury bill rate and the discount rate

r = the 91 day Treasury bill rate
 B_{t-1} = lagged borrowed reserves
 AX_{t-1} = lagged reserve position computed as excess reserves plus
 due-from balances less borrowing
 u = an error term about which the usual simplifying assumptions
 are made (equation (1))

Linearity is assumed in both cross sectional and individual bank equations. Least squares estimation is a maximum likelihood estimating procedure if the assumptions about the error term are true. The assumption that the error term is independent of the explanatory variables can be violated easily in least squares analysis of time series data. If dependence exists between the error term and the explanatory variables, the least squares estimate gives biased parameter estimates and the bias must be eliminated, if the results are to be statistically reliable. The estimated residuals should behave "like mutually independent random variables with zero mean and finite standard deviation. If this behavior is not reproduced, as evidenced by significant values of the so-called Durbin-Watson statistic or the von Neuman ratio," a correction factor must be introduced or an alternative estimating procedure used.¹ Lagged relationships are introduced in the daily estimates. The Durbin-Watson statistic is not applicable in these cases as a test of autocorrelation. Proper specification must rely mainly on theoretical consideration.²

1. Karl A. Fox, Intermediate Economic Statistics (New York: John Wiley & Sons, Inc., 1968), p. 440.

2. Marc Nerlove and Kenneth F. Wallis, "Use of the Durbin-Watson Statistic in Inappropriate Situations," Econometrica, XXXIV (January 1966), pp. 235-238.

A problem in using balance sheet data for a bank is the close relationship between the items, plus the fact that a balance sheet must balance and correlating asset items with liability items could be invalid as a test of behavioral relationships. Banks hold various kinds of deposits, e.g., government, interbank and other deposits, and these are related one to another and influenced by similar economic factors. There is evidence from my study that these deposit items are independent enough to reveal separate behavior patterns. Therefore, balance sheet data were used individually as well as in various aggregates in several equations.

Equation (2) resembles Stephen M. Goldfeld's equation in which the borrowing of individual banks from the Federal Reserve is a function of seasonal factors, changes in time deposits, changes in commercial loans outstanding, changes in potential demand deposits (which resembles the potential earning assets variable used in my study), and an interest rate differential between the discount rate and the 91 day Treasury bill rate.³ Goldfeld develops an entire statistical model of bank behavior and his borrowing equation is only one part of the model.

Variables

The variables hypothesized as significant in this study are discussed below. The theory justifying their inclusion as independent variables is not developed in any detail but theoretical expectations are noted.

3. Stephen M. Goldfeld, op. cit., p. 143.

Each bank must predict short-run changes in sources and uses of reserves in order to be able to meet reserve requirements over settlement periods. The predictions which a bank makes will be based on its knowledge of seasonal and cyclical influences which cause the demand for loans and supply of deposits to fluctuate and, of course, its own position and those of competitors. Both large and small banks are assumed to attempt to achieve their objectives by managing their reserve position daily, or frequently enough to achieve their objectives subject to cost limitations.⁴ Managing its reserve position is an integral part of bank operations. The primary difference from overall asset management is that reserve position management typically involves the use of the most liquid assets and liabilities available to banks, namely, borrowing and lending of federal funds, sale of short-term securities, and borrowing from the Federal Reserve. Reserve position management must involve liquid assets because of the shortness of time in which a member bank normally chooses or is required to adjust its position, and with a minimum loss of principal or interest to the bank. As indicated in Chapter I, large banks adjust through federal funds transactions, accumulation or liquidation of assets, and borrowing from the Federal Reserve. There is evidence that smaller banks use correspondent balances as well to adjust reserves in the short run. Federal funds were not much used by small banks until recently because of minimum transaction requirements, though recently smaller banks have gotten

4. Roland I. Robinson, The Management of Bank Funds (New York: McGraw-Hill Book Company, 1962), p. 5.

into the funds market on both the buying and selling side because of high interest rates and associated reduction in transaction requirements.⁵ Federal funds activity was not studied in this project because federal funds data were not made available for the sample of banks. Also, the small banks represented in the sample were not expected to be active in the federal funds market during the 1961-1965 period, even though some of these banks became active late in the period under study. Goldfeld excluded federal funds activity for a similar reason.

Interest rates. Market interest rates are expected to be directly related to member bank borrowing. Such influence might be expected since interest rates are the price at which borrowed money can be invested by banks. Each of the reserve adjustments open to a bank has an associated expense and income. Accepted investment theory would indicate that the discounted present value of costs and returns should be compared and that the adjustment providing the greatest spread between present cost and return should be used until each adjustment alternative offers equal marginal net yields. These costs and returns are measured in terms of interest rates and transaction costs for banks. Interest rates, therefore, should influence a bank's decision to borrow from the Federal Reserve. This influence is lessened to the extent that tradition, legislation, Federal Reserve surveillance, management policy, etc. discourage borrowing from the Federal Reserve and arbitrarily change the associated costs and returns, while such influences have a

5. Nevins D. Baxter, op. cit.

lesser effect on other adjustments. The daily reserve position of an individual bank is expected, therefore, to be influenced by the level of interest rates and the differential between the discount rate and alternative costs of adjustment. The Treasury bill rate is the alternative cost used in this study. The importance of interest rates may differ for individual banks, depending on such factors as the philosophy of the bank management regarding different reserve adjustments, and the institutional constraints facing different banks (e.g., size limits on federal funds). As the bill rate rises relative to the discount rate, borrowing is expected to rise. When the discount rate rises relative to the bill rate, borrowing should decline since borrowing becomes more expensive as an adjustment tool. Interest rate comparisons and adjustments based on interest rates are made difficult for banks because of short-run variability of rates. There is evidence of inter-settlement week variability of rates which apparently explains inter-settlement week borrowing behavior.

Size. The hypothesis regarding bank size depends on an expectation that large banks have lower relative transaction costs than small banks but that borrowing at the Fed is relatively more expensive for large banks than selling securities or buying federal funds. Lower transaction costs for large than small banks follows from economies of scale. But there is no particular reason to expect that there are similar economies of scale in borrowing from the Federal Reserve. For small banks borrowing at the Fed is relatively less costly than selling securities. Thus, the size variable in this study is accordingly interpreted as a proxy for transaction costs. Large banks, therefore, would be expected to borrow less relative to deposits than smaller banks.

The theory underlying the above hypotheses regarding bank size is not extensively discussed in the literature. One popular, but unsubstantiated reason explaining why large banks are heavier users of Federal Reserve borrowing than small banks, is that large banks are less reluctant in approaching the Federal Reserve than are small banks. Robinson states that "quite a few country banks never borrow as a matter of managerial policy."⁶ This idea appears to be deeply implanted in the literature. It is the least justifiable reason for explaining the borrowing behavior of large versus small banks--behavior that presumably reflects different market opportunities facing banks of different sizes. Small banks usually own larger relative amounts of due-in from balances and excess reserves, and use these balances to adjust reserves both on a daily basis and over reserve settlement periods. But large banks have access to alternative reserve adjustments including the federal funds market and should, therefore, be less subject to last resort borrowing from the Federal Reserve.

Deposit Variability. Robinson states that large banks are more subject to deposit fluctuations and erratic loan behavior than small banks, and are consequently less able to anticipate reserve needs in the short-run than small banks.⁷ He bases this conclusion only on the fact that large banks tend to hold larger relative amounts of 'notoriously unstable' accounts such as balances of correspondents,

6. Robinson, op. cit., p. 88.

7. Ibid., pp. 88 and 101.

public funds and trust accounts. Contrary to Robinson, it is reasonable that large banks should have less variability of deposits and loans because of their large size which permits uncorrelated risks to offset each other. The empirical results from the structural data in this study lend strong evidence in favor of this hypothesis. The insurance principle of large numbers applies in that the great number of different depositors minimizes the possibility that deposits will fluctuate greatly and leads one to expect that the large number of accounts allows greater accuracy in predicting deposit changes in large banks as it does in predicting deaths for large insurance companies. Large banks should, therefore, have less relative variability of deposits or loans and should not be forced to the discount window because of random deposit changes as often as smaller banks, which cater to a smaller number of depositors. This argument depends on individual deposit and loan changes being independent. If they are not, of course, the law of large numbers is inapplicable.

It is hypothesized in this study that large banks have relatively less "random" deposit variability than small banks and that banks with high "random" deposit variability borrow most frequently and in largest relative amounts. Deposit variability is measured as the "random" deposit variability divided by average total deposits. The measure of "random" deposit variability is the standard error of estimate in regressing each bank's total deposits against seasonal dummy variables and trend. Banks are aware of daily, weekly, and other regular patterns of variation in their deposit accounts. Banks must meet reserve requirements weekly, or bi-weekly; and those with

the greatest irregular variability in deposits could not expect to predict day-to-day reserve requirements as accurately as other banks. Banks that can predict variability of deposits would be expected to take a defensive position by holding reserves or liquid assets large enough to reduce costs of forced liquidation of assets to meet unexpected deposit losses. By doing this, a bank would sacrifice profits on loans or investments but by less than costs on security sales and repurchases. A question asked here is whether banks with great "random" variability of deposits borrow more from the Federal Reserve than other banks with less variability.

Reserve Position. The reserve position of a bank is measured in several different ways in this study. In one instance it is defined to include deposits at the Federal Reserve, plus vault cash and balances due from other banks less borrowed reserves. The addition of due-from balances is somewhat different from the measure used in most studies. Due-from balances cannot satisfy legal reserve requirements. Hence, in another instance the reserve position is defined to exclude due-from balances. A bank in a deficit legal reserve position must cover the deficit before ending the settlement period. It may do this daily or wait until the last day of the period. Banks with accumulated excess reserves may adjust downward by lending or investing these reserves. Some banks may adjust daily while others may adjust less frequently. A bank with good information about deposit flows and loan demand will be able to make adjustments without costly reversing transactions or idle cash. Deposits may be forthcoming, securities may be maturing to meet accumulated deficits. If a deficit is not

expected to be covered at the end of the period by the flow of deposits or from other sources than the bank must borrow or sell assets. There is no reason that a bank must borrow from the Federal Reserve. There are alternative sources of reserves.

Seasonal Factors. There are several reasons to expect seasonality in borrowing by individual banks. Other studies have found significant seasonality patterns in borrowing. In this study seasonal variables are assumed to be proxies for deposit and loan fluctuations and to reflect inter-weekly and daily interest rate differences. It is the regular flow of deposits and loans that explain seasonal patterns of adjustment for banks. And alternative costs and returns based on the relative supply and demand for funds determine which sources of reserves a bank will use on any given day or during a given period.

In summary, the major hypotheses of the study are that borrowing is inversely related to bank size, other things equal, and that deposit variability is positively associated with borrowing. The reserve position of a bank is hypothesized to be inversely related to borrowing. Individual banks are hypothesized as having significant seasonal borrowing patterns if they have significant deposit and loan seasonal patterns. It is hypothesized that banks reduce reserve positions when the bill rate is rising, and that large banks "fine-tune" their adjustments, meaning that they adjust more rapidly than small banks.

Some results which are expected are not considered major hypotheses. It is expected that total deposit fluctuations are more predictable for large banks than small banks. In the light of the variability

hypothesis, it is expected that banks experiencing the greatest relative "random" deposit variability will be the most liquid.

CHAPTER III

RESULTS OF CROSS SECTION ANALYSIS

This chapter presents the cross sectional results of the study in which data for each bank are used as separate observations in a regression analysis. In Chapter I the variables hypothesized as significant in explaining borrowing included size of bank, random deposit variability, reserve position, liquidity, seasonality factors, and interest rates. The last two variables were identical for each bank and therefore were not used in the cross section analysis. They are used in the analysis of individual bank borrowing behavior presented in Chapter V. The above variables are used here because they proved significant in other studies and on theoretical grounds as summarized in earlier chapters.

Bank size refers to the 7 categories of total deposits used to classify banks in the sample. Random deposit variability is a measure of unexpected fluctuations in total deposits for each bank. Expected total deposits are assumed to be the average level observed within particular periods of the week, month and year. It is important to note that daily deposit figures were used in estimating expected deposits.^{1.}

1. The actual variable used in the regressions is the standard error of residuals of total deposits divided by average total deposits with the standard error determined by regressing total deposits against seasonal dummy variables and trend. These results are contained in Appendix 1.

Reserve position is the excess or deficit reserve position of each bank averaged over the study period. Several different measures of reserve position were used in the study. Liquidity is measured inversely by the loan to total deposit ratio.

Summary of Findings

The most important results of the structural analysis center around deposit variability and its effect on both borrowing at the Fed and other reserve adjustments made by banks. An uncertainty facing a bank is the flow of deposits. Although banks do not know precisely their deposit variability, they are not totally ignorant of deposit flows and they can adjust their assets by tailoring investment maturities and cash holdings to expected reserve needs. By structuring their assets in this way they can be prepared for considerable fluctuation in deposits that is of a seasonal and cyclical nature or they can be prepared to borrow at the Fed when unexpected reserve deficits appear. This uncertainty also might be accommodated by maintaining excess reserves and other free cash assets or by adopting a conservative lending policy.

An important result in this structural analysis is that borrowing at the Fed by individual banks is significantly correlated with deposit variability at individual banks. Furthermore, those banks in the sample that faced the largest deposit uncertainties tended to maintain the most liquid position. They nevertheless borrowed at the Fed relatively more than other banks when deposit losses took place. From the point of view of monetary policy this is an important finding although it is based on a relatively small sample of banks. The point is that

the shock of unexpected deposit variability significantly affects borrowing.

Further implications of the results are that banks generally could predict their deposit flows reasonably well, especially the largest banks. The largest bank in the sample has the lowest variability and the smallest bank the highest variability. There is a growing list of studies on the problem of variability itself, and one of the important conclusions of these studies is that variability is inversely related to bank size as is indicated in my findings.² While evidence from this study is based on a relatively small sample of banks including only two very large banks, deposit variability has a greater effect on the borrowing of small than large banks. Yet borrowing throughout the Federal Reserve System is done mostly by large banks, i.e., reserve city banks. It is possible for reasons that are explained below in Chapter V that large banks rely on the Fed for reasons different from smaller banks, particularly to accommodate increasing loans and other portfolio opportunities.

The importance of my results in comparison with other analyses of deposit variability lies in the fact that daily data were used in the computation of variability and these data reflect more accurately the adjustment problem facing bank decision makers. The settlement period for banks is either one or two weeks, and borrowing decisions, therefore, must be made in light of short-run changes in deposits and

2. Frederick M. Struble and Carrol H. Wilkerson, "Deposit Variability at Commercial Banks," Monthly Review, Federal Reserve Bank of Kansas City. (July-August, 1967), pp. 27-34.

assets. In the other studies of variability weekly or bi-weekly data were used. Moreover, and this is particularly important, my computation assumes that unpredictable deposit flows take place around an expected seasonal pattern and trend.³ Separating out the expected deposit flows is important. If banks can reasonably predict deposit flows, then they can adjust their position in anticipation of deposit flows and not be forced to make costly adjustments after the fact. This is also important from the point of view of overall monetary policy since reduced aggregate deposit variability would imply changes in the demand for borrowed reserves.

Expanding on the distinction between the variability measure used here and in other studies it should be noted that variability is measured by the standard deviation in other studies rather than as the fluctuation around a given seasonal pattern which is a crude approximation of the expected pattern. The standard deviation measure was used in this study as an alternative measure of variability and interestingly it proved insignificant in explaining borrowing and was even negatively associated with borrowing given other factors. This result

3. In the computation of the deposit variability measure, contained in Appendix 1, it is important to note that trend is included as a separate independent variable. Otherwise, a bank which experienced an increase in total deposits over the period would likely show greater deposit variability than a bank with little deposit growth. Deposit variability is thus a measure which has taken into account growth in deposits. A bank could have experienced considerable growth in its deposits yet have a relatively low variability measure, e.g., bank 11 whose deposits grew by 50 per cent but whose variability is .019 (Appendix 2, columns 20 and 8).

contradicts theoretical expectations. I contend that the hypothesis that unexpected deposit losses would trigger borrowing is misspecified where regular seasonal variation is ignored. It is not deposit variability that causes banks problems in managing their reserves but deposit variability that is not predictable.

Another important result was that bank size was significant in explaining borrowing. Large banks borrow more than small banks but small banks were estimated to borrow more relative to total deposits than large banks, given other factors. Larger banks in the sample were estimated to borrow less relative to total deposits than smaller banks even though large banks borrowed more frequently. It is reasonable to assume that bank size serves as a proxy for transaction costs. Large banks have lower relative transaction costs than small banks and therefore would be in a position to use federal funds transactions and security transactions for reserve adjustments on more favorable terms than small banks. It would be expected that borrowing would be inversely related to bank size as a proxy for economies of scale in affecting transactions. This important result was estimated to significantly affect borrowing.

Other results from the structural analysis of borrowing are that banks having relatively large excess reserves and due-from balances borrowed less frequently than other banks with relatively fewer excess reserves and due-from balances. Both serve as alternative sources of reserves to borrowed reserves for reserve adjustments. Hence, this result was expected.

Estimates of the relation between reserve positions and the various explanatory factors were made with the reserve position measure computed in several different ways. A due-from balances relation was also estimated. Deposit variability was a significant explanatory factor in both the reserve position and due-from balances relations and with the expected positive sign. Other results are quite similar between the reserve position and due-from balances estimates when the reserve position is the ratio of excess reserves to total deposits (X/TD). Vault cash is positively associated with the dependent variable in each equation, while bank size and borrowing are negatively related. In using a broad measure of reserve position, the results are generally inferior in terms of significant variables and R^2 , though the percentage error (standard error/mean) of the estimate is lower.

A summary of all equations is presented in Table 2. The structural data, by bank, are contained in Appendix 2.

Estimating Equations

The estimating equations for borrowing, due-from balances, and excess reserves are presented here. The variables used in the equations are as follows:

DF/TD	= ratio of due-from balances to total deposits
G/TD	= ratio of government deposits to total deposits
VC/TD	= ratio of vault cash to total deposits
L/TD	= ratio of loans to total deposits
X/TD	= ratio of excess reserves to total deposits
T/TD	= ratio of time deposits to total deposits
S	= size class of bank based on total deposits
DV	= variability of total deposits using the ratio of the standard error of estimate of total deposits to average total deposits
FV	= variability of due-from balances using the ratio of the standard error of estimate of due-from balances to average total due-from balances

CV	= variability of vault cash using the ratio of the standard error of estimate of vault cash to average vault cash
IV	= variability of interbank deposits using the ratio of the standard error of estimate of interbank deposits to average interbank deposits
SD	= variability of total deposits using the ratio of the standard deviation of the mean of total deposits to average total deposits
B/TD	= ratio of borrowed reserves to total deposits
(X+DF-B)/TD	= excess reserves plus due-from balances less borrowed reserve ratios divided by average total deposits

The last variable listed above represents an alternative measure of reserve position and is used in alternative tests of some equations. Except for size class (S) all variables were computed from the daily bank data of each bank. It should be mentioned that because of differences in bank size ratios were used in the regressions instead of levels of data. The borrowing equations will be discussed first, then the excess reserve and due-from balances equations.

Borrowing. The estimating equation which best explains borrowing for the sample of banks is as follows:

$$\begin{array}{cccccc}
 B/TD = +.0035 & -.0698*DF/TD & -.3001*X/TD & -.00081*S & +.1533*DV & \\
 & (.0258) & (.1261) & (.00029) & (.0360) & \\
 & 2.71 & 2.38 & 2.79 & 4.26 &
 \end{array}$$

$$n=18; R^2=.641; S.E.=.00151; D.W.=2.264 \quad (4.1)$$

All of the variables in equation 4.1 are significant at the 5 per cent significance level. The standard error of each coefficient appears in parentheses directly below it and t values lie below the standard errors. The most significant variable in terms of t value is deposit variability (DV). As hypothesized, borrowing is positively related to deposit variability.

*Indicates significant coefficient.

Coefficients for the due-from balances ratio (DF/TD) and the excess reserves ratio (X/TD) are significant in equation 4.1, each having a negative sign. These two variables are closely related in the adjustment of reserves in that they are alternative repositories of funds. The estimates show that the greater the quantity of balances at other banks the less likely a bank will borrow. Similarly, banks which have more excess reserves available are not as likely to borrow as much as banks with less. As mentioned earlier in this paper, due-from balances are held by banks to facilitate check clearing and to reward correspondent banks for other services. Among the sample of banks, the largest two banks have lower relative holdings of these balances compared with the other sixteen banks. Similarly, the largest two banks have the lowest excess reserve ratios.

An alternative reserve position variable, the ratio of excess reserves plus due-from balances less borrowed reserves to total deposits ($\frac{X+DF-B}{TD}$), is introduced into equation 4.1 (equation 4.1a shown in Table 2). It has a significant and negative coefficient, although less significant than (X/TD) in equation 4.1.

The size variable (S) is significant in equation 4.1 and has a negative coefficient. This indicates that the larger a bank the less it borrows relative to total deposits. It is quite obvious from the data that large banks borrow large absolute amounts. The implication of the result with size is that large banks do not rely on the Federal Reserve to the same relative extent as small banks.

The borrowing variable in this study was computed in two ways: first, the average of borrowing for the entire period to deposits for

the entire period; second, the average of borrowing on only those days when a bank borrowed to the average of deposits on those days. Comparable estimation results were obtained with borrowing ratios defined in each of these ways. Given other factors, large banks not only borrow relatively less than small banks on any average borrowing day, but also large banks borrow relatively less on the average than small banks over the entire period. It is important to realize that large banks borrow more frequently than small banks and for shorter periods. Column 22 in Appendix 2 lists the number of separate occasions on which each bank borrowed. The figure in column 19 is the total number of days banks borrowed. In measuring frequency of borrowing in column 22 to count a separate borrowing at least one day passed before banks borrowed again. Large banks clearly made more trips to the discount window than small banks. The two largest banks borrowed an average of 2.2 and 1.7 days each time they borrowed. The smaller banks borrowed an average of from 2.0 to 48.0 days each time. (Column 23, Appendix 2).

The coefficient of the loan to deposit ratio (L/TD) was estimated to be insignificant. The sign of the coefficient each time was positive as expected, since a high loan to deposit ratio implies a low security ratio, and thus an illiquid earning assets portfolio. However, illiquid earning assets can be offset by holding large amounts of due-from balances, excess reserves and vault cash. In the sample the most frequent borrowers have relatively large amounts of loans and small amounts of due-from balances and excess reserves.

Government deposits relative to total deposits (G/TD) also proved to be an insignificant explanatory factor when introduced into the

regressions. Robinson, among others, has argued that this variable is highly unstable and therefore a proximate cause of member bank borrowing.⁴ Banks with large relative amounts of government deposits would therefore be subject to additional fluctuations in total deposits. However, when (G/TD) is introduced into the equations as a separate variable (not shown) in addition to aggregate deposit variability its coefficient has a negative sign. It is interesting that some banks with low holdings of government deposits also have high deposit variability measures, e.g., banks 3, 10, and 14. Other banks with large amounts of government deposits also have a high deposit variability ratio, e.g., banks 2 and 9 in Appendix 2, columns 2 and 8. Robinson's assertion is contradicted by these results.

The vault cash to deposits ratio (VC/TD) was introduced into the borrowing equations, but proved an insignificant explanatory factor. Vault cash is kept to facilitate the daily currency transactions of a bank and its customers and while usable to meet reserve requirements usually fluctuates within a predictable weekly or monthly pattern for individual banks. However, by the logic applied to total deposit fluctuations large banks should experience less relative variability in vault cash than small banks. The unexpected loss of cash would more likely trigger a deficit and thus a borrowing situation for a small bank than a large bank. However, neither vault cash (VC/TD) nor variability of vault cash (CV) was significant in explaining borrowing.

4. Robinson, op. cit., p. 101.

The time to total deposits ratio (T/TD) was introduced into the regressions but was insignificant in explaining borrowing. It appears that time deposits and deposit variability are inversely related and the relative size of variability for each bank is influenced by the proportion of time to total deposits it holds. Somewhat similar results concerning the relationship of time deposits to deposit variability were recently obtained by economists at the Kansas City and Philadelphia Federal Reserve Banks.⁵

The hypothesis of this study regarding bank size and the relationship of deposit variability to bank size is tested in equation 4.2. This is the same as equation 4.1 except that the two largest banks are excluded from the regression.

$$\begin{array}{ccccc} B/TD = +.0027 & -.0617*DF/TD & -.2841*X/TD & -.00092*S & +.1761*DV \\ & (.0273) & (.1261) & (.00032) & (.0361) \\ & 2.26 & 2.25 & 2.88 & 4.88 \end{array}$$

$$n=16; R^2=.745; S.E.=.00143; D.W.=2.610. \quad (4.2)$$

5. Struble and Wilkerson, op. cit.; Hugh Chairnoff, "Deposit Variability: A Banker's Headache," Business Review, Federal Reserve Bank of Philadelphia (September, 1967), p. 13+.

The R^2 of equation 4.2 is considerably higher than for 4.1. Eliminating the two largest banks makes the results of equation 4.2 representative of the behavior of relatively homogeneous sized banks. The coefficient of the deposit variability measure (DV) is more significant based on the t ratio in equation 4.2 than in equation 4.1. The standard error is the same. Among small banks deposit fluctuations are more significant as a cause of borrowing than among all banks.

The estimate of the coefficient of the ratio of due-from balances to total deposits (DF/TD) also changed from equation 4.1 to 4.2 but not significantly. One might have expected that due-from balances and borrowings would have been closer substitutes for small than large banks since small banks hold larger relative amounts of these balances as shown in Appendix 2, column 1. Large banks hold relatively low due-from balances and are less able to rely on these balances for reserve adjustment purposes. In light of their greater ability to profitably use funds, it also follows that large banks would find more outlets for funds at relatively low transaction costs. And with greater knowledge of financial markets ascribed to them, the large banks would not tend to hold due-from balances above some required minimum. However, when the two largest banks are excluded from equation 4.1, the significance of due-from balances (DF/TD) falls, contrary to expectation, though the difference is insignificant.

The coefficients of the excess reserve ratio (X/TD) and size (S) remain significant in equation 4.2, each having the same sign (negative) as in equation 4.1. The coefficients are not significantly different from one estimate to another.

Equations 4.1 and 4.2 give good results and no significant serial correlation or misspecification is indicated by the Durbin-Watson statistic. The R^2 of equation 4.2 is much higher than for equation 4.1, going from .641 to .745. Equation 4.2 represents an estimate for primarily small banks while 4.1 includes banks with considerably greater range in size.

An alternative hypothesis is that deposit variability itself, rather than unexpected deposit variability, would be positively related to borrowing. The alternative measure (SD) was introduced into the equation as an independent variable in place of (DV). The results are contained in equation 4.3.

$$\begin{array}{rccccc}
 B/TD = & +.0056 & -.0058DF/TD & -.207LX/TD & -.0006S & -.0028SD \\
 & & (.0326) & (.1996) & (.0004) & (.0149) \\
 & & .18 & 1.04 & 1.40 & .19
 \end{array}$$

(4.3)

$n=18$; $R^2=.144$; $S.E.=.00233$; $D.W.=1.974$.

The power of the initial result with unexpected deposit variability is dramatically demonstrated by the fact that none of the variables in equation 4.3 is significant at the .05 significance level, and that the overall explanatory powers drop from 60 to 70 per cent to 14 per cent. This is indeed a significant result. The coefficient of deposit variability (SD), measured as the ratio of the standard deviation of total deposits to average total deposits, is insignificant and has a negative sign, contrary to theoretical expectations. SD is the measure of variability in several recent studies. But the results of my analysis cast serious doubts on the validity of its interpretation. The weakness with SD is its exclusion of predictable total deposit changes for individual banks around a given seasonal pattern and trend.

Essentially, it ignores the random loss of deposits which is hypothesized in this study as a significant cause of borrowing. During any given settlement period, it is not so much the range of deposit fluctuations that affects reserves as the loss of deposits over and above expected losses. The former is measured by (SD); the latter, by (DV).

In summary, the estimating equations for borrowed reserves provide quite good results. Deposit variability (DV) appears to be a highly important factor on which borrowing depends. An alternative measure of deposit variability (SD) proved to be highly insignificant in explaining borrowings. Total deposits variability was found to be the significant factor in comparison with analysis of the effect of the distribution of deposits among interbank, government, and other deposits. Vault cash variability was also insignificant in explaining borrowing.

Alternatives to borrowing for reserve adjustment, include due-from balances and excess reserves, both of which are inversely correlated with borrowed reserves. Estimating equations for these two assets are now presented.

Due-From Balances. The estimating equation for due-from balances for the sample of banks is as follows:

$$DF/TD = +.0216 + .9514*VC/TD - 3.0477*X/TD - .0060*S + 1.1104*DV - 3.7708*B/TD$$

(.3904)	(.9270)	(.0022)	(.2782)	(1.7202)
2.44	3.29	2.67	3.99	2.19

$$n=18; R^2=.747; S.E.=.01105; D.W.=1.667. \quad (4.4)$$

All variables in equation 4.4 are significant at the .05 significance level. Vault cash (VC/TD) and due-from balances are positively and significantly related. Banks that have relatively high vault cash variability would presumably hold additional vault cash, and since

many small banks draw on correspondent balances to get vault cash, they might also be expected to hold additional due-from balances. This effect was discussed earlier. One of the most obvious characteristics of the smaller banks in the sample is the randomness in their vault cash. It is much greater than for the large banks. This can be seen in column 10 of Appendix 2, where a measure of vault cash variability is presented.

Due-from balances and excess reserves (X/TD) are inversely and significantly related. A bank holding excess reserves as a buffer to deposit variability, would likely minimize its due-from balances since each is a non-earning asset. In this sense due-from balances and excess reserves are alternatives for reserve adjustments and managed as such by the banks. This relation is supported in the excess reserve equation estimates below.

Bank size (S) is inversely related to due-from balances as found in the borrowing relationship. The estimates show that deposit variability is positively and significantly related to due-from balances. A positive sign was expected on the basis of hypotheses presented early in the study.

Borrowing (B/TD) is inversely and significantly related to due-from balances in equation 4.4. This result supports the result in equation 4.1 where due-from balances were used as an independent variable in the borrowing equation. Borrowing would usually not be undertaken by a bank if sufficient due-from balances were available for reserve adjustment purposes. Banks apparently maintain these balances to some degree to avoid the necessity of borrowing.

In summary, equation 4.4 provides a good explanation of due-from balances. The strong negative correlation between due-from balances and borrowing indicates that for the sample of banks at least, due-from balances are effectively used by banks as an alternative to borrowing. Due-from balances and excess reserves appear to be substitutes. Vault cash is positively related to due-from balances as is deposit variability. And small banks hold relatively larger amounts of due-from balances than large banks.

Excess Reserves. The estimating equation obtained for excess reserves (X/TD) is given below.

$$\begin{array}{rccccc} X/TD = & +.0087 & +.1869VC/TD & -.1555*DF/TD & -.0018*S & +.1854*DV \\ & & (.0933) & (.0473) & (.0004) & (.0795) \\ & & 2.00 & 3.29 & 4.89 & 2.33 \\ & & & & & \\ & -.8200*B/TD & & & & \\ & (.3942) & & & & \\ & 2.08 & & & & \end{array}$$

$$n=18; R^2=.753; S.E.=.00250; D.W.=2.038 \quad (4.5)$$

The most significant variables are size class (S), due-from balances (DF/TD), deposit variability (DV), and borrowing (B/TD). Vault cash (VC/TD) is close to being significant. Larger banks hold relatively smaller amounts of excess reserves. This would support the hypothesis that larger banks have lower security trading costs or federal funds costs and, therefore, can operate with lower working reserves than small banks. As assumed in this study, banks offset the need to borrow at the Fed by maintaining alternative cash or near cash assets. Excess reserve holdings would lessen the need to borrow at the Fed. The inverse relation between excess reserves and borrowing in equation

4.5 would be expected from this. In the borrowing equation (equation 4.1) excess reserves (X/TD) were inversely related to borrowing.

Deposit variability (DV) in equation 4.5 is significant although it is less significant than in equation 4.4 or equation 4.6. Apparently, banks experiencing great deposit variability offset the uncertainty associated with this variability by maintaining additional excess reserves. This finding is in agreement with the hypotheses of this study regarding bank behavior with respect to deposit uncertainties.

An alternative measure of reserve position is the ratio of excess reserves plus due-from balances less borrowed reserves to total deposits ($\frac{X+DF-B}{TD}$). This measure represents a more complete measure of reserve position in that both due-from balances and excess reserves are available to banks for reserve adjustments. It represents an augmented version of the net free reserve computation of the Federal Reserve.

Equation 4.6 shows results using this measure of reserve position:

$$\frac{X+DF-B}{TD} = -.0041 + 1.46 \frac{VC}{TD} + .00128 + .6550 DV$$

(.4463)	(.0019)	(.2714)
2.56	.63	2.41

(4.6)

n=18; $R^2=.514$; S.E.=.01394; D.W.=2.007

The R^2 of equation 4.6 falls considerably from that of equation 4.5. Since equation 4.6 estimates a broad measure of reserve position a more relevant comparison is that the percentage error (standard error/mean) falls to .371 for equation 4.6 from .446 for equation 4.5. The vault cash ratio (VC/TD) and deposit variability (DV) are significant explanatory factors in equation 4.6. The coefficient of each rises significantly in equation 4.6 compared with equation 4.5. The significance of the coefficient of size (S) declines considerably in equation

4.6 compared with 4.5. In light of the hypotheses of this study the results with the reserve position estimates and the due-from balances estimate are as expected. Both excess reserves and due-from balances serve as alternative adjustments to borrowing. Some banks appear to prefer due-from balances, while others prefer excess reserves. However, the greater its deposit variability, the larger a bank's holdings of excess reserves and due-from balances. The reserve position measure used in equation 4.6 is used in the individual estimating equations presented in Chapter V.

In summary, the results presented in the excess reserve and due-from balances equations substantiate the results with borrowing. The fact that borrowing is negatively correlated with these two alternative measures of reserves is significant. This strong negative relationship implies that banks consider alternative reserve sources. Since borrowing at the Federal Reserve has a fixed and known cost while the costs of excess reserves and due-from balances are less fixed but calculable by bankers, then consideration of alternative reserve sources involves consideration of alternative costs. Another very important finding is the significance of deposit variability, although it is less significant in explaining the banks' reserve positions or due-from balances on the basis of t tests than in explaining borrowing. This can mean that sudden and unexpected deposit losses are offset by banks by borrowing at the Federal Reserve rather than relying on due-from balances or using excess reserves. However, banks which are subject to this kind of loss apparently prepare to some extent by maintaining higher levels of excess reserves and due-from

balances. More on this point can be said after individual behavior patterns are presented in Chapter V. The results also indicate that large banks hold fewer relative amounts of due-from balances and excess reserves than small banks and that vault cash is positively related to both due-from balances and excess reserves.

Conclusions

The findings presented in this chapter are to some extent further evidence of what is expected to be the behavior of banks. For instance, there is evidence that excess reserve holdings of small banks tend to be higher than for larger banks. Many reasons for this are given in the literature, one of the more frequent being that small banks are just 'conservative'. And although due-from balances are not often discussed or studied by economists, similar assumptions are popular about these balances. Small banks keep them to pay correspondents for services performed. There is evidence from this study that small banks do behave differently than large banks regarding these items.

Several of the findings in this study break new ground, particularly the effect of deposit variability on member-bank reserve adjustments. Certainly, on the basis of this study alone, deposit variability appears to be a significant reason for bank borrowing. The results cannot be generalized to the banking system as a whole because there were but two very large banks in the survey. Nevertheless, there is some substantiation of the hypothesis that deposit variability and bank size are inversely related. There is also some evidence that deposit variability is related to time deposits, the latter having a

dampening effect on deposit variability. Other recent studies and have found a similar relationship between time deposits and deposit variability.⁶

Regarding liquidity, it appears that banks do maintain a liquid position either by holding additional excess reserves or due-from balances in the light of additional uncertainty about reserve needs. The loan ratio of the banks was not significant in explaining borrowing. There is some evidence from the data that borrowing banks hold relatively more loans than infrequently borrowing banks or non-borrowing banks (bank 4). The apparent reaction of banks is to hold non-earning assets instead of reducing loan portfolios in the face of uncertainty.

Bank size is significant in explaining borrowing. It can be assumed that bank size is a proxy for transaction costs in this study, in view of evidence in this regard. Large banks have low transaction costs relative to the average size transaction made by them. Small banks have relatively larger transaction costs. The results of the cross section analysis support the hypothesis that transaction costs and borrowing are significantly related and inversely. Borrowing at the Fed is relatively more expensive for large banks than alternative reserve sources. Borrowing at the Fed is relatively less expensive for small banks than alternative reserve sources as hypothesized. It may also be a reflection of the fact that large banks have greater knowledge of deposit losses and do not accumulate large deficits. The assumptions about bank size and deposit behavior presented in this

6. Struble and Wilkerson, op. cit.; Chairnoff, op. cit.

study support the latter explanation. Finally, large banks borrow more often than small banks and for shorter periods of time. Small banks tend to borrow infrequently, but keep the borrowing outstanding for relatively long periods of time.

Due-from balances and excess reserves are alternative adjustment mechanisms to borrowing and banks which hold relatively high balances in these accounts are less likely to borrow at the Federal Reserve. Small banks hold larger relative amounts of these items and for this reason can avoid borrowing at the Fed when deficit reserve positions occur. However, large and frequent deposit losses can offset the sufficiency of these assets and still force a bank to borrow at the Fed, particularly the smaller banks.

Other variables were used in testing the hypotheses of this study. Assumptions about bank behavior especially regarding behavior resulting from different kinds of deposits, e.g., government deposits or time deposits, were discussed and to some extent tested in the equations of this chapter. The significance of variables other than those mentioned in the chapter was slight. Specification of the equations followed as nearly as possible from the theoretical relationships discussed in early chapters. The results of the cross section analysis lend support to the importance of deposit variability and its implications for bank borrowing. More evidence is needed regarding this important variable and bank size. Considerable difference exists between various measures of variability which difference could influence the importance attached to variability. The measure used in this study appears to represent most realistically the uncertainty facing

banks regarding deposit losses and fluctuations over time. Since this uncertainty is so vital in bank decision making then greater knowledge about it is essential to greater understanding of bank behavior and its effect on important monetary phenomena.

TABLE 2

SUMMARY OF ESTIMATING EQUATIONS USING CROSS SECTION DATA

B/TD =	+.0035	-.0698*DF/TD (.0258) 2.71	-.3001*X/TD (.1261) 2.38	-.00081*S (.00029) 2.79	+.1533*DV (.0360) 4.26	
			n=18; R ² =.641; S.E.=.00151; D.W.=2.264.			(4.1)
B/TD =	+.0007		-.0670*Xa/TD (.0245) 2.73	-.00042S (.00021) 1.94	+.1479*DV (.0348) 4.21	
			n=18; R ² =.593; S.E.=.00155; D.W.=1.988.			(4.1a)
B/TD =	+.0027	-.0617*DF/TD (.0273) 2.26	-.2841*X/TD (.1261) 2.25	-.00092*S (.00032) 2.88	+.1761*DV (.0361) 4.88	
			n=16; R ² =.745; S.E.=.00143; D.W.=2.610.			(4.2)
B/TD =	+.0056	-.0058DF/TD (.0326) .18	-.2071X/TD (.1996) 1.04	-.0006S (.0004) 1.40	-.0028SD (.0149) .19	
			n=18; R ² =.144; S.E.=.00233; D.W.=1.974.			(4.3)
DF/TD =	+.0216	+.9514*VC/TD (.3904) 2.44	-3.0477*X/TD (.9270) 3.29	-.0060*S (.0022) 2.67	+1.1104*DV (.2782) 3.99	-3.7708*B/TD (1.7202) 2.19
			n=18; R ² =.747; S.E.=.01105; D.W.=1.667.			(4.4) ^Σ

$$X/TD = \begin{array}{cccccc} +.0087 & +.1869VC/TD & -.1555*DF/TD & -.0018*S & +.1854*DV & -.8200*B/TD \\ & (.0933) & (.0473) & (.0004) & (.0795) & (.3942) \\ & 2.00 & 3.29 & 4.89 & 2.33 & 2.08 \end{array}$$

$$n=18; R^2=.753; S.E.=.00250; D.W.=2.038. \quad (4.5)$$

$$\frac{X+DF-B}{TD} = \begin{array}{ccc} -.0041 & +1.146*VC/TD & -.0012S \\ & (.4463) & (.0019) \\ & 2.56 & .63 \end{array} \quad \begin{array}{c} +.6550*DV \\ (.2714) \\ 2.41 \end{array}$$

$$n=18; R^2=.514; S.E.=.01394; D.W.=2.007 \quad (4.6)$$

^aIn this equation excess reserves are equal to $\frac{X+DF-B}{TD}$.

CHAPTER IV

DESCRIPTIVE ANALYSIS OF INDIVIDUAL BANKS

A distinguishing characteristic of this study is the use of both daily data and balance sheet items for individual banks. There is little written about individual bank daily behavior. If such knowledge were available then some of the effects of monetary policy could be better predicted.¹ The banking system is the channel through which monetary policy transmits its effects. Monetary policy affects the money supply, portfolio shifts by banks and other financial institutions, interest rate changes and ultimately price, output, and employment changes. One of the gaps in our knowledge of monetary forces is the timing, direction and effects of day to day reserve adjustments of individual banks.

The balance sheet data for each bank are discussed in this and the next chapter regarding the circumstances under which borrowing took place during the study period. Two related approaches are used in studying this data. First, a careful description of individual banks is presented; second, regression analysis is used with individual bank balance sheet items as independent variables.

1. Leonall C. Andersen, op. cit., p. 1-2.

2. DUE TO BANKS			3. U.S. GOVERNMENT DEMAND DEPOSITS			4. OTHER DEMAND DEPOSITS			5. CASH ITEMS IN PROCESS COLLECTION			6. DEMAND BALANCE DUE FROM BANKS			7. NET CURRENCY DEPOSITS			8. TIME DEPOSITS		9. VAULT CASH		10. DATE	
ML	TH	THOUSANDS	MILLION	THOUSANDS		MILLION	THOUSANDS		MILLION	THOUSANDS		MILLION	THOUSANDS		MILLION	THOUSANDS		MILLION	THOUSANDS	MONTH	DAY		
DEMAND DEPOSITS						DEDUCTIONS						NET		(REPORT ALL AMOUNTS IN NEAREST EVEN THOUSANDS OF DOLLARS)									

DO NOT FOLD
OR MUTILATE

DAILY REPORT OF DEPOSITS AND VAULT CASH

TO ACCOUNTING DEPARTMENT
FEDERAL RESERVE BANK OF CLEVELAND
CLEVELAND 1, OHIO

IMPORTANT:

REPORTED TOTALS FOR EACH DAY (INCLUDING SATURDAYS AND HOLIDAYS) ARE TO BE BASED ON THE CLOSING BALANCES OF THE PRECEDING BUSINESS DAY. THEREFORE, REPORTS PERTAINING TO THE NEXT DAY MAY BE PREPARED AND MAILED AT THE CLOSE OF BUSINESS EACH DAY. THIS WILL ENABLE REPORTS TO ARRIVE AT THE RESERVE BANK ON THE DAY CORRESPONDING WITH THE REPORTED DAY'S FIGURES. REPORTS ARE NOT TO BE PREPARED FOR SUNDAYS.

SIGNATURE OF BANK STAMP

AC 328

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

EXHIBIT 1

DAILY REPORT OF DEPOSITS AND VAULT CASH

The Data, Computation of Required Reserves and Reserve Position

The daily balance sheet items made available consisted of the individual bank figures used in computing reserve requirements. Some of these data are reported daily to the Cleveland Federal Reserve Bank by each bank in the fourth district. Exhibit 1 is a copy of the daily report filed by each bank. In addition, daily data were made available from the Fed for reserve balances and borrowings of each bank. Required reserves are based on weekly averages of net demand deposits and time deposits. Net demand deposits are equal to total deposits less cash items in process of collection and demand balances due from banks. Vault cash is deducted from computed actual required reserves to get the reserve requirement that must be satisfied with balances held at the Fed. This, in the jargon of Federal Reserve officials, is what is often called "required reserves." The difference between actual required reserves and reserve balances held at the Fed is the excess or deficient reserves of the individual bank. An important clarification must be made concerning the computation of excess or deficient reserves. It can be seen from Exhibit 1 that the report is prepared on the basis of data for the close of business. It is filed so that it will reach the Federal Reserve Bank the following morning. The data become opening of business data that the Federal Reserve Bank uses to compute required reserves. Reserve balances of each bank which satisfy the requirement and which are held at the Fed, are taken as of the close of business on the day on which the Fed received the report. A deficit reserve position must be interpreted correctly. A deficit computed on Wednesday, the last day of the settlement period, means

that the average of reserve balances through Wednesday's close of business was less than the reserve requirement calculated from average deposits for the preceding day's close of business. Thus a bank has a day's grace period to adjust reserves to its requirement. In addition, there are waivers of various size allowing banks to ignore penalties charged on small deficits and individual Reserve Banks permit consecutive deficit periods, etc.².

In looking for explanations of why banks borrowed, the deficit computed by the Federal Reserve on the basis of the close of business deposit data through Tuesday is important because a bank would want to eliminate it by sufficiently increasing its reserves the following day. What the regulation says is that a bank may change its reserves on Wednesday, but its required reserves for the settlement period would be fixed. A bank may increase or decrease its reserves on any day of the settlement period. When a bank borrows from the Federal Reserve the amount borrowed will be included in the reserves of that day. Borrowing thus immediately increases reserve balances. A bank's reserves are also increased when more checks clear the Federal Reserve or Clearing House in its favor than clear against it. In selling securities either to the Federal Reserve or to dealer's, the bank's reserves may be immediately increased or may be increased a day later if the funds go through the Clearing House (the latter depends mainly on how dealers choose to make payment).

2. Individual Reserve Banks have discretionary control over these matters.

We can now proceed to a discussion of the descriptive analysis and the multiple regression analysis. Results of the former analysis are contained in this Chapter and the latter in Chapter V.

Methods of Analyzing Daily Data

Descriptive Analysis. The daily data were studied carefully to search for factors that might have triggered borrowing, such as recent deposit changes, due-from balances changes, vault cash changes, accumulated reserve position and the interest rate situation. Seasonal patterns of borrowing were studied in relationship to these items. The data were studied during non-borrowing periods also for comparative purposes. The logic of this approach was not to find offsetting or matching sums in each borrowing period but to find consistent patterns of behavior around borrowing periods.

As part of the descriptive analysis the ratios for individual banks which were extensively used in the structural regressions were arranged according to their frequency of borrowing in Table 3 and their size in Table 4. The ratios combined with detailed study of each bank's daily activity make a convenient and interesting description of the characteristics of banks in various borrowing classes. It permits individual banks to be viewed in relationship to other individual banks; and allows groups of banks closely similar in their borrowing frequency and size to be contrasted with others. Determination of frequently borrowing banks was arbitrary but based on a convenient discontinuity in the data. Looking at column 19 in Appendix 2 this can be seen. Seven of the 18 banks borrowed 15 days or less over the study period, or less than 1 per cent of the time. Eleven banks borrowed 45 days or more of

the time. There is a good representation of large and small banks in both groups, and, therefore, the data in Table 3 are arranged on this basis. Similarly, distribution by size in Table 4 also is based on a convenient grouping of the banks which can be seen in column 24 Appendix 2: the largest five banks had average total deposits over \$29,000,000; the middle sized group of banks had average deposits over \$10,000,000 and under \$18,000,000; the smallest group had average deposits less than \$7,000,000.

Regression Analysis. The second method used in studying the daily borrowing behavior of the banks was multiple regression analysis. Besides the daily balance sheet data, seasonal dummy variables and daily interest rate variables were used in the regressions. The hypotheses tested in the daily individual bank regressions are discussed at length in Chapter II. In general, it was hypothesized that significant seasonal patterns of borrowing would appear, that reserve position would be inversely correlated with borrowing (and probably with a lag), that deposit losses would help explain borrowing in that these losses cause reserve losses and deficit situations, and that banks would borrow when its cost was lower than alternative reserve sources. The basic estimating equation for individual banks was given in Chapter II where the theoretical underpinnings of the variables were also presented. Specification of the equations, statistical problems associated with regression analysis and complications arising from the use of distributed lags, which are introduced into the equations, are discussed in the section dealing with the estimating equations in Chapter V.

The descriptive analysis of individual bank borrowing patterns will now be presented.

TABLE 3

AVERAGE RATIOS OF BANKS BASED ON FREQUENCY OF BORROWING

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank Grouping Based on Borrowing Frequency	Aver.No. Days Borrowed	DF/TD	G/TD	VC/TD	L/TD	X/TD	DV	T/TD
Frequent Borrowers:	158	.029	.020	.018	.585	.00340	.035	.533
Large Banks (2)	161	.011	.028	.012	.630	.00005	.022	.459
Small Banks (9)	158	.035	.015	.020	.578	.00620	.040	.562
Infrequent Borrowers:								
All Banks: (7)	9	.038	.015	.024	.526	.00690	.032	.589
Average		.034	.017	.021	.552	.00560	.034	.590

TABLE 4

AVERAGE RATIOS OF BANKS, BY SIZE, IN DESCENDING ORDER OF SIZE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank Grouping Based on Size in Descending Order of Size	Aver.No. Days Borrowed	DF/TD	G/TD	VC/TD	L/TD	X/TD	DV	T/TD
Largest Banks								
1,2.	161	.011	.028	.012	.630	.00005	.022	.459
Next Largest Banks:								
3,4,5.	42	.046	.020	.020	.460	.00093	.040	.428
Largest 5 Banks:	90	.032	.024	.017	.528	.00058	.033	.440
Middle 7 Banks:	93	.033	.016	.026	.577	.00760	.034	.600
Smallest 6 Banks:	117	.035	.013	.019	.543	.00670	.034	.624
Average of All Banks		.034	.017	.021	.552	.00560	.034	.590

The data in Tables 3 and 4 are defined as follows:

<u>COLUMN NO.</u>	<u>SYMBOL</u>	<u>VARIABLE NAME AND COMPUTATION</u>
2	DF/TD	= ratio of due-from balances to total deposits
3	G/TD	= ratio of government deposits to total deposits
4	VC/TD	= ratio of vault cash to total deposits
5	L/TD	= ratio of loans to total deposits
6	X/TD	= ratio of excess reserves to total deposits
7	DV	= variability of total deposits using the ratio or the standard error of estimate of total deposits to average total deposits
8	T/TD	= ratio of time deposits to total deposits

Results of Descriptive Analysis

Due-From Balances. It can be seen from Table 3, column 2, that frequently borrowing banks have lower due-from balances ratios than banks borrowing less frequently. Due-from balances are a cash asset that can be converted by banks to use at their discretion. The two largest banks held considerably lower relative amounts of these balances than the smaller banks. This is apparent in both Table 3 and 4, and in Appendix 2, column 1. Looking at the daily data of the banks, it is clear that operating banks never draw down these balances to zero since some amount of due-from balances must be maintained to allow correspondent banks to remit on checks for their correspondents and as an indirect payment for other services.

When a bank faces a deficit reserve position a potential borrowing situation exists. The smaller banks in the sample frequently draw down due-from balances during these times apparently to avoid continuation of the deficit. The two largest banks do not follow this pattern, but appear to maintain their due-from balances at a comparatively low and stable level. Some of the smaller banks also held relatively small amounts of due-from balances, e.g., banks 7, 8, 15 and 16, but unlike

the largest two banks they held relatively large amounts of excess reserves; or they borrowed frequently at the Fed, e.g., bank 7. On the basis of this analysis and because due-from balances were significantly and negatively correlated with borrowed reserves in the structural equations, it was concluded that these balances should be incorporated into the measure of reserve position used in the regressions for individual banks.

Government Deposits. The government deposit ratio is higher for frequently borrowing banks than for other banks and is directly related to bank size. The former conclusion is apparent from Table 3, column 3, the latter in column 3 of Table 4. Since these deposits are controlled by the Treasury and are manipulated on a very well known schedule, it would not seem likely that loss of government deposits would be an altogether unexpected occurrence for any one bank. The figures for the two large banks in both Tables are deceiving in that bank 2 has government deposits equalling about 4 per cent of total deposits on average, the highest ratio in the sample while bank 1 holds less than 1 per cent in government deposits. The average of all banks is 1.7 per cent. This is an example of the difficulty of using averages when so few banks are included in the average. While borrowing banks tend to hold larger relative amounts of government deposits, the evidence from structural analysis and from close study of individual banks does not indicate a particularly significant role for these deposits in explaining borrowing, except for bank 2 as will be shown later in Chapter V (equation 4). The very high government ratio for frequently borrowing banks is weighted considerably by bank 2 with its high ratio. It might be concluded that small banks hold relatively

fewer government deposits regardless of their borrowing patterns. This conclusion is supported by the ratios in Tables 3 and 4, column 3. Except for bank 2, there is little difference between the frequently and infrequently borrowing banks in terms of the government ratio.

Vault Cash. Vault cash holdings are relatively lower for frequently borrowing banks than for infrequent borrowers. Large banks have very low vault cash ratios compared with the smaller banks. This is seen in column 4 of both tables. While vault cash is suitable for meeting required reserves, it is kept to facilitate currency transactions of a bank's customers. However, as with many of its balance sheet items, the small bank is subject to greater and more unpredictable changes in vault cash. The variability of vault cash for large banks is rhythmic and highly predictable. This characteristic of vault cash can be seen in Appendix 2, columns 10 and 13. To offset the random outflows of vault cash small banks apparently maintain larger relative amounts of vault cash. This is especially characteristic of banks 8, 9 and 16, columns 3 and 10, Appendix 2.

From examining the daily data, it appears that vault cash flows out of the large banks toward the end of the week and generally by the following settlement Wednesday has flowed back. While reserve deficits may be caused by this outflow, the expectation that vault cash will soon be rebuilt does not lead to borrowing by the large banks. Occasionally, however, the small banks experienced deficits resulting from vault cash losses, and offset the deficits by borrowing. From the data in Table 3 it appears that banks with large relative amounts of vault cash do not borrow as often from the Fed as others. Small banks

hold relatively more non-earning assets including vault cash than the large banks.

Loans. Column 5 in Tables 3 and 4 contains the loan ratio for the banks. Frequently borrowing banks are less liquid than infrequently borrowing banks. Their loan to deposit ratios are higher. The two largest banks appear to be the least liquid. The average hides something because bank 1 has the second highest loan to deposit ratio and bank 2 has one of the lowest (Appendix 2, column 4). The complement of the loan ratio is the security ratio of the banks. It is normally true that security sales are cheaper reserve sources than loan liquidation, at least in the short-run. Hence, it would be expected that banks with large loan portfolios would be forced to borrow at the Fed more than banks with relatively fewer loans, since the latter could presumably sell securities instead in the face of an impending reserve deficit.

The daily data suggest that banks experiencing a deficit in reserves rely on security sales before borrowing at the Fed. The security data are call date figures and must be interpreted with caution. This interpretation is easier to establish for small than large banks because of the nature and timing of borrowing by small banks. Small banks in the sample borrow for relatively long periods of time and seldom repay the borrowing in the same settlement period as it was extended. Bank 14, for example, averaged 48 consecutive days each time it borrowed. This is primarily true because small banks suffer reserve deficits directly attributable to deposit losses. These deposit losses frequently are not expected to be reversed in a day or two, but

are of a long term nature, particularly if they follow a seasonal pattern as they do for some banks. Most often, the quarters during which deposits flow out show a decline in security holdings of the banks, indicating that securities were either sold or allowed to run-off in order to supplement reserves. It was generally when security holdings were quite low that the small banks borrowed.

The pattern for the larger banks, including here banks 1, 2, and 5, is different in that these banks borrow frequently and for very short periods of time. Banks 1 and 2 average 1.9 days each time they borrowed compared with 14.7 days for the smaller banks. Moreover, borrowing for the large banks is evenly distributed over the year while the smaller banks appear to borrow regularly in the same seasonal periods of the year. It was impossible to find a security decline for the large banks during borrowing periods with only call report data. However, a related and important finding was that deficits for the large banks frequently were erased by reserve increases unrelated to borrowing. Apparently, the large banks rely on reserve sources other than borrowing at the Fed, either security sales or federal funds borrowing, to erase a given deficit. The small banks normally borrowed at the Fed a sum sufficient to offset the deficit, and this usually after securities were sold off. This interpretation is tentative on the basis of call report data for loan and security holdings.

Excess Reserves. Large banks have low excess reserve positions. See column 6 of Table 3. Frequently borrowing small banks hold slightly less excess reserves on average than infrequent borrowers. It

appears that both large and small banks borrow to offset a deficit. However, large banks have frequent deficits. In fact, banks 1 and 2 experienced deficits at some time during 90 per cent of the settlement periods of the study period. Small banks usually experience deficits when deposits flow out of the banks and these periods are relatively infrequent. In most settlement periods, small banks accumulate excess reserves and seldom dispose of these excess reserves before settlement dates. When the small banks which borrow frequently are not suffering deficits, they follow a similar pattern of accumulating excess reserves. For instance, it frequently happens that small banks accumulate excess reserves greater than total deposits when they are not in a deficit situation, which is possible because of the 14 day accumulation process for excess reserves. It is, therefore, not difficult to understand why average excess reserves for smaller banks are higher than for larger banks regardless of their borrowing behavior.

Deposit Variability. One of the most significant relationships appearing in the analysis of daily data is the close association of deposit losses and bank borrowing. This relationship is a focal point of this study. All of the banks in the study appear to borrow when deficits existed. These deficits can be caused by many things, including the loss of reserves through deposit flows or through the insufficiency of reserves due to increases in required reserves. There is some evidence from the data that smaller banks borrow in anticipation of deficits, but this is more characteristic of large banks, especially bank 5.

A bank may have foreknowledge of an impending change in reserves and/or required reserves. Also, some of the small banks borrow for longer periods than necessary, surprisingly ending the settlement period with net free reserves of considerable amounts. They apparently reacted with a lag to information about their reserve position. Since the loss of deposits usually requires a loss of reserves, deposit losses are a proximate cause of borrowing. And for the small borrowing banks it is apparent from the daily data that large deficits are associated with these losses. For the small banks the deficits are not always offset by borrowing at the Fed, but frequently they are, particularly when the smaller banks have run down their security holdings. As the deposits begin flowing back into the banks, the borrowing is repaid. For most of the small banks, due-from balances are also drawn down during these periods; but as mentioned earlier these balances cannot be drawn down to zero since they are needed for the services performed by correspondents.

An attempt was made to relate deficits to losses of specific kinds of deposits, either interbank, government, or other deposits. Only the five largest banks owned interbank deposits. There does not appear to be a close relationship between fluctuations in these deposits and deficits, nor between fluctuations in government deposits and deficits. Interestingly, however, interbank and government deposits are significant in the estimating equations for the two largest banks as reported in Chapter V. Since other deposits, which represent individual, partnership, and corporate deposits, make up approximately 90 per cent of the banks' demand deposits it is

reasonable to expect losses of other deposits to be closely related to reserve losses. It is this item which precipitated deficits for most of the banks generally. And for the small banks the average loss of other deposits over relatively long periods of time, e.g., one month, is closely associated with reserve losses during these periods. For larger banks, deficits result from the loss of reserves relative to required reserves. But these deficits are not closely associated with other deposit flows. It is likely that reserve losses are due to activity in the security's market, the federal funds market or to lending operations.

Time Deposits. The time deposit ratio appears in column 8 of Table 3. The two large banks have much lower ratios of time deposits than the small banks. The frequently borrowing banks have lower time deposit ratios than the infrequently borrowing ones. For almost all the banks the ratio of time deposits to total deposits increased over the study period.

The interpretation of this ratio in terms of borrowing behavior appears to lie in its effect on deposit variability. Looking at the individual bank ratios presented in Appendix 2, it can be seen that the second and third largest banks have the two lowest time deposit ratios (column 7). Bank 3 has the lowest time deposit ratio of all the banks. It also has the second highest deposit variability ratio (column 8). Yet it seldom borrowed. Similarly, bank 2 has a relatively high deposit variability measure considering its large size, and the second lowest time deposit ratio of the sample of banks. From this, it might be concluded that time deposits exert a dampening

effect on deposit variability regardless of bank size. This possibility was discussed in the previous chapter. But this effect does not seem to work for small banks. A relatively high time deposit ratio is associated with high variability for small banks 7, 12, 16, and 18, which is somewhat different from the conclusions of Struble and Wilkerson, and Chairnoff who measure variability as the ratio of the standard deviation of total deposit to average total deposits.³ Their measure was used as an alternative in the regressions of Chapter IV, and proved insignificant in those regressions. More evidence is needed on the interaction of time deposits on total deposit variability, although bank size and time deposits appear to be key variables in explaining random deposit fluctuations.

Seasonal Influences. Analysis of the daily behavior of these banks lends some evidence in support of seasonal influences on borrowing. They relate mostly to monthly and quarterly patterns of borrowing, primarily of the smaller banks of the sample. For the largest two banks there is no significant difference between the first and second week of the country bank settlement period. Each bank borrowed equally in the first and second week. For the smaller banks there is no strong inter-settlement pattern primarily because small banks borrowed for extended periods of time which overlapped settlement periods.

Daily seasonal patterns were not consistently followed by either the small or large banks or the frequent versus infrequent borrowing

3. Struble and Wilkerson, op. cit., p. 8; Chairnoff, op. cit., pp. 13-14.

banks. The most popular borrowing day for the five larger banks was Wednesday. In fact, bank 2 borrowed almost exclusively on Wednesday. As was mentioned earlier, Wednesday borrowing was supplemented by other reserve sources by the large banks. This was not as true for the smaller banks which generally borrowed an amount equal to the size of their deficits. Smaller banks tended to borrow later in the settlement period than did the larger banks, supporting the conclusion of McKinney. However, it must be considered that the smaller banks were not borrowing for short periods of time, but rather in reaction to large and longer term deposit losses. Thus, considerations about interest rates at the beginning of a given settlement period versus the end were probably less important than for larger banks. Discussion of interest rate influences follows later.

There is no consistent week-end pattern of borrowing for the larger banks and, in fact, week-end borrowing was more frequently done by the smaller banks. The first and last parts of the month were not significantly influential in explaining borrowing compared with the middle part of the month for any of the banks.

One significant seasonal pattern of borrowing relates to the smaller banks in the sample which experienced deposit losses in the second and third quarters of the year. These four banks borrowed extensively during the second and third quarters. It might be inferred that these banks lend heavily to farmers and related enterprises and hold their deposits which traditionally are run down during the planting season and are rebuilt during the harvest time. No other significant monthly or quarterly patterns appeared. All of the

significant seasonal patterns of borrowing will be discussed later when the estimating equations for individual banks are presented.

Interest Rate Influence. Alternative sources of reserves have alternative costs. In this study the cost of borrowing at the Fed compared with some other reserve source was measured by the interest rate differential between the 91 day Treasury bill rate and the discount rate. Other costs of borrowing and non-pecuniary costs were ignored. Table 5 presents the relationship between the bill rate and discount rate at different times over the study period. The discount rate was above the bill rate 83 per cent of the time. It was only when rates were rising that the two began to converge. In fact, the few times the bill rate was above the discount rate were immediately before the discount rate was raised.

In measuring alternative costs of reserves, however, the differential is not the only significant figure.* In addition to transaction costs of trading, and the interest loss when securities are sold, security prices can fluctuate widely with the possibility that there would be capital losses in selling securities, and when the bill rate rises, the price of bills falls. For a bank to sell bills when prices are falling may be too expensive compared with the cost of discounting at the Fed. Alternative interest costs are used frequently in studying reserve adjustments including the federal funds rate. As mentioned early in this study, the daily federal funds rate

* Transaction costs are further discussed in the following chapter.

TABLE 5

RELATIONSHIP OF TREASURY BILL RATE TO DISCOUNT RATE, 1961-65

Date	Bill Rate	Discount Rate	Differential	No. Days Bill Rate Above Dis- count Rate
7/2/63	3.02%	3.00%	.02%	
7/17/63 ^a	3.24	3.50	-.26	
11/5/63	3.51	3.50	.01	15
11/16/64	3.60	3.50	.10	
11/26/64	3.82	3.50	.32	
11/27/64 ^a	3.81	4.00	-.19	220 ^b
9/28/65	4.01	4.00	.01	
12/8/65	4.36	4.00	.36	
12/9/65	4.34	4.00	.34	
12/10/65 ^a	4.33	4.50	-.17	62
Total				297 ^c

^a Indicates the dates over the study period when the discount rate was raised at the Cleveland Federal Reserve Bank.

^b On 2/28/64 the differential went to .10. Between 11/5/63 and 11/26/64 the bill rate was above the discount rate for 220 days and on 11/27/64 the discount rate went to 4.00%.

^c On 297 out of 1,704 days of the study the bill rate was actually above the discount rate or 17.4% of the days.

was not available when the study was begun. Moreover, it is questionable when dealing with relatively small banks, whether the federal funds rate is truly an alternative cost since small banks generally were not active in the funds market during the study period even though they apparently began moving into the funds market late in the study period.⁴

4. Baxter, op. cit., p. 34.

Another important consideration is the lack of cyclical variation in interest rates over the study period. During the period 1961 through 1965 interest rates trended upward and there were no significant declines in rates. The discount rate was raised three times during the study period from 3.00 per cent to 3.50 per cent on July 17, 1963; from 3.50 to 4.00 per cent on November 27, 1964; and from 4.00 to 4.50 per cent on December 10, 1965.⁵ The Treasury bill rate and federal funds rate had similar positive trends. It was impossible to measure capital losses on bank security transactions. And because short-run changes in the interest rate differential were very slight, it was difficult to measure precisely the cost of borrowing from the Fed versus other costs.

The borrowing of the two largest banks does not show any strong relationship to interest rates in the study. However, since these two banks relied on several sources of reserves in any deficit situation, it might by implication be said that alternative sources of reserves were carefully considered by the banks. No apparent interest rate patterns appear for any of the smaller banks either. However, the fact that portfolios of securities of the smaller banks were quite low when large reserve deficits appeared indicates that they also considered alternative adjustments. Some banks might not borrow under any circumstances, but none of these was included in the sample.

5. These are the dates the changes became effective at the Cleveland Federal Reserve Bank.

One of the hypotheses of this study relative to interest rates was that an increase in the bill rate relative to the discount rate would make discounting at the Fed relatively more attractive to banks. Presumably there is a desire of banks to borrow and lend at a profit; or alternatively to offset a deficit without having to sell securities at a loss. Borrowing behavior was observed during periods of rising bill rates and specifically during periods immediately preceding the rise in the discount rate. For the smaller banks no borrowing pattern in anticipation of a changed discount rate appeared. For banks 1 and 5, two of the largest five banks, a very large increase in borrowing occurred several weeks preceding the rise in the discount rate in July, 1963. Interestingly, no large deposit losses appear to explain the large reserve losses during these borrowing periods. Similar patterns did not occur for either of these banks preceding the discount changes in 1964 or 1965. Other than these incidents borrowing and interest rate differentials show no close relation from visual analysis of the data. As with other relationships studied in this chapter, regression analysis sheds additional light on the borrowing patterns of the individual banks.

Summary of Descriptive Analysis

While the analysis presented in this section has been subjective and the ratios are affected by extreme values for one or two banks in some instances, it is interesting that the results strongly support several of the major hypotheses of this study. It was hypothesized that banks actively used due-from balances in the same way they use excess reserves, that is, for adjusting to withdrawals that are not

expected. The banks, therefore, holding relatively more of these balances and excess reserves would be less frequent borrowers at the Fed than others. Moreover, it was expected that smaller banks would hold relatively more due-from balances and excess reserves than larger banks. Both of these hypotheses are confirmed by the evidence presented in Tables 3 and 4.

It was hypothesized that deposit variability would be an important cause of borrowing, and moreover, that this variability would be greater for small banks and consequently a more significant cause of borrowing for them. No specific hypotheses were made regarding the composition of deposits and its effect of total deposit variability although some evidence suggests that time deposits affect overall variability but the direction of the effect is open to further study. The variability of interbank, government and other deposits can also affect total deposit variability.

Total deposit variability was the key variable in the hypothesis, however, and the results strongly suggest that small banks borrow during periods of falling deposits. There are exceptions to this pattern, but they appear to be relatively few. Borrowing of larger banks is less clearly related to deposit flows, but presumably is more closely related to short term money market opportunities.

Regarding liquidity, measured in terms of the loan ratio, there is evidence from the analysis that securities are sold by many of the banks before borrowing from the Fed. Study of call date loan and security data for the banks showed, particularly for the smaller banks, that they borrowed during periods when their security holdings

were at their lowest levels relative to previous levels when no borrowing was outstanding. As security holdings rose, borrowing was repaid. The interpretation given to this pattern was that securities were either sold or allowed to mature without the bank reinvesting because the bank needed the funds to meet required reserves. Banks with relatively large holdings of securities were hypothesized to be infrequent borrowers at the Fed compared with banks holding relatively fewer securities. The evidence supports the hypothesis, although this result is subject to the limitations of the loan and security data, which were call date figures.

The differences between frequently borrowing banks and those borrowing infrequently are in the direction expected by the hypotheses. Frequently borrowing banks are less liquid than infrequent borrowers in that they hold relatively lower ratios of due-from balances, excess reserves, vault cash, and securities. Frequently borrowing banks hold relatively high ratios of government deposits, but this is overwhelmingly influenced by bank size. Frequent borrowers have relatively high deposit variability measures although variability is also inversely related to bank size. Moreover, the lower time deposit ratios of the frequently borrowing banks probably tends to increase deposit variability for these banks relative to infrequent borrowers.

If frequently borrowing banks, regardless of size, were not significantly different from infrequently or non-borrowing banks, this would likely have appeared in the ratios. The ratios and detailed study of the individual bank daily data indicate a significant difference.

CHAPTER V

ESTIMATING EQUATIONS FOR INDIVIDUAL BANKS

The estimating equations for five banks are presented in this chapter. Daily data for individual banks were used with several different specifications. Although several equations for each bank in the sample were estimated, only the important findings will be discussed here and for five of the most frequently borrowing banks.

Variables

For ease in discussion and for the reader's convenience variables used in the daily estimating equations are listed and defined.

<u>SYMBOL</u>	<u>DEFINITION</u>
TH	= Thursday
FR	= Friday
S	= Saturday
M	= Monday
TU	= Tuesday
W	= Wednesday
FT	= First 10 days of month
LT	= Last 10 days of month
J	= January
FB	= February
MR	= March
AP	= April
MY	= May
JN	= June
JL	= July
AU	= August
SP	= September
OC	= October
NO	= November
SW	= second week of country bank period
T	= trend
Δr	= first difference of bill rate
rTD	= bill rate x total deposits

<u>SYMBOL</u>	<u>DEFINITION</u>
I	= interest rate differential computed as $r - d$
r	= the Treasury bill rate
iTD	= interest rate differential x total deposits
I	= interbank deposits
G	= government deposits
O	= other deposits
DF	= due-from balances
AX	= accumulated reserve position (computed as $AX_{t-1} + DF_t - B_{t-1}$) ^a
AX_{t-1}	= accumulated reserve position lagged 1 period
AX_{t-2}	= accumulated reserve position lagged 2 periods
B	= borrowed reserves
B_{t-1}	= borrowed reserves lagged 1 period
B_{t-2}	= borrowed reserves lagged 2 periods
B_{t-3}	= borrowed reserves lagged 3 periods
P	= potential earning assets computed by subtracting required reserves from total deposits
P/TD	= ratio of potential earning assets to total deposits
I/TD	= ratio of interbank deposits to total deposits
G/TD	= ratio of government deposits to total deposits
O/TD	= ratio of other deposits to total deposits
FB/TD	= ratio of reserve balances at Fed to total deposits
B/TD_{t-1}	= ratio of current borrowed reserves to lagged total deposits
B_{t-1}/TD_{t-2}	= ratio of lagged borrowed reserves to lagged (2 periods) deposits
B_{t-2}/TD_{t-3}	= ratio of lagged borrowed reserves (2 periods) to lagged (3 periods) deposits
AX_{t-1}/TD_{t-2}	= ratio of lagged reserve position (1 period) to lagged deposits (2 periods)
AX_{t-2}/TD_{t-3}	= ratio of lagged reserve position (2 periods) to lagged deposits (3 periods)
ΔB	= first difference of borrowed reserves
ΔP	= first difference of potential earning assets
ΔP^2	= ΔP squared
ΔI	= first difference of interbank deposits
ΔG	= first difference of government deposits
ΔG^2	= ΔG squared
ΔO	= first difference of other deposits
ΔO^2	= ΔO squared
ΔAX	= first difference of accumulated reserve position
$\Delta P/TD$	= ratio of ΔP to total deposits
$\Delta P^2/TD$	= ratio of ΔP^2 to total deposits
$\Delta I/TD$	= ratio of ΔI to total deposits

^aThis computation gives the open of business figures for reserves or what is the same thing the close of business figure for the previous day. By definition I am using a unique and broad reserve position figure.

<u>SYMBOL</u>	<u>DEFINITION</u>
$\Delta G/TD$	= ratio of ΔG to total deposits
$\Delta G^2/TD$	= ratio of ΔG^2 to total deposits
$\Delta O/TD$	= ratio of ΔO to total deposits
$\Delta O^2/TD$	= ratio of ΔO^2 to total deposits

Specification and Estimation of Individual Bank Equations

A number of estimating equations were tested for five of the eighteen banks of the sample. They represent the five most frequently borrowing banks in the sample. The five include the two largest banks of the sample with average total deposits over \$839,000,000 and three small banks with average total deposits less than \$15,000,000.

Seven equations are presented for each bank, five estimates of borrowing using a combination of independent variables, and two for reserve position. The dependent variables for borrowing are defined as borrowing levels (B), changes in the levels (ΔB), and the ratio of borrowed reserves to total deposits (B/TD_{t-1}). For the reserve position equations the dependent variable is change in reserve position (ΔAX) or the ratio of accumulated excess reserves to total deposits (AX_{t-1}/TD_{t-2}). Generally, the independent variables are seasonal dummy variables as a proxy for deposit and loan changes or deposit and loan changes themselves. In addition, independent variables included interest rates, potential earning assets, lagged borrowed reserves, and lagged reserve position.

Seasonal dummy variables have been used recently in most econometric studies of borrowing, including those of Dewald and Gibson, Goldfeld and Kane, and de Leeuw. These studies are summarized in Chapter I and my results are compared with them in the summary. In this

study a slightly different interpretation of seasonal patterns underlies the use of seasonal variables. It is assumed that while seasonal variables might significantly explain borrowing or reserve position, that the underlying financial flows are responsible for the seasonal patterns of borrowing. For instance, in the equations for bank E (the banks in every equation are listed A, B, C, D, and E in descending order of size), a very significant seasonal pattern exists. However, it is the seasonal outflow of deposits in the second and third quarters that is likely responsible for the reserve deficits that triggered borrowing.

A similar problem occurred for the potential earning asset variable, which is a proxy for earning assets computed by subtracting required reserves from total deposits.¹ By the nature of its calculation (total deposits less required reserves) it covers up interesting knowledge about specific kinds of deposits and about the portfolio composition of banks which are hypothesized as significant in explaining borrowing.

Thus, because of the interaction of seasonal variables with deposit flows and interaction of potential earning assets with specific deposits, the equations were tested with only one or the other of these variables. For example, in equation 5.1 seasonal items and potential earning assets are used, plus other variables to be mentioned shortly; in equation 5.2 only potential earning assets are used

1. This variable (P) was computed because it was desirable to have earning asset data in the equations and they were not available on a daily basis. The computed variable was compared with the actual figure on call dates and was very close each time (15 calls were made during the study period).

with other variables; and in equation 5.4 specific deposits are used along with other variables. Similar adjustments were made for the reserve position equations, except that only two equations are presented here both of which include only seasonal variables along with interest rates and lagged reserve position.

Various interest rate measures are used in each of the regressions. There is a growing list of studies that have found interest rates significant in explaining member-bank borrowing, one of the most recent being Goldfeld and Kane's study discussed earlier. It can be recalled from earlier discussion that borrowing, absorption of excess reserves, shifting of due-from balances, and sales of assets are the usual reserve adjustment methods available to banks. A profit maximizing bank will choose between these sources on the basis of several dimensions of market opportunities. The cost of borrowing is the discount rate plus the transaction cost of discounting. Selling Treasury bills involves (1) loss of interest on the bills; (2) possible capital losses on the bills; and (3) transaction costs involved in the sale. Presumably a bank will compare alternative costs of reserves. By oversimplifying somewhat it can be said that the differential between the bill rate and the discount rate is the marginal profit to be made or marginal cost to be paid in choosing one or the other sources of reserves. If the bill rate is rising relative to the discount rate, the differential is getting smaller. A bank with knowledge of its transaction costs and the price of bills, can easily determine which source of reserves to tap. On the basis of this behavior, it was expected that borrowing would be positively correlated.

with the differential, because this implies that as the bill rate is rising it is or it is becoming relatively cheaper to borrow at the Fed than to sell bills. A slightly different way to measure the same thing is by the use of first differences of the bill rate (Δr). It should be remembered that the differential (i) changes primarily because the bill rate changes. The discount rate changed only three times over the five year study period. Using (Δr) emphasizes the bill rate and does not consider specifically its relationship to the discount rate as does the differential (i). A third interest rate measure was used in some equations. It is the differential times total deposits (iTD). The bill rate (r) was used in one reserve position equation as well. As might be expected, several of the interest rate measures are intercorrelated. Moreover, they are all highly correlated with trend over the study period. Borrowing, the dependent variable, had no strong upward trend over the study period.

Reserve position is represented in the equations by a relatively complex measure. While it is referred to as accumulated reserve position, it is in fact computed as $AX_{t-1} + DF_t - B_{t-1}$. This definition is used because it is assumed that due-from balances are usable as reserves to the individual bank. Borrowing is netted out because it is borrowing that is being explained and not to subtract it would have been equivalent to correlating current borrowing with itself. This is so because borrowed reserves are included in the Fed's measure of reserve balances and thus in its calculation of excess reserves on any given day. Another complication arises in computing excess reserves. Accumulated reserves (AX) and borrowed reserves (B) are close of

business data. Due-from balances (DF) are open of business data. To make them comparable it was necessary to use the computation $AX_{t-1} + DF_t - B_{t-1}$. This amounts by its very computation to AX_{t-1} or lagged reserve position, when included in the equations, because the dependent variable in the equations is either B_t , $B_t - B_{t-1}$, or $AX_{t-1} - AX_{t-2}$. There is, therefore, no variable titled "current" (meaning close of business) reserve position (AX_t). It could not be calculated except as $AX_t + DF_{t+1} - B_t$. And the close of business reserve position on the day borrowing took place is meaningless in terms of what the estimating equations attempt to explain.

The lagged value (AX_{t-1}) which is used in the equations indicates the direction of the adjustment relative to a bank's reserve position, and the speed of that adjustment (the smaller the coefficient the faster the adjustment). The inclusion of reserve position is quite important in explaining borrowing. It is hypothesized in this study that banks borrow to offset a reserve deficit. The deficit facing a bank on Wednesday morning will be erased by evening possibly by borrowing. If a bank had excess reserves and borrowed it would be borrowing to add to excess reserves or in anticipation of a loss of reserves. Moreover, lagged reserve position has been significant in explaining borrowing in other studies, e.g., Goldfeld and Kane.

A final problem of specification arises with the lagged reserve position variable (AX_{t-1}). A constraint was attached in computing the variable. If the accumulated reserve position of an individual bank was equal to or greater than its reserve balances ($AX_{t-1} \geq FB$) it was assumed the bank would begin adjusting reserves downward

either by selling reserves in the funds market or buying assets. The logic of this specification is that an individual bank, on any given day of the settlement period can only lend its actual reserve balances, even though over the settlement period accumulated excess reserves can become greater than these balances. For example, suppose a bank has reserve balances of \$100 and required reserves of \$50 and maintains this relationship over its 14 day settlement period. At the close of business on the first day it has accumulated excess reserves of \$50 ($\$100 - \$50 = \50). By the close of business of the second day it has excess reserves accumulated to \$100, and by the third \$150, and by the fourth \$200 and so on over the 14 day period. However, even though it has \$200 in accumulated excess reserves by the fourth day (excluding here due-from balances which would make the excess reserve position higher) it could not lend more than the actual reserve balances it held at the Fed, and with correspondent banks, in this example \$100. On any given day, a bank cannot lend more than its actual reserve balances. To make this variable realistically representative of bank decision making, the above constraint was introduced. Similarly, when accumulated reserves were less than reserve balances, the accumulated reserve variable was used. This could be most important during deficit situations when a bank would be seeking to reduce the deficit by borrowing or some other means. The reserve position variable computed to account for this constraint is employed in every equation.

Lagged borrowed reserves (B_{t-1}) are introduced into the equations for reasons similar to those given for reserve position (AX_{t-1}). Adjusting reserves usually is not an instantaneous action. Some

banks adjust slowly. Others, particularly large banks, appear to be in and out of the Fed often, taking advantage of short term profit opportunities and quickly fine-tuning, so to speak, their cash management. Lagged borrowed reserves as an independent variable sheds light on a particular bank's adjustment timing.

The equations are specified on the basis of the above adjustment theory, which mainly follows the theory developed in the literature, particularly the studies of Goldfeld, and Goldfeld and Kane. The primary difference is the use of daily individual bank data in my equations whereas they used aggregate data on a weekly, monthly, or quarterly basis.

The very nature of daily data leads to certain statistical difficulties including the possibility of serial correlation, feedback, and multicollinearity. There are many random influences on a banker and his daily management behavior, and in the tradition of other studies that have used daily data, high R^2 's were neither expected nor found. Yet a great deal of important and interesting information can be obtained from studying daily bank behavior. Consequently, the equations were tested with a concern for these statistical problems. Further problems arise with the use of distributed lags. All of these difficulties are best avoided by careful specification of the equations on the basis of good a priori theoretical relationships and inspection of the data. A discussion of estimating problems is presented next and specific problems are discussed where they occur.

Estimating Procedures and Problems

The reserve adjustment process implied in the equation takes place over a period of time and is presumably not completed within 1 day. The use of distributed lags in the equations raises important questions which have not yet been entirely answered.² The lagged independent variables used in this study (B_{t-1} , AX_{t-1}) proved significant in most equations. An attempt was made to see if these variables were interrelated with other independent variables. This was done by examining the variance - covariance matrices and the partial correlation matrices. While the lagged variables are not absolutely independent of all other independent variables, there is no obvious problem of multicollinearity. The equations were specified to avoid such problems, and preliminary equations were carefully inspected before the final tests. Yet, some problems occurred as will be noted later.

Another pitfall associated with distributed lag estimations is serial correlation of the disturbance term, though a lagged specification would seem to be particularly appropriate where daily bank data are used as in this study. There is no easy test for serial correlation in distributed lag estimates. Proper specification of the equations is the primary solution to the problem. Griliches and others have discussed alternative estimating procedures and some tests for serial correlation.³

2. Zvi Griliches, "Distributed Lags: A Survey," Econometrica, XXXV (January, 1967), pp. 16-49; Carl F. Christ, Econometric Models and Methods (New York: John Wiley & Sons, Inc., 1966), pp. 487-88.

3. Griliches, op. cit., p. 33+.

Results of Individual Bank Estimating Equations

Equation 5.1.* Equation 5.1 estimates the level of borrowing (B) for the five banks. The results are presented for each bank in descending order of bank size. Equation 5.1 is the only one using the level (B) of borrowed reserves; all others use first differences of borrowing (ΔB) or ratios (B/TD_{t-1}) as the dependent variable. First differences were used in order to minimize possible autocorrelation and to provide an estimate of flows of borrowing rather than of stocks. Moreover, because of the range in bank size it was felt that variables having close relationship to bank size might consistently affect the results. Therefore, the third specification of the dependent variable was the ratio of borrowing to total deposits, with all of the dollar valued independent variables divided by total deposits. An assumption was made that the equations were homogeneous with respect to total deposits, although as indicated later the assumption may be questionable when studying individual banks.⁴

A variety of seasonal patterns appear in estimates of equation 5.1. Days of the week are significant for the three larger banks only. Bank A appears to increase borrowing early in the settlement period and to repay by Tuesday. Bank B has a highly significant positive coefficient for Wednesday, as mentioned in the descriptive section. Bank B borrows frequently and almost exclusively on Wednesday. It is hard to imagine that a bank which restricts its

Throughout the equations an asterisk () indicates significant coefficients.

4. See also Bryan and Carleton, op. cit., p. 346.

TABLE 6

ESTIMATING EQUATION NO. 5.1 FOR FIVE INDIVIDUAL BANKS^a

B _A =	+22390.00* (10700.00)	-387.70TH (617.40)	+323.30FR (610.10)	+720.40S (611.70)	-743.40M (610.70)	-2140.00*TU (611.30)
	-53.42W (626.60)	-554.10*FT (403.80)	-724.30*LT (398.70)	-2093.00*J (817.20)	-3705.00*FB (851.00)	-847.20MR (827.60)
	-2455.00*AP (823.20)	-754.90MY (778.40)	-2070.00*JN (775.20)	-777.90JL (771.60)	-3320.10*AU (775.80)	-1329.00*SP (793.20)
	-1902.000C (773.50)	-1335.00NO (782.10)	+2.80T (2.19)	-565.50SW (326.30)	+1241000.00Ar (1019000.00)	+452200.00*1 (110500.00)
	-.153*AX _{t-1} (.013)	-.0130P (.0090)	R ² = .149 S.E. = 6713.68 D.W. = .946			
B _B =	+1707.00 (2394.00)	+116.10TH (298.60)	-29.40FR (295.20)	+17.50S (295.20)	-478.70M (295.30)	-204.00TU (298.20)
	+2099.00*W (304.20)	+382.30FT (204.20)	+43.20LT (193.80)	+113.20J (394.00)	+1085.00*FB (415.40)	+949.00*MR (401.50)
	+1457.00*AP (402.70)	+636.40MY (377.30)	459.40JN (374.90)	+96.50JL (370.60)	+993.40*AU (376.70)	+150.70SP (376.10)
	+267.500C (372.20)	+801.80*NO (373.00)	-1.41*T (.48)	-100.10SW (158.20)	+570700.00Ar (493600.00)	+185600.00*1 (55750.00)
	-.027*AX _{t-1} (.007)	-.0001P (.0034)	R ² = .113 S.E. = 3246.60 D.W. = 1.188			

$B_C =$	-22.44 (61.43)	-16.81*TH (8.81)	-3.15FR (8.73)	+52S (8.73)	+21.57*H (8.73)	+29.84*TU (8.73)
	+20.05*W (9.00)	-4.09FT (5.75)	+9.46LT (5.69)	+6J (11.62)	-2.67TB (11.98)	-7.55MR (11.75)
	+42.17*AP (11.90)	+34.61*MY (11.12)	+2.14JN (11.14)	-2.97JL (11.33)	+26.16AU (11.33)	+30.55SP (11.40)
	-13.27OC (11.05)	-11.67NO (11.07)	-.022T (.024)	+38.63*SW (4.66)	-8510.00Ar (14590.00)	+5581.00*i (1597.00)
	-.045*AX _{t-1} (.004)	.0044P (.0058)				

$R^2 = .195$ S.E. = 95.96 D.W. = .729

$B_D =$	+754.00* (77.38)	-11.32TH (13.71)	+3.07FR (13.71)	+3.88S (13.71)	-16.53M (13.71)	-12.05TU (13.71)
	-8.85W (13.71)	+37.00*FT (8.91)	+49.41*LT (8.84)	+8.36J (18.35)	-40.30*FB (18.79)	-60.34*MR (18.16)
	+3.62AP (18.22)	-14.51MY (17.18)	-47.38*JN (17.26)	+6.14JL (17.06)	-18.17AU (17.06)	-30.95SP (17.31)
	-9.69OC (17.15)	+13.71NO (17.18)	-.079*T (.001)	+15.20*SW (7.20)		+242.70*i (26.60)
	-.052*AX _{t-1} (.015)	-.0440*P (.0060)				

$R^2 = .120$ S.E. = 149.25 D.W. = .409

$B_E =$	+234.70* (19.07)	+22TH (2.68)	-1.81FR (2.68)	+1.55S (2.68)	+79M (2.68)	+27TU (2.68)
	+57W (2.68)	+2.50FT (1.75)	+81LT (1.75)	-9.64*J (3.59)	-24.25*FB (3.85)	-23.47*MR (3.77)
	-22.43*AP (3.79)	+1.48MY (4.08)	-8.07*JN (4.19)	-3.33JL (4.32)	+23.98*AU (4.48)	+7.97*SP (3.58)
	-1.79OC (3.36)	-5.52NO (3.38)	+0.32*T (.005)	+1.54SW (1.41)		+37.81*i (5.08)
	-.081*AX _{t-1} (.009)	-.0440*P (.0045)				
				R ² =.490	S.E.29.46	D.W.=.133

*Asterisk indicates a statistically significant coefficient.

^aSubscript on dependent variable indicates which bank is represented by the equation, and the banks are arranged in descending order of bank size based on average total deposits.

borrowing to one day of the settlement period would be taking advantage of inter-weekly differentials. However, both of the large banks, even though they borrow for short periods of time, i.e., less than 2 days on average, consistently show increases in reserves greater than the amount borrowed. This is not as true for small banks. Large banks apparently rely on several sources of reserves on any given day. This has been observed by Willis.⁵ Borrowing is less important compared with other reserve sources, probably because it is relatively more expensive for the large banks than selling securities or buying federal funds.

There are significant monthly patterns for each of the banks, although the behavior of bank E is most easily explained. This bank regularly experienced deposit losses in the second and third quarters of the year and borrowed to offset the subsequent reserve losses. Bank D followed a similar but less obvious pattern. Call report data suggest that these two banks sell securities during these periods before borrowing. This is supported by the potential earning asset variable (P) which is significant with negative sign for these two banks. It is also negative for bank A and B but insignificant.

The large banks appear to reduce borrowing in the second week of the country bank settlement period, while the three small banks increased their borrowing. This variable is significant for banks C and D.

5. Parker B. Willis, The Federal Funds Market: Its Origin and Development (Boston: The Federal Reserve Bank of Boston, 1964).

The coefficient of the interest rate differential (i) is significant with expected sign for each bank. Banks appear to consider alternative costs when a borrowing situation occurs. The coefficients for the two small banks are most significant. It is interesting to note that for the three small banks when the interest rate is multiplied by total deposits (iTD) as in equations 5.3 and 5.4 and when ratios are used in equation 5.5, the interest rate variables are generally highly insignificant for the smaller banks. This possibly implies lack of homogeneity with respect to deposit size in equations 5.1 through 5.4 and to that extent these equations may be misspecified. Coefficients of changes in the bill rate (Δr) are insignificant in equation 5.1 for the three larger banks. However, as mentioned in earlier discussion of this variable relative to the differential (i), (Δr) accounts for almost all the change in the differential and, therefore, some of the explanatory power of (Δr) likely is being picked up by the differential (i).

The coefficient of the lagged reserve position (AX_{t-1}) has a negative sign and is significant for each bank. This result suggests that accumulated deficits trigger borrowing, while excess reserves cause borrowing to be repaid. Either of these adjustments would generate a negative correlation with borrowing. The results with this variable are consistently significant throughout the equations. When lagged borrowed reserves are introduced into the equations, the faster adjustment is estimated for the larger banks.

Equation 5.1 was modified and respecified because it was assumed that seasonal variables were hiding important financial relations

involved in borrowing, and particularly individual bank deposit and loan changes. Seasonal variables were excluded in equations 5.2, 5.3, and 5.4. The dependent variable in these equations is (ΔB). This specification gives results similar to those using levels, but permits one to estimate flows of borrowing directly. The basic behavior model is identical to one with the level of borrowings (B) as the dependent variable.

Equation 5.2. In equation 5.2 and subsequent equations, lagged borrowed reserves (B_{t-1}) are used in the regression in order to test the direction and speed with which banks adjust to their opportunities; and because it is assumed that a bank's borrowing today will be functionally related to yesterday's borrowing. Goldfeld explains the negative correlation between current borrowing and lagged borrowing as due to the surveillance effect of the Fed. Banks hesitate to borrow too long and attempt to reduce their debt as quickly as possible.

The results with lagged reserves (AX_{t-1}) in equation 5.2 are similar to those in equation 5.1. Borrowing is inversely related to lagged reserves. A bank with excess reserves will tend to repay borrowing and banks with deficits will tend to increase borrowing. If a positive sign had resulted with this variable it would have implied that on average banks were borrowing to build up excess reserves. There is some evidence from the data that a few banks borrowed in anticipation of reserve losses, but this would not seem to be typical behavior since most of the banks borrowed after reserve losses had occurred. The coefficient of (AX_{t-1}) is largest for the smallest bank and smallest for the largest bank. This implies a

ESTIMATING EQUATION NO. 5.2 FOR FIVE INDIVIDUAL BANKS

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shorter adjustment period for the large bank relative to the smaller banks. Bank B, the second largest bank has a relatively large coefficient compared with the other large bank. This would imply a relatively slow adjustment pattern for bank B. This may be explained by the fact that bank B suffered frequent deficits, but allowed the deficits to grow until the last day of the period. It borrowed almost exclusively on the last day of the period.

The lagged borrowed reserve variable (B_{t-1}) is significant for each bank with negative sign as expected. The coefficients for the two large banks are small compared with the smaller banks. Interestingly, bank B has the smallest coefficient implying the fastest repayment of borrowing of all the banks. Bank E has a relatively large coefficient implying a slow repayment pattern. As has been mentioned throughout this study, the small banks in the sample generally borrowed for extended periods of time and only slowly reduced the debt. The larger banks were in and out of the Fed rapidly, less than two days on average for any borrowing period. The regression coefficients support the previous interpretation regarding patterns of adjustment.

The specification with respect to (P) is modified in equation 5.2 by using first differences (ΔP) and squared first differences (ΔP^2). The same combination is used for each of the deposit variables in equation 5.4. The reason for using squared first differences of earning assets as well as deposit items is that in looking at several of the banks' balance sheets it appeared that banks would only borrow in reaction to large changes in earning assets and deposits, while small changes were frequently not causes of borrowing.

If a bank could predict deposit flows and loan or security run-offs, it would not be subject to unexpected deficits. A large drop in deposits or some large change in earning assets might not be anticipated and thus would force a borrowing situation. The squared differences generally provided insignificant coefficients.

In equation 5.2 the level of earning assets (P) is inversely related to borrowed reserves for banks A, B, D, and E, but significantly only for B and D. The sign of the estimated coefficient is positive for bank C. For the three smaller banks changes in potential earning assets (ΔP) are negatively (and significantly for C and D) related to borrowing. Banks which suffer large and/or relatively extended deposit losses, mostly small banks, which in turn cause accumulated reserve deficits, appear to sell earning assets before borrowing from the Fed. However, borrowing for banks A and B is related to increases in earning assets (ΔP), and increases in both the bill rate (Δr) and the differential (i). Also, for banks A and B earning assets are at a low level (P) when borrowing takes place. A possible interpretation of this behavior for banks A and B is that earning assets are rebuilt by borrowing at the Fed. The interest rate variables (Δr) and (i) are insignificant for the three smaller banks.

Equation 5.3. Equation 5.3 is the same as 5.2 except that the interest rate variable is (iTD). As in equation 5.2 it is insignificant except for banks A and B. Other estimated coefficients were about the same.

TABLE 8

ESTIMATING EQUATION NO. 5.3 FOR FIVE INDIVIDUAL BANKS

$\Delta^B_A =$	+2477.00 (2356.00)	+1818000.0* Δr (826000.0)	+0.15900* iTD (.06100)	-0.0772* AX_{t-1} (.0110)	-0.480* B_{t-1} (.021)		-0.00030* P (.00200)
	+0.01400* ΔP (.03900)	-0.0000020* ΔP^2 (.0000020)		$R^2=.248$	S.E.=5182.10	D.W.=1.982	
$\Delta^B_B =$	+4649.00* (1145.00)	+2363000.0* Δr (437900.0)	+0.12900* iTD (.06300)	-0.0240* AX_{t-1} (.0059)	-0.597* B_{t-1} (.022)		-0.00510* P (.00140)
	+0.01200* ΔP (.01400)	-0.0000004* ΔP^2 (.0000004)		$R^2=.321$	S.E.=3072.90	D.W.=2.058	
$\Delta^B_C =$	-2.07 (17.58)	+13180.0* Δr (10740.0)	+0.02500* iTD (.08400)	-0.0180* AX_{t-1} (.0030)	-0.352* B_{t-1} (.018)		+0.00140* P (.00120)
	-0.03100* ΔP (.01200)	+0.0000200* ΔP^2 (.0000060)		$R^2=.186$	S.E.= 75.71	D.W.=1.840	
$\Delta^B_D =$	+31.48 (40.36)		+0.00030* iTD (.00090)	-0.0310* AX_{t-1} (.0080)	-0.168* B_{t-1} (.025)	-0.011* B_{t-2} (.032)	-0.031* B_{t-3} (.024)
	-0.04300* ΔP (.01900)	-0.0000600* ΔP^2 (.0000400)		$R^2=.110$	S.E.= 89.32	D.W.=2.008	+0.00009* P (.00030)
$\Delta^B_E =$	+7.48* (2.73)		+0.00029* iTD (.00027)	-0.0095* AX_{t-1} (.0022)	-0.052* B_{t-1} (.024)	0.017* B_{t-2} (.033)	-0.010* B_{t-3} (.024)
	-0.00052* ΔP (.0080)	-0.0000600* ΔP^2 (.0000400)		$R^2=.030$	S.W.= 9.12	D.W.=2.001	-0.00085* P (.00053)

TABLE 9

ESTIMATING EQUATION NO. 5.4 FOR FIVE INDIVIDUAL BANKS

$\Delta B_A =$	-1925.00 (3430.00)	$+1643000.0 \Delta r$ (826200.0)	$+15800 \Delta TD$ (.05100)	$+0.0311$ (.057)	$+0.0054G$ (.0410)	$+0.0034 \Delta 0$ (.0060)	$-0.0780 \Delta AX_{t-1}$ (.0110)	$-0.482 \Delta B_{t-1}$ (.021)	
			$-0.184 \Delta AI$ (.069)	$-0.047 \Delta G$ (.109)	$-0.000005 \Delta G^2$ (.000011)	$-0.0076 \Delta 0$ (.0400)	$+0.0000010 \Delta 0^2$ (.0000020)		$R^2 = .252$ D.W. = 1.974 S.E. = 5806.90
$\Delta B_B =$	+6823.00* (1469.00)	$+2369000.0 \Delta r$ (440300.0)	$-0.02100 \Delta TD$ (.05000)	$+0.0181$ (.010)	$-0.0093G$ (.0060)	$-0.0180 \Delta 0$ (.0040)	$-0.0270 \Delta AX_{t-1}$ (.0060)	$-0.610 \Delta B_{t-1}$ (.022)	
			$+0.018 \Delta AI$ (.015)	$-0.089 \Delta G$ (.041)	$-0.000005 \Delta G^2$ (.000005)	$+0.0015 \Delta 0$ (.0610)	$+0.0000002 \Delta 0^2$ (.0000006)		$R^2 = .331$ D.W. = 2.057 S.E. = 3054.00
$\Delta B_C =$	-18.29 (14.69)	$+12850.0 \Delta r$ (10750.0)	$+0.02300 \Delta TD$ (.08100)		$+0.0040G$ (.0220)	$+0.0080 \Delta 0$ (.0030)	$-0.0210 \Delta AX_{t-1}$ (.0030)	$-0.352 \Delta B_{t-1}$ (.018)	
				$+0.1318 \Delta G$ (.2120)	$-0.000200 \Delta G^2$ (.001500)	$-0.0346 \Delta 0$ (.0110)	$+0.0000100 \Delta 0^2$ (.0000050)		$R^2 = .198$ D.W. = 1.849 S.E. = 75.63
$\Delta B_D =$	-22.21 (19.38)		$+0.00076 \Delta TD$ (.00087)		$+0.0051G$ (.0100)	$+0.0095 \Delta 0$ (.0034)	$-0.0430 \Delta AX_{t-1}$ (.0090)	$-0.164 \Delta B_{t-1}$ (.025)	
	$-0.009 \Delta B_{t-2}$ (.030)	$-0.017 \Delta B_{t-3}$ (.020)		$+0.0400 \Delta G$ (.0930)	$-0.000300 \Delta G^2$ (.000300)	$-0.0570 \Delta 0$ (.0190)	$+0.0000100 \Delta 0^2$ (.0000300)		$R^2 = .110$ D.W. = 2.014 S.E. = 89.06
$\Delta B_E =$	+9.50* (2.77)		$+0.00030 \Delta TD$ (.00024)		$+0.0032G$ (.0050)	$-0.0027 \Delta 0$ (.0010)	$-0.0073 \Delta AX_{t-1}$ (.0025)	$-0.052 \Delta B_{t-1}$ (.024)	
	$+0.014 \Delta B_{t-2}$ (.033)	$-0.012 \Delta B_{t-3}$ (.024)		$+0.0170 \Delta G$ (.029)	$-0.000130 \Delta G^2$ (.000260)	$-0.0032 \Delta 0$ (.0082)	$-0.0000500 \Delta 0^2$ (.0000400)		$R^2 = .040$ D.W. = 2.003 S.E. = 9.11

Equation 5.4. Equation 5.4 is the same as 5.5 except that potential earning assets are replaced by specific deposit items (I , G , and O), their changes (ΔI , ΔG , and ΔO), and their squared changes (ΔG^2 and ΔO^2). Coefficients of the lagged reserve position (AX_{t-1}) and lagged borrowed reserves (B_{t-1}) remain significant in equation 5.4. Results with interbank deposits (I , ΔI) appear for banks A and B only since the other banks held none of these deposits. Changes in these deposits (ΔI) are negatively and significantly related to borrowing for bank A, suggesting that for the largest bank in the sample the interbank deposit loss is particularly important in triggering deficits and, thus, borrowing. Other deposits (O) and government deposits (G) are positively related to borrowing, except for bank B. Changes in other deposits (ΔO) are negatively related to borrowing and significantly for two small banks, C and D. All of the banks appear to borrow while other deposits are falling except bank B. This conclusion fits in with the conclusions of Chapter IV, regarding the importance of deposit losses in explaining borrowing. It seems that losses of other deposits (ΔO), which are mostly corporate and individual deposits, are most significant in explaining small bank borrowing behavior; and interbank deposit (ΔI) losses are most significant when looking at bank A, or government deposit losses (ΔG) when looking at bank B, the latter two being large banks.

The possibility of lack of homogeneity with respect to deposits is suggested in equations 5.1, 5.2, 5.3, and 5.4. In specifying the equations it was assumed that homogeneity existed with respect to total deposits, implying that a change in total deposits would result

in a proportional change in borrowing or in reserves. In equations 5.1 through 5.4 there is an indication that total deposits do not affect borrowing homogeneously, because of 20 constant terms in the estimates 9 were significantly different from zero. Homogeneity would imply no constant term or at least a highly insignificant one, i.e. $Y=bX$, $a=0$. It may possibly be true that expected changes and/or percentage change in deposits affect the banks differently. For instance, it may take very large losses in deposits before small banks consider the possibility of alternative reserve sources to borrowing or simply reducing excess reserves or due-from balances. Or it may take large interest rate differentials (i) before small banks react. It is sometimes assumed that small banks do not "fine-tune" their adjustments, in that they have relatively high transaction costs, and therefore, they cannot afford to be in and out of the financial markets as readily as large banks.

It is interesting that most studies using aggregate data have assumed homogeneous relationships. The assumption makes a great deal of sense using aggregate data if nominal or dollar changes do not alter the relative position of various groups of banks. The individual differences cancel out in aggregation. However, if an individual bank grows relative to other banks, there may be economies of scale involved. This could be an important reason for further study of individual banks. A similar conclusion is presented by Bryan and Carleton in their recent study.⁶

6. Bryan and Carleton, op. cit.

Equation 5.5. Equation 5.5 differs from the previous equations in the specification of the dependent variable as the ratio of borrowed reserves to lagged total deposits (B/TD_{t-1}). The use of ratios was explained earlier. The independent variables in dollar terms in these two equations were divided by lagged total deposits. It should be recalled that borrowing is a close of business figure and deposits are open of business figures. Required reserves are computed on the basis of opening of business data to the Fed (recall the complex discussion of the data in the first part of this chapter) which are the previous day's close of business figures to the individual bank. Borrowing will take place to erase a given deficit existing at the beginning of business for a bank. This is easy to visualize if one thinks of open of business on the settlement day. If a bank borrows on Wednesday to erase a deficit that existed at the beginning of business on Wednesday, then using the ratio B/TD_{t-1} concentrates on the relevant adjustment of reserves to deposits on which required reserves are calculated. The same logic was applied in the computation of the lagged borrowed reserve ratio B_{t-1}/TD_{t-2} . The lagged reserve position ratio is computed in a similar way. There is a slight variation because the relevant reserve position is an opening of business figure, i.e., AX_{t-1} applies to day t . Thus, the reserve position variable (AX_{t-1}/TD_{t-2}) is associated with day t . In the reserve position equation where (AX_{t-1}/TD_{t-2}) is the dependent variable, the lag value used as an independent variable is (AX_{t-2}/TD_{t-3}).

Other balance sheet items were not computed this way, e.g., the government deposit ratio, because they are in a sense given and not

TABLE 10

ESTIMATING EQUATION NO. 5.5 FOR FIVE INDIVIDUAL BANKS

$E/TD_{t-1A} =$	$+.0021^*$ (.0004)	$-.00250TH$ (.0003)	$+.000600FR$ (.000300)	$+.0002S$ (.0003)	$-.0003M$ (.0003)	$-.001700TU$ (.000300)	$+.0005W$ (.0004)	$-.0001FT$ (.0002)
	$-.00040LT$ (.00020)	$-.00060J$ (.00050)	$-.0010^*FB$ (.00050)	$-.00010MR$ (.00050)	$-.0007AP$ (.0005)	$-.0002MY$ (.0004)	$-.0005JN$ (.0004)	$-.00030JL$ (.00040)
	$-.00100^*AU$ (.00040)	$-.00030S$ (.00040)	$-.00030C$ (.00040)	$-.0003NO$ (.0004)	$-.0002SW$ (.0002)	$+.6692Ar$ (.5700)	$+.1077^*i$ (.0439)	
	$+.5250^*B_{t-1}/TD_{t-2}$ (.0206)		$-.0752^*AX_{t-1}/TD_{t-2}$ (.0108)		$R^2 = .382$	$S.E. = .0388$	$D.W. = 1.97$	
$B/TD_{t-1B} =$	$-.0001$ (.0004)	$-.0010^*TH$ (.0003)	$-.000002FR$ (.00030)	$+.0002S$ (.0003)	$-.0006M$ (.0003)	$+.000002TU$ (.000300)	$+.00026^*W$ (.0003)	$+.0004FT$ (.0002)
	$+.00003LT$ (.00020)	$+.00030J$ (.00050)	$+.0011^*FB$ (.0005)	$+.00080MR$ (.00050)	$+.0012^*AP$ (.0005)	$+.0005MY$ (.0004)	$+.0004JN$ (.0004)	$+.00080JL$ (.00040)
	$+.00007AU$ (.00040)	$+.00006SP$ (.00040)	$+.00020C$ (.0004)	$+.0006NO$ (.0004)	$-.00007SW$ (.00020)	$+1.120^*Ar$ (.5688)	$-.0532i$ (.0426)	
	$+.4198^*B_{t-1}/TD_{t-2}$ (.0222)		$-.0199^*AX_{t-1}/TD_{t-2}$ (.0062)		$R^2 = .253$	$S.E. = .0037$	$D.W. = 2.07$	
$B/TD_{t-1C} =$	$+.0002$ (.0005)	$-.0020^*TH$ (.0005)	$+.0002FR$ (.0005)	$+.0006S$ (.0005)	$+.00016^*M$ (.00050)	$+.00120^*TU$ (.00050)	$+.0002W$ (.0005)	$-.0002FT$ (.0003)
	$+.00050LT$ (.00030)	$+.00002J$ (.00060)	$-.0002FB$ (.0006)	$-.00002MR$ (.00060)	$+.0013^*AP$ (.0006)	$+.0008MY$ (.0006)	$+.0002JN$ (.0006)	$-.00005JL$ (.00060)
	$+.00070AU$ (.00060)	$+.000100SP$ (.000600)	$-.00060C$ (.0006)	$-.0002NO$ (.0006)	$+.0019^*SW$ (.0002)	$+.3559Ar$ (.7674)	$+.0892i$ (.0574)	
	$+.6279^*B_{t-1}/TD_{t-2}$ (.0180)		$-.0239^*AX_{t-1}/TD_{t-2}$ (.0026)		$R^2 = .544$	$S.E. = .0051$	$D.W. = 1.85$	

B/TD _{t-1D} =	+ .0026* (.0008)	-.0006TH (.0006)	+ .0008FR (.0006)	-.0001S (.0006)	-.0011*M (.0006)	-.0010TU (.0006)	-.0002W (.0006)	+ .00008FT (.0005)
	+ .00150LT (.00040)	+ .00020J (.00080)	+ .0002FB (.0008)	-.0006MR (.0008)	+ .0002AP (.0008)	-.0007MY (.0008)	-.0003JN (.0008)	+ .0003JL (.0008)
	-.00080AU (.00080)	-.00090SP (.00080)	-.00030C (.0008)	+ .00008NO (.0008)	+ .00002SW (.0003)	-.0880Ar (1.019)	-.0264i (.0782)	
	+ .8261*B _{t-1} /TD _{t-2} (.0140)		-.0367*AX _{t-1} /TD _{t-2} (.0086)		R ² =696	S.E.=.0067	D.W.=2.02	

B/TD _{t-1E} =	+ .00002 (.0002)	-.00002TH (.0002)	+ .0002FR (.0002)	+ .000005S (.0002)	+ .0002M (.0002)	-.0003TU (.0002)	-.00003W (.0002)	+ .000007FT (.0001)
	+ .00009LT (.0001)	-.00003J (.0002)	-.00008FB (.0002)	-.00007MR (.0002)	-.00007AP (.0002)	+ .0008*MY (.0002)	-.0002JN (.0002)	+ .0005*JL (.0002)
	+ .00100*AU (.00020)	-.00040*SP (.00020)	+ .0000070C (.0002)	-.00003NO (.0002)	+ .0001SW (.00009)	+ .2011Ar (.2746)	+ .0337i (.0239)	
	+ .9461*B _{t-1} /TD _{t-2} (.0069)		+ .0047*AX _{t-1} /TD _{t-2} (.0026)		R ² =.954	S.E.=.0018	D.W.=2.02	

assumed to be manipulable for reserve adjustment purposes. A bank cannot do anything about its opening of business deposit figures on that day and, therefore, cannot change its required reserves. It can, however, borrow, transfer due-from balances or change excess reserves.

The results in equation 5.5 regarding the seasonal variables are similar to the results in equation 5.1. Bank A appears to increase borrowing early in the period and repay on Tuesday; bank B borrows generally on Wednesday; bank C borrows in a significant pattern on Monday and Tuesday of its second settlement week; bank D has a mixed pattern; and bank E significantly increases borrowing in July and August and reduces it in September. These patterns appeared earlier and support much of the discussion on seasonal patterns presented in the descriptive part of this paper.

The interest rate differential (i) is insignificant for the small banks, but significant and positive for bank A. Changes in the bill rate (Δr) are positively related to the borrowing ratio for all five banks, but significantly only for bank B. The lagged ratio of borrowed reserves (B_{t-1}/TD_{t-2}) is highly significant for all banks with positive sign. The two large banks have the smallest coefficients of the lagged borrowing ratio, implying a faster adjustment of borrowing by these relative to the timing of adjustment by the small banks. The lagged reserve position (AX_{t-1}/TD_{t-2}) is significant for all banks with negative sign as expected. The largest bank has the smallest coefficient. The coefficient rises systematically as the bank size falls, except that bank B, the second largest bank has the second highest coefficient. The results with lagged reserve position

TABLE 11

ESTIMATING EQUATION NO. 5.6 FOR FIVE INDIVIDUAL BANKS

$\Delta AX_A =$	+3138.0*	+7692.0*TH	+1404.0FR	+6140.0*S	-350.3M	+2114.0* ² TU	+5793.0*W	+480.2FT
	(1623.0)	(940.9)	(932.3)	(933.9)	(967.1)	(936.9)	(943.9)	(609.5)
	+1034.0LT	+1196.0J	-845.7FB	-1388.0MR	-923.5AP	-1174.0MY	-788.6JN	-1535.0JL
	(607.4)	(1242.0)	(1273.0)	(1243.0)	(1253.0)	(1193.0)	(1186.0)	(1175.0)
	-2223.0*AU	-2657.0*SP	-926.5OC	-866.2NO	+575.0SW	-2204000.0Ar	-.0484*rTD	
	(1174.0)	(1192.0)	(1170.0)	(1178.0)	(498.6)	(1556000.0)	(.0214)	
	-.3647*AX _{t-2}				R ² =.255	S.E.=10258.81	D.W.=2.10	
	(.0189)							
$\Delta AX_B =$	+207.9	+5544.0*TH	-4110.0*FR	+2056.0*S	-161.4M	-4483.0* ² TU	+2422.0*W	+1083.0*FT
	(1381.0)	(826.6)	(824.1)	(821.5)	(820.8)	(820.5)	(847.6)	(539.4)
	+1158.0*LT	+860.6J	+622.8FB	+282.7MR	-998.8 AP	+25.1MY	+652.4JN	+189.2JL
	(535.4)	(1093.0)	(1122.0)	(1092.0)	(1103.0)	(1049.0)	(1046.0)	(1031.0)
	-188.9AU	-23.3SP	+264.9OC	+1134.0NO	+737.5SW	-670900.0Ar	-.0038rTD	
	(1034.0)	(1040.0)	(1030.0)	(1038.0)	(439.4)	(1370000.0)	(.0321)	
	-.3303*AX _{t-2}				R ² =.283	S.E.=9025.01	D.W.=1.95	
	(.0181)							
$\Delta AX_C =$	-109.0*	-35.53TH	+125.30*FR	+74.40*S	-8.60M	-95.40* ² TU	-124.10*W	-32.27FT
	(36.81)	(36.59)	(36.50)	(37.47)	(36.50)	(36.47)	(37.47)	(23.96)
	-19.93LT	+9.26J	+8.75FB	+118.10*MR	+84.02AP	+24.84MY	+96.05*JN	+79.24JL
	(23.74)	(48.55)	(49.89)	(48.91)	(49.82)	(46.54)	(46.59)	(45.97)
	+74AU	+98.87*SP	+14.72OC	+67.67NO	+32.91SW	-3083.00Ar	+2569*rTD	
	(45.71)	(46.60)	(45.68)	(46.17)	(19.51)	(60890.00)	(.0684)	
	-.1543*AX _{t-2}				R ² =.122	S.E.=401.32	D.W.=1.70	
	(.0130)							

AAX _D =	+196.80*	+6.42TH	-50.40*FR	+61.11*S	-1.98M	-19.78TU	-32.03*W	-22.15*FT
	(30.14)	(13.71)	(13.61)	(13.65)	(13.97)	(13.62)	(13.61)	(8.92)
	-9.85LT	-8.26J	-5.47FB	+3.19*MR	+12.34AP	-6.52NY	+7.43JH	+7.43JL
	(8.86)	(18.18)	(18.61)	(18.13)	(18.29)	(17.39)	(17.37)	(17.13)
	+64AU	+10.29SP	+7.57OC	15.16NO	+11.43SW	+10760.00Ar	-.1611*rTD	
	(17.09)	(17.22)	(17.10)	(17.20)	(7.28)	(22710.00)	(.0468)	
	-.1861*AXt-2			R ² -.141	S.E.=149.72	D.W.=2.06		
	(.0142)							
ΔAX _E =	+40.45*	+21.37*TH	-8.06FR	+66.40*S	+12.87*H	+13.73*TU	+28.45*W	-1.82*FT
	(9.35)	(4.48)	(4.44)	(4.48)	(4.57)	(4.45)	(4.45)	(2.90)
	-5.71*LT	-11.29*J	-14.58*FB	-15.85*MR	-11.63*AP	-29.32*HY	-20.75*JN	-31.48*JL
	(2.89)	(5.96)	(6.22)	(6.07)	(6.13)	(6.18)	(5.98)	(6.24)
	-36.73*AU	-6.10SP	-2.95OC	-1.42NO	+4.72*SW	-11800.00Ar	-.0714*rTD	
	(6.60)	(5.73)	(5.57)	(5.61)	(2.38)	(7406.00)	(.0279)	
	-.1407*AXt-2			R ² -.247	S.E.=48.83	D.W.=1.96		
	(.0123)							

TABLE 12

ESTIMATING EQUATION NO. 5.7 FOR FIVE INDIVIDUAL BANKS

$AX_{t-1}/TD_{t-2A} = +.0044^*$ (.0013)	$+.0015^*TH$ (.0006)	$+.0010FR$ (.0006)	$+.0042^*S$ (.0006)	$-.0003M$ (.0006)	$+.0014^*TU$ (.0006)	$+.0039^*W$ (.0006)
$+.0003FT$ (.0004)	$+.0006LT$ (.0004)	$+.0007J$ (.0008)	$-.0005FB$ (.0008)	$-.0008MR$ (.0008)	$-.0007AP$ (.0008)	$-.0007MY$ (.0008)
$-.0006JN$ (.0008)	$-.00012JL$ (.0007)	$-.0014^*AU$ (.0007)	$-.0018^*SP$ (.0008)	$-.00070C$ (.0007)	$-.0005NO$ (.0008)	$+.0004SW$ (.0003)
$-1.5534r$ (1.026)	$-.1161^*r$ (.0308)	$+.6438^*AX_{t-2}/TD-3$ (.0187)		$R^2 = .485$	$S.E. = .0068$	$D.W. = 2.07$
$AX_{t-1}/TD_{t-2B} = +.0010$ (.0021)	$+.0064^*TH$ (.0010)	$-.0052^*FR$ (.0010)	$+.0026^*S$ (.0010)	$-.002M$ (.0010)	$-.0053^*TU$ (.0010)	$+.0034^*W$ (.0010)
$+.0012FT$ (.0007)	$+.0014^*LT$ (.0007)	$+.0011J$ (.0013)	$+.0009FB$ (.0014)	$+.0003MR$ (.0013)	$-.0012AP$ (.0013)	$+.0001MY$ (.0013)
$+.0008JN$ (.0013)	$+.0003JL$ (.0013)	$-.0003AU$ (.0013)	$-.0001SP$ (.0013)	$+.00020C$ (.0013)	$+.0013NO$ (.0013)	$+.0003SW$ (.0013)
$-1.0424r$ (1.664)	$-.0264r$ (.0489)	$+.6765^*AX_{t-2}/TD-3$ (.0179)		$R^2 = .499$	$S.E. = .0109$	$D.W. = N.A.$
$AX_{t-1}/TD_{t-2C} = -.0023$ (.0045)	$+.00001TH$ (.0024)	$+.0091^*FR$ (.0024)	$+.0063^*S$ (.0024)	$+.0002M$ (.0024)	$-.0045^*TU$ (.0024)	$-.0051^*W$ (.0024)
$-.0015FT$ (.0015)	$-.0010LT$ (.0015)	$-.0007J$ (.0031)	$-.0002FB$ (.0031)	$+.0071^*MR$ (.0031)	$+.0047AP$ (.0031)	$+.0007MY$ (.0030)
$+.0054JN$ (.0030)	$+.0042JL$ (.0030)	$-.0013AU$ (.0030)	$+.0063^*SP$ (.0030)	$+.00070C$ (.0030)	$+.0041NO$ (.0030)	$+.0024^*SW$ (.0013)
$-.2546Ar$ (3.923)	$+.0539r$ (.1155)	$+.8595^*AX_{t-2}/TD-3$ (.0126)		$R^2 = .775$	$S.E. = .0259$	$D.W. = 1.74$

AXt-1/TDt-2D = +.0209*									
	(.0025)	-.0008TH	(.0010)	-.0041*FR	+ .0036*S	-.0005M	(.0010)	-.0015TU	-.0028*W
	-.0015*TR	-.0005LT	(.0007)	-.0003J	-.0003FB	+ .0001MR	(.0013)	+ .0004AP	-.0009MT
	(.0007)	(.0007)		(.0013)	(.0014)	(.0013)	(.0013)	(.0013)	(.0013)
	+ .0005JN	+ .00008JL	(.0013)	-.0003AU	-.00007SP	-.00008OC	(.0013)	-.00006NO	+ .0009SW
	(.0013)	(.0013)		(.0013)	(.0013)				(.0005)
	+ .8418Ar	-.3002*r	(1.672)	+ .7900*AXt-2/TD-3		R ² = .694	S.E. = .0110		D.W. = 2.63
		(.0534)		(.0149)					
AXt-1/TDt-2E = +.0149*									
	(.0024)	+ .0036*TH	(.0009)	-.0020*FR	+ .0122*S	+ .0022*M	(.0009)	+ .0021*TV	+ .0050*W
				(.0009)	(.0009)			(.0009)	(.0009)
	-.0005*TR	-.0011LT	(.0006)	-.0021J	-.0023*FB	-.0026*MR	(.0012)	-.0020AP	-.0052*MY
	(.0006)	(.0006)		(.0011)	(.0012)	(.0012)	(.0012)	(.0012)	(.0012)
	-.0033*JN	-.0056*JL	(.0011)	-.0067*AU	-.0010SP	-.0010OC	(.0011)	-.0004NO	+ .0009*SW
	(.0011)	(.0012)		(.0012)	(.0011)			(.0011)	(.0005)
	-2.4090Ar	-.2759*r	(1.424)	+ .8503*AXt-2/TD-3		R ² = .851	S.E. = .00094		D.W. = 1.94
		(.0481)		(.0127)					

and lagged borrowed reserves are significant, with expected signs and consistently indicate a different adjustment pattern depending on bank size. This is possibly the most substantial result of the individual bank regressions. While the interest rate results are generally significant for the large banks, interest rates lack cyclical variation during the study period and results with them are accepted with caution. The R^2 rises as the speed of adjustment pattern decreases and is very high for bank E (95 per cent) and lowest for bank B (25 per cent).

Equation 5.5 was tested with seasonal variables replaced by specific kinds of deposits as in equation 5.4. The results are quite similar to those above regarding lagged borrowed reserves, lagged reserve position and interest rates. And as in equation 5.4, changes in interbank deposits ($\Delta I/TD$) are inversely related to borrowing for bank A; changes in government deposits ($\Delta G/TD$) are inversely related to borrowing for bank B; and changes in other deposits ($\Delta O/TD$) are inversely related to borrowing for banks C, D, and E. The coefficients are significant except for bank E.

Equations 5.6 and 5.7. These two equations estimate the reserve position of the banks. In 5.6 the dependent variable is changes in reserve position (ΔAX); and in 5.7 the dependent variable is the ratio of reserve position to total deposits (AX_{t-1}/TD_{t-2}).

The coefficients of interest rate variables (Δr , rTD) in equation 5.6 indicate that the banks adjust reserves downward when the bill rate is rising. The two exceptions are banks C and D, the former appearing to raise its reserves when the interest rate variable

is (r_{TD}); and the latter bank appears to increase its reserves when the bill rate is rising (Δr). Other than these exceptions, the interest rate results indicate a profit oriented reserve management pattern for the large and small banks.

The estimated coefficient of the lagged reserve position variable (AX_{t-2}) is negative and highly significant for each bank. The large banks have the smallest coefficients, indicating again a more rapid adjustment pattern than the small banks.

The seasonal results in equation 5.6 are mixed. Of interest is the fact that the two large banks appear to increase their reserves on Wednesday while banks C and D decrease their reserves. Bank E increases its reserves on Wednesday. Bank E has a monthly seasonal pattern that reflects its loss of deposit and reserves during the second and third quarters of the year.

The results with equation 5.7 are similar. Significant and negative coefficients are estimated for the bill rate (r) for banks A, D, and E. Bank B has a negative but insignificant coefficient of (r), and bank C shows a positive coefficient similar to the result in equation 5.6. The largest bank has the lowest coefficient for lagged reserves (AX_{t-2}/TD_{t-3}). The small banks have considerably higher coefficients than the large banks again implying a more rapid adjustment pattern for the large banks. The seasonal variables in equation 5.7 have coefficients that closely resemble those estimated in equation 5.6.

The R^2 's in equation 5.7 increase as the bank size decreases. This is understandable since the small banks adjust more slowly than

the large banks and a high R^2 would be expected with lagged dependent variables as independent variables. Moreover, introduction of lagged reserves into the equations last boosts the R^2 considerably for each bank. Eliminating seasonal variables and substituting potential earning assets (P) or individual deposits (I,G,O) does not change the outcome very significantly for equation 5.7. It is reasonable that for the reserve position equations using the lagged reserve position alone as an explanatory factor would have yielded high R^2 's. This was not as true for the borrowing estimates.

Conclusions

The estimating equations for daily behavior patterns of these five banks show mainly the significance of lagged borrowed reserves, lagged reserve position (including due-from balances in this measure), deposit items and interest rates in explaining borrowing. The importance of the lagged variables lies mainly in the size of the coefficient and the relationship between the small and large banks in the timing of their reserve adjustments. The smaller coefficients appear for the two large banks relative to the small banks. This indicates a quicker adjustment pattern for the large banks, a fact that is supported by inspection of the data. This result is in keeping with the hypotheses of this study, and also supports recent findings by Goldfeld and Kane.⁷

Accumulated deficits trigger borrowing generally and for the smaller banks total deposit flows seem to be important proximate

7. Stephen M. Goldfeld and Edward J. Kane, op. cit., p. 512.

causes of these deficits. Overall deposit flows do not seem to cause borrowing, in a significant way, for the two largest banks although aggregates and ratios of interbank and government deposit losses are significantly related to borrowing. It is interesting to note that interbank deposit variability for both of these banks is greater than variability of other deposits (Appendix 2, column 11 and 8). Interbank deposits are less predictable than other deposit flows and thus likely trigger borrowing situations. The conclusion is highly tentative and more study is needed regarding interbank and government deposit influences on bank borrowing.

The three smaller banks appear to rely on the Fed after earning assets have been sold or when few earning assets are available. Banks A and B appear to borrow at the Fed while earning assets are low but rising. From a profit point of view this makes sense. This might imply that large banks buy securities when their yield is relatively high; and adjust reserves by borrowing at the Fed. It may be true that small banks do not adjust their positions so frequently as large banks, since their transactions costs may be higher. An insignificant interest rate relationship to some extent supports this assumption. Considering the trend problem associated with interest rates during the study period, these conclusions are made with some caution.

Interest rate influences are strongest for the large banks as was expected in view of the hypotheses of this study. A longer period with cyclical interest rate changes would be required if strong conclusions were to be made. Nevertheless the signs of the coefficients

are in keeping with the hypotheses and also similar to recent results with practically the same variable.⁸

The strongest seasonal pattern that appears in the original data was supported by the estimating equations. It is the monthly behavior of deposits for the smaller banks, particularly C and D, and the borrowing which follows these flows. The intra-weekly and intra-monthly patterns are varied among the banks, although bank B has a strong propensity to borrow on Wednesdays. It is hard to generalize about seasonal patterns since each bank had basically different patterns.

8. Goldfeld and Kane, ibid., p. 509.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The results of this study fall into two main categories, the importance of deposit variability to a bank and the way it structures its balance sheet relative to variability; and the speed and method by which individual banks adjust portfolios. Banks face important uncertainties in their day to day operations with respect to deposit flows, loan demands, and security market conditions. Banks must structure their assets around an expected pattern of deposit flows in order to maximize profits and yet they must be prepared to meet depositor claims. Consequently, an important part of bank decision making revolves around this phenomenon of expected deposit flows and the uncertainty that is associated with them.

In this study repeated evidence has shown that there are regular movements in total deposits at individual banks. Total deposits are a reasonably predictable factor for banks, and the greater the bank size, the greater the predictability. Especially significant is the use of daily data in this study and the measure of variability used. Other recent studies employed deposit variability measures, but there is reason to suspect that they are altogether inadequate because they did not take into account the regular calendar related

variability in deposits at individual banks.^{1.} The measure of deposit variability used here considered variations in deposits relative to regular deposit flows. The deposit variability measure used in this study is a most significant cause of borrowing, as was hypothesized, for the sample of banks, whereas the alternative measures proved highly insignificant.

Deposit variability at individual banks is subject to many influences in terms of the composition of a bank's deposits. It was found that interbank deposits and government deposits were highly volatile and contributed to deposit variability of large banks, where such deposits were as expected relatively more important than at small banks. Nevertheless large banks were found to have less deposit variability relative to their size than small banks, presumably because deposit flows are at least partly independent and tend to be offsetting in large firms, analagous to the law of large numbers applicable in the insurance industry. There are factors that affect variability regardless of bank size. One of these is the ratio of time deposits to total deposits. It was found that time deposits exert a depressing effect on variability for large banks but not for small banks contrary to findings of Struble and Wilkerson and Chairnoff in their recent studies.^{2.}

1. These include all of the studies done by individual Federal Reserve Banks.

2. Struble and Wilkerson, op. cit.; Chairnoff, op. cit.

Bank size which served as a proxy for transaction costs in this study is significantly related to borrowing with large banks borrowing less relative to deposits than small banks because borrowing from the Fed is typically more expensive for large banks than selling securities or buying federal funds, though presumably marginal cost rates are equated. Small banks find borrowing at the Fed relatively less expensive than alternative reserve sources where they do not have a strong nonpecuniary reluctance to borrow.

The results in this study indicate that actual and desired levels of deposits are adjusted by the banks by several means. Banks with greater uncertainty about deposit flows tend to hold relatively higher levels of reserves and due-from balances on average. Similarly, they keep relatively larger amounts of liquid earning assets such as securities as well as nonearning assets such as vault cash.

The rapidity with which larger banks adjust implies that they take advantage of market opportunities more readily than the smaller banks, most likely because they experience low transaction costs relative to smaller banks. The significance of the interest rate measure for the two largest banks supports this conclusion. Interest rates were generally insignificant for the smaller banks and this combined with their more usual concern with deposit flows and consequent adjustments to offset the effects of these flows, implies that smaller banks do not "fine-tune" their cash management in the way that larger banks do. And with their relatively high transaction costs they cannot afford to.

Seasonal borrowing patterns appear to be proxies for important financial flows affecting the banks and they were treated as such in this study. The ebb and flow of deposits and loan and security portfolios of the banks are apparently responsible for significant seasonal patterns of borrowing. Intra-weekly patterns of borrowing are most significant for large banks and again most likely because of their active adjustment behavior.

There is some evidence, though it is far from conclusive, of lack of homogeneity in the individual bank equations with respect to deposits, conceivably associated with economies of scale in banking operations. This may be significant in terms of future studies of bank behavior in that most aggregate models of borrowing have assumed homogeneous relationships.

The explanatory power of the estimating equations measured by their individual R^2 's is reasonably high for the cross section analysis. Explanatory power, as expected, was much lower for individual bank equations. High R^2 's are not common, however, where daily data are studied and usually are not expected because of random influences on daily behavior of individual data. Regardless of the R^2 's, there was a consistent finding that bank borrowing was inversely related to a bank's accumulated reserve position for a reserve settlement period and that the speed of adjustment of borrowing was directly related to lagged borrowings. This offers some encouragement for further study of daily behavior of individual banks.

Individual bank daily borrowing patterns substantiate the importance of deposit flows in explaining borrowing for small banks.

Large banks appear to be more affected by losses of interbank and government deposits than small banks. Each of the banks has significant effects of reserve position on borrowings. Lagged reserves are significantly and inversely related to current borrowing. Moreover, the large banks appear to have a faster reserve adjustment pattern relative to the small banks as seemed reasonable, and there appears to be a systematic decline with bank size in the speed with which banks adjust reserves.

Comparison of Results With Other Studies

The results of this study cannot be compared in detail with others because of the use of daily data for individual banks in this study and related specifications of relationships. Nevertheless, there are some findings that are relevant to other studies.

McKinney. Some evidence exists from the present study which indicates that the smaller banks borrow toward the end of their settlement period and that at least one large bank (bank A) borrows early in its period and repays late in the period. These patterns are similar to McKinney's findings. While he found a significant weekend pattern, such a pattern was not observed for the banks in my sample.

Goldfeld.³ In his study of bank behavior Goldfeld specifies equations for country and city banks separately. His variables are similar to those used in the present study. The assumption that city banks are larger than country banks generally and therefore on that

3. Goldfeld's borrowing results are contained in Appendix 3.

basis, I can compare large bank behavior with his city bank behavior and similarly for small banks and country banks. Goldfeld finds that lagged borrowed reserves are inversely related to changes in borrowing for city and country banks, although the coefficient is smallest for the city banks implying that the larger banks make faster adjustments and repay borrowing sooner than country banks. Similar findings appear in my results relative to large and small banks.

Goldfeld's interest differential is significant with positive sign for city and country banks though much more significant for city banks. I expected a positive sign for the comparable coefficient estimated for individual banks. My results with the differential (i) are generally significant for large banks and insignificant for smaller ones. Goldfeld and Kane found a similar interest rate result in their recent study.⁴

While Goldfeld does not use reserve position in his final equations he does introduce lagged excess reserves into his equation for country banks and finds it significant with negative sign. Not only are my results similar but also my coefficients. And this was true for coefficients of lagged borrowed reserves as well.

Goldfeld's potential demand deposits closely resembles my potential earning assets (P) variable. Goldfeld finds this variable significant with negative sign for city and country banks. The results in my study are mixed. The variable is negative and generally significant for the small banks, but positive and insignificant for the large banks.

4. Goldfeld and Kane, op. cit., p. 512.

Quarterly seasonal variables are generally not significant for Goldfeld though in this study seasonality with respect to months, weeks, and days was typically significant.

In general, the results compare favorably even though one study used aggregate, monthly and quarterly data; and the other used daily individual bank data.

Dewald and Gibson. In their study of sources of variation in reserves, these authors found that the uncontrolled factors that enter into monetary policy effectiveness were reasonably predictable. Member-bank borrowing was found to be significantly related to interest rates (funds rate) and Wednesdays. The seasonal pattern of my study differs for each bank but the two large banks had significant intra-weekly patterns. Bank B has a significant Wednesday pattern although not a great deal should be said about the behavior of one bank.

de Leeuw. In his borrowings equation de Leeuw found the interest differential, lagged borrowed reserves and a variable equivalent to my potential earning assets significant with expected signs. An important inclusion of de Leeuw's study are changes in deposits as an explanatory factor. Both the de Leeuw study and my results show an important role for deposits and deposit changes in explaining variation in borrowed reserves.

Studies of Variables Other than Borrowing. As mentioned in the beginning there has been a good deal of research on closely related topics such as free reserves and reserve position adjustment. It is therefore appropriate to compare my results with those of Meigs, and

Bryan and Carleton. And then a comparison will be made with some studies of deposit variability in a general way.

Meigs. Meigs finds the rate of change of free reserves to be related to interest rates (market rates and the discount rate), expected deposit flows and composition of bank portfolios. When actual and desired ratios differ, adjustment takes place, usually through sale of assets or borrowing. My results indicate an adjustment pattern for banks based on actual and expected total deposit flows. Unexpected deposit flows cause deficits which in turn trigger borrowing or some other reserve adjustment.

Bryan and Carleton. In their recent study of an individual bank's reserve adjustment pattern, these authors conclude that the bank reacts to shifts in deposits and loan demand by borrowing at the Fed rather than through adjustments of excess reserves. Borrowing tends to rise when deposits fall and fall when deposits rise. Excess reserves appear to be most responsive to bill rate changes in their study.

My results are similar in that deposit variability is the most significant cause of borrowing though less significant in explaining the reserve position of the banks. The individual bank equations do not indicate the significance of deposit and loan flows except for the small banks generally.

A difference between the studies is the fact that Bryan and Carleton's bank borrowing included federal funds and borrowing at the Fed. Although the difference is not theoretically important, it may be important in that my study includes primarily small banks which

were not active in the funds market during the study period. The important similarity between the studies regardless of the differences in data and specification, appears to be the reaction of banks to deposit losses, and the timing of the adjustment.

Other Related Studies. Results in this study have some relationship to other recent studies, particularly those concerned with deposit variability. There are several studies which have found an inverse relationship between bank size and deposit variability. Some of these studies used demand deposits only, e.g., Rangarajan, while those of Struble and Wilkerson and Chairnoff concentrated on total deposit variability and the effect of deposit composition on total deposit variability.⁵ The effect of the time deposits on total deposit variability is discussed in these studies, though generally it is reported that the greater the relative proportion of time deposits, the less the variability of total deposits. This same effect is found in the present study. It is most clearly observable for large banks.

My results lend some evidence to the inverse relationship between bank size and total deposit variability, although my result with the effect of time deposits on total deposit variability is mixed. Contrary to Robinson's view my results suggest that large banks have relatively less day-to-day variability in deposits and are thus more able to anticipate reserve needs than small banks. The present study has found that large banks adjust their reserves more rapidly than small banks and that they repay borrowing more rapidly as well.

5. Struble and Wilkerson, op. cit.; Chairnoff, op. cit.; C. Rangarajan, "Deposit Variability in Individual Banks," The National Banking Review, IV (September, 1966), pp. 61-71.

Areas of Study Suggested by the Results

Several areas of further investigation are suggested by the results of this study. Perhaps the most important is to press on the study of individual banks and their borrowing and cash management behavior. In comparison with the present investigation, a larger sample of banks should be studied over a longer time period. The deposit variability measure used in this study should be tested for a group of very large banks which play such a significant role in monetary flows in the economy. While studying small banks is interesting they are relatively less important, particularly with respect to borrowing aggregates.

Implications for Monetary Policy

Results of this study cannot be projected on a wide scale or even applied to individual banks of similar size without reservations. The sample represents a cross section of banks of a size typical of most banks in the country. Only one truly large bank by national standards is included in the sample, although several banks in the sample are quite large in terms of the Cleveland district. Yet the results are meaningful and encouraging for continued analysis. An important area of monetary policy not yet explored in detail is the daily reaction of member-banks to given policy actions and the timing of reactions, particularly where policy actions are reversed on a day to day basis. One part of the reaction is the distribution of deposits and reserves among the various banks and among different parts of the country about which little is known. The timing of bank reaction could be important in making policy effective. This study has

presented evidence in support of the contention that individual bank behavior is reasonably predictable regarding reserve adjustment patterns and regarding individual bank deposits flows. And this is a contribution to our knowledge of how monetary policy works or could be made to work in affecting the economy.

APPENDIXES

APPENDIX 1

ESTIMATING EQUATIONS FOR TOTAL DEPOSITS OF EACH BANK USING SEASONAL DUMMY VARIABLES

TD ₁ = 1280857.00* (2305.00)	-4549.00*TH (1779.30)	-6558.12*FR (1779.30)	+286.11S (1779.30)	-304.42M (1779.30)	-1626.19TU (1779.20)	-1642.16W (1779.30)	-4562.58*FT (1779.30)
-2092.95LT (1160.70)	+8764.61*J (3374.10)	-18584.96*FB (2436.20)	-17542.55*MR (2372.40)	-9113.48*AP (2392.60)	-9034.40*MY (2253.70)	-5213.61*JU (2259.99)	+10248.19*JL (2239.40)
-9843.37*AU (2238.60)	-19556.93*SP (2255.80)	-11353.28*OC (2235.90)	-14793.61*NO (2253.80)	+238.84*T (.98)	+967.29SW (952.30)	R ² = .973 X̄ = 1,492,861.0	S.E. = 19611.0
TD ₂ = 734606.00* (3068.3)	+3308.18TH (2368.5)	-2454.18FR (2368.5)	+189.24S (2368.4)	-207.79M (2368.4)	+7713.45*TU (2368.5)	+8547.81*W (2368.5)	-19566.45*FT (1545.1)
-5993.60*LT (1545.1)	-4921.22*J (3160.3)	-27397.25*FB (3243.0)	-22301.00*MR (3158.1)	-21568.24*AP (3184.9)	-13191.17*MY (3000.0)	-4956.46*JU (3008.4)	+2436.61*JL (2981.1)
-21766.63*AU (2979.9)	-14226.93*SP (3002.8)	-14705.02*OC (2976.3)	-12560.76*NO (3000.1)	+144.93*T (1.3)	-1663.60SW (1267.7)	R ² = .886 X̄ = 838,777.	S.E. = 26,105.
TD ₃ = 101325.80* (685.8)	-488.78TH (529.4)	-470.66FR (529.4)	+31.63S (529.4)	-22.73M (529.4)	-512.21TU (529.4)	-939.59W (529.4)	-2637.49*FT (345.5)
-2107.22*LT (345.3)	-3272.39*J (706.4)	-6908.77*FB (724.9)	-7165.76*MR (705.9)	-8164.04*AP (711.9)	-6063.09*MY (670.5)	-4277.26*JU (672.4)	+2436.61*JL (666.3)
-4623.44*AU (666.0)	-3088.61*SP (671.2)	-1606.34*OC (665.2)	-626.19NO (670.6)	+19.18*T (.290)	+43.53SW (283.3)	R ² = .747 X̄ = 112,008.	S.E. = 5834.5

TD ₄ = 51303.89* (288.9)	+127.60TH (222.0)	-12.51FR (222.0)	+14.07S (222.0)	-5.61M (222.0)	+43.08TU (222.0)	+82.56W (222.0)	-30.19FT (144.6)
+175.51*LT (145.0)	-2521.71*J (298.5)	-2502.55*FB (306.3)	-3261.82*MR (298.4)	-8164.04*AP (300.9)	-1339.64*MY (283.6)	-726.87*JU (284.4)	-1296.35*JL (281.9)
-1023.49*AU (281.8)	-912.11SP (284.0)	-322.80OC (281.6)	+197.60NO (284.0)	+12.52*T (.172)	+78.37SW (118.8)	R ² = .870 X̄ = 60,672.	S. E. = 2,441.
TD ₅ = 28228.14* (94.8)	+75.32TH (72.9)	+47.56FR (72.9)	+4.50S (72.9)	+1.49M (72.9)	+19.26TU (72.9)	+17.24W (72.9)	-207.71*FT (47.5)
-407.57*LT (47.6)	-714.65*J (98.0)	-1117.98*FB (100.6)	-1233.48*MR (98.0)	-1693.39*AP (98.8)	-1404.88*MY (93.1)	-1149.16*JU (93.4)	-1266.62*JL (92.5)
-1232.43*AU (92.5)	-509.60*SP (93.3)	-220.74*OC (92.5)	-38.22NO (93.2)	+2.13*T (.040)	-18.91SW (39.0)	R ² = .702 X̄ = 28,986.	S. E. = 802.
TD ₆ = 14720.81* (47.0)	-63.78*TH (36.1)	-80.61*FR (36.1)	-38.45S (36.1)	-5.39M (36.1)	+21.57TU (36.1)	+43.31W (36.1)	-107.38*FT (23.5)
-91.56* (23.6)	-309.59*J (48.5)	-450.39*FB (49.8)	-389.61*MR (48.5)	-351.62*AP (48.9)	-493.99*MY (46.1)	-378.18*JU (46.2)	-776JL (45.8)
-132.30*AU (45.8)	-104.66*SP (46.2)	-79.46OC (45.8)	-109.93*NO (46.2)	+3.97*T (.020)	+23.01SW (19.3)	R ² = .961 X̄ = 17,803.	S. E. = 397.

$TD_7 = 11225.73^*$
 (68.3)

-113.47*LT (34.3)	-119.86J (70.6)	-141.53*FR (52.5)	-9.55S (52.5)	-6.25M (52.5)	-71.83TU (52.5)	-255.12*W (52.51)	-155.64*FT (34.2)
+551.08*AU (66.6)	+723.69*SP (67.1)	+301.85*OC (66.6)	+265.71*NO (67.1)	+4.02*T (.029)	-5.33SW (28.1)	$R^2 = .924$ $\bar{X} = 14,655.$	+497.68*JL (66.7)

$TD_8 = 12330.37^*$
 (46.6)

-61.82*LT (23.4)	-32.95TH (38.8)	-12.54FR (35.8)	-10.93S (35.8)	-1.94M (35.8)	+163.74*TU (35.8)	+1.67W (35.8)	+25.76FT (23.3)
+93.90*AU (45.5)	+208.71*SP (45.8)	+156.89*OC (45.4)	+128.50*NO (45.8)	+2.10*T (.020)	-23.56SW (19.2)	$R^2 = .878$ $\bar{X} = 14,096.$	-102.03*JL (45.5)

$TD_9 = 13070.40^*$
 (36.9)

-125.11*LT (43.6)	-478.09*J (89.8)	-283.37*FB (92.2)	-109.33*MR (89.8)	+313.93*AP (90.6)	-33.59MY (85.3)	-233.71*JU (85.6)	+85.5*JL (84.8)
+143.59*AU (84.8)	+378.38*SP (85.5)	+477.36*OC (84.7)	+439.14*NO (85.3)	+366*T (.037)	+857SW (35.7)	$R^2 = .203$ $\bar{X} = 13,481.$	S.E. = 735.

TD ₁₀ = 9122.90* (61.1)	-8.89TH (47.0)	-106.27*FR (42.0)	-69.98S (47.0)	-4.85M (47.0)	+120.04*TU (47.0)	+80.26W (47.0)	-189.97*FT (30.6)
-189.41*LT (30.7)	+194.54*J (63.1)	-181.91*FB (64.8)	-284.34*MR (63.1)	-367.08*AP (63.7)	+4.89MY (60.0)	-228.30JU (60.2)	-239.15*JL (59.6)
-268.94*AU (59.6)	-54.91SP (60.1)	+392.80*OC (59.6)	+312.33*NO (60.1)	+5.07*T (.026)	-6.37SW (25.1)	R ² = .960 X̄ = 13,243.	S.E. = 516.
TD ₁₁ = 8445.39* (23.6)	-30.28TH (18.1)	-66.16*FR (18.1)	-29.22S (18.1)	-3.26M (18.1)	-5.74TU (18.1)	+6.26W (18.1)	-59.24*FT (11.8)
-124.41*LT (11.8)	-157.46*J (24.4)	-254.96*FB (25.0)	-284.34*MR (24.4)	-295.13*AP (24.6)	-297.66*MY (23.2)	-155.48*JU (23.2)	-117.47*JL (23.0)
-87.13*AU (23.0)	-71.06*SP (23.2)	+33.39OC (23.0)	+107.67*NO (23.2)	+2.75*T (.0099)	+1.55SW (9.7)	R ² = .979 X̄ = 10,573.	S.E. = 199.
TD ₁₂ = 7854.39* (44.9)	-77.53*TH (34.5)	-93.59*FR (34.5)	-42.19S (34.5)	-3.60M (34.5)	+18.91TU (34.5)	+20.62W (34.5)	-18.63*FT (22.5)
-9.21LT (22.5)	-180.82*J (46.4)	-51.54FB (47.6)	+16.53MR (46.4)	-72.36AP (46.8)	-245.30*MY (44.1)	-3.46JU (44.2)	+62.04JL (43.8)
-39.28AU (43.8)	+117.05*SP (44.2)	+72.71OC (43.8)	-35.54NO (44.1)	+3.18*T (.019)	+32.53SW (18.5)	R ² = .945 X̄ = 10,506.	S.E. = 380.

TD ₁₃ = 6444.06* (24.7)	+5.97TH (19.0)	+1.43ER (19.0)	+545S (19.0)	-.403M (19.0)	+7.53TU (19.0)	+9.37W (19.0)	+25.15FT (12.4)
-37.97*LT (12.4)	+36.01J (25.6)	-117.20*FB (26.2)	-162.33*MR (25.6)	-261.52*AP (25.8)	-260.43*MY (24.3)	-196.17JU (24.3)	-83.40*JL (24.1)
-65.46*AU (24.1)	-90.02*SP (24.3)	+68.32*OC (24.1)	+37.14NO (24.1)	+331* ^T (.0105)	+74.46*SW (10.2)	R ² = .494 X̄ = 6,673.	S.E. = 209.
TD ₁₄ = 4824.75* (23.5)	+21.68TH (18.1)	-8.49FR (18.1)	-13.53S (18.1)	-.083M (18.1)	+22.90TU (18.1)	+23.15W (18.1)	-7.79FT (11.8)
-33.44*LT (11.8)	-96.68*J (24.3)	-327.90*FB (24.9)	-339.92*MR (24.3)	-321.25*AP (24.5)	-561.40*MY (23.1)	-623.11*JU (23.2)	-684.86*JL (22.9)
-719.67*AU (22.9)	-286.61*SP (23.1)	+38.82OC (22.9)	-43.55NO (23.1)	+892* ^T (.010)	+3.84SW (9.7)	R ² = .878 X̄ = 5,239.	S.E. = 199.
TD ₁₅ = 3635.50* (9.2)	-3.48TH (7.0)	-18.27*FR (7.0)	-23.34*S (7.0)	-1.33M (7.0)	+10.03TU (7.0)	+6.83W (7.0)	+2.93FT (4.6)
-11.26*LT (4.6)	-91.66*J (9.5)	-175.80*FB (9.7)	-209.74*MR (9.5)	-159.52*AP (9.5)	-196.70*MY (9.0)	-220.83*JU (9.0)	-196.42*JL (8.9)
-225.82*AU (8.9)	-151.21*SP (9.0)	-83.23*OC (8.9)	+88.71*NO (9.0)	+1.01* ^T (.004)	+3.90SW (3.8)	R ² = .978 X̄ = 4,354.	S.E. = 77.

TD ₁₆ =3838.40* (15.3)	+25.14*TH (11.8)	+13.77FR (11.8)	+2.268S (11.8)	+4.464H (11.8)	+16.6TU (11.8)	+24.95*W (11.8)	-5.99NT (7.7)
	-64.31*J (15.9)	-93.70*FB (16.3)	-73.37*MR (15.9)	-88.52*AP (16.0)	-83.71*NY (15.1)	-89.76*JU (15.1)	-160.17*JL (15.0)
	-45.15*SP (15.1)	-39.47*OC (15.0)	+67.70*KO (15.1)	-.124*T (.006)	+15.43*SW (6.31)	R ² =318 X = 3,690.	S.E. = 130.
TD ₁₇ =1954.97* (6.7)	-1.67TH (5.2)	-4.46FR (5.2)	-7.93S (5.2)	-.552H (5.2)	+2.09TU (5.2)	+3.74W (5.2)	+8.23*FT (3.4)
	+9.64J (6.9)	-28.08*FB (7.1)	-65.88*MR (6.9)	-104.23*AP (7.0)	-117.34*NY (6.6)	-127.50*JU (6.6)	-135.10*JL (6.6)
	-126.12*SP (6.6)	-53.40*OC (6.5)	+7.51NO (6.6)	+5.38T (.003)	+6.27SW (2.8)	R ² =959 X = 2337.	S.E. = 57.
TD ₁₈ =1042.40* (8.2)	-.296TH (6.3)	-8.70FR (6.3)	-10.77S (6.3)	-.147H (6.3)	+4.16TU (6.3)	-1.35W (6.3)	+3.61T (4.1)
	-23.92*J (8.5)	-50.14*FB (8.7)	-31.10*MR (8.5)	+20.77*AP (8.6)	-31.90*NY (8.1)	-33.87*JU (8.1)	-42.65*JL (8.1)
	+48.99*SP (8.1)	+21.38*OC (8.0)	+31.80*NO (8.1)	+1.91*T (.003)	+1.05SW (3.4)	R ² =686 X = 1,196.	S.E. = 70.

APPENDIX 2

DISTRIBUTION OF IMPORTANT DATA FOR EACH BANK
BY DESCENDING ORDER OF BANK SIZE

Bank No.	(1) DE/TD	(2) G/TD	(3) VC/TD	(4) L/TD	(5) X/TD	(6) S	(7) T/TD	(8) DV	(9) FV
1	.010	.017	.016	.724	.00010	7	.560	.013	.185
2	.012	.040	.008	.536	.00001	7	.357	.031	.253
3	.054	.024	.023	.564	.00060	7	.316	.052	.200
4	.047	.021	.019	.430	.00020	6	.521	.040	.268
5	.038	.016	.018	.386	.00200	5	.447	.028	.219
6	.025	.011	.024	.586	.00300	4	.639	.022	.372
7	.009	.011	.018	.785	.00900	4	.664	.039	.299
8	.024	.010	.037	.356	.00900	4	.773	.028	.537
9	.050	.038	.029	.593	.00600	4	.488	.054	.364
10	.071	.013	.026	.633	.00600	4	.405	.039	.280
11	.030	.013	.031	.538	.00700	3	.621	.019	.286
12	.025	.015	.019	.547	.01300	3	.616	.036	.237
13	.045	.036	.024	.516	.00300	3	.642	.031	.326
14	.052	.023	.016	.419	.00100	2	.482	.038	.391
15	.011	.037	.012	.599	.01000	2	.698	.018	.535
16	.052	.005	.033	.574	.01100	2	.704	.035	.445
17	.016	.007	.014	.498	.00900	2	.592	.024	.573
18	.036	.004	.016	.655	.00600	2	.625	.058	.969

APPENDIX 2-Continued

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
CV	IV	SD	SC	SG	SI	B/TD	X-B/TD	X+DF-B/TD
.052	.120	.081	.162	.412	.134	.001300	-.0012	.0088
.062	.067	.092	.172	.396	.100	.001000	-.0010	.0110
.104	.088	.103	.196	.469	.118	.000030	.0005	.0545
.096	.319	.110	.257	.542	.622	.000000	.0002	.0472
.114	.535	.050	.201	.386	.590	.002600	-.0006	.0378
.087	.000	.113	.128	.501	.000	.001000	.0020	.0270
.127	.000	.142	.245	.590	.000	.002100	.0039	.0159
.268	.000	.079	.325	.512	.000	.000100	.0039	.0329
.154	.000	.061	.219	.526	.000	.004400	.0015	.0516
.102	.000	.193	.226	.455	.000	.000400	.0056	.0766
.127	.000	.130	.275	.273	.000	.000200	.0068	.0369
.128	.000	.153	.211	.506	.000	.001000	.0120	.0370
.142	.000	.043	.253	.468	.000	.000200	.0028	.0478
.145	.000	.108	.217	.356	.000	.003200	-.0022	.0498
.160	.000	.119	.222	.297	.000	.000600	.0094	.0204
.252	.000	.042	.311	.253	.000	.000180	.0108	.0628
.198	.000	.119	.303	.821	.000	.000002	.0090	.0249
.277	.000	.104	.316	.231	.000	.002800	-.0028	.0332

APPENDIX 2-Continued

(19)	(20)	(21)	(22)	(23)	(24)
DYS	GRD	BB	TMB	ADB	ATD
157	.344	.014	71	2.2	\$1,473,195.
165	.432	.010	100	1.7	839,009.
4	.347	.016	1	4.0	112,044.
0	.428	0	0	0	60,752.
122	.153	.037	14	8.7	29,000.
122	.416	.013	15	8.1	17,813.
156	.477	.023	42	3.7	14,674.
12	.277	.015	4	3.0	14,107.
234	.241	.032	40	5.9	13,484.
45	.771	.014	6	7.5	13,262.
14	.505	.019	1	14.0	10,589.
69	.618	.024	4	17.2	10,523.
14	.115	.024	2	7.0	6,675.
289	.445	.019	6	48.1	5,247.
73	.458	.014	4	18.0	4,360.
15	-.050	.020	1	15.0	3,688.
2	.415	.017	1	2.0	2,339.
308	.421	.029	20	15.4	1,197.

The following are definitions of data appearing in Appendix 2.

COL. NO.	SYMBOL	VARIABLE NAME AND COMPUTATION
1	DF/TD	ratio of due-from balances to total deposits
2	G/TD	ratio of government deposits to total deposits
3	VC/TD	ratio of vault cash to total deposits
4	L/TD	ratio of loans to total deposits
5	X/TD	ratio of excess reserves to total deposits
6	S	size class of bank based on average total deposits
7	T/TD	ratio of time deposits to total deposits
8	DV	variability of total deposits using the ratio of the standard error of estimate of total deposits to average total deposits
9	FV	variability of due-from balances using the ratio of the standard error of estimate of due-from balances to average due-from balance
10	CV	variability of vault cash using the ratio of the standard error of estimate of vault cash to average vault cash
11	IV	variability of interbank deposits using the ratio of the standard error of estimate of interbank deposits to average interbank deposits
12	SD	variability of total deposits using the ratio of standard deviation of the mean of total deposits to average total deposits
13	SC	variability of vault cash using the ratio of the standard deviation of the mean of vault cash to average vault cash
14	SG	variability of government deposits using the ratio of the standard deviation of government deposits to average government deposits
15	SI	variability of interbank deposits using the ratio of the standard deviation of the mean of interbank deposits to average interbank deposits
16	B/TD	ratio of borrowed reserves to total deposits
17	X-B/TD	ratio of excess reserves less ratio of borrowed reserves to total deposits
18	X+DF-B/TD	ratio of excess reserves plus ratio of due-from balances less ratio of borrowing to total deposits
19	DYS	number of days over study period borrowing outstanding
20	GRD	percent growth in total deposits over study period
21	BB	average borrowed reserves for <u>only</u> those days when borrowing outstanding
22	TMB	number of separate times borrowing outstanding-differs from 19 above in that <u>at least</u> one day lapsed before borrowing was reopened by the bank
23	ADB	average number of days borrowing outstanding-variable 19 divided by variable 22
24	ATD	average total deposits over the study period (in thousands of dollars)

APPENDIX 3

GOLDFELD'S ESTIMATING EQUATIONS FOR BORROWING^a

$$\Delta B^N = +.049 \quad +.081s_2 \quad +.077s_3 \quad +.187s_4 \quad -.411B_{-1}^N \quad +.117ACL^N \quad -.153(r_d - r_s) \\ (.080) \quad (.099) \quad (.133) \quad (.088) \quad (.035) \quad (.106) \\ +.311dp \quad -.049AD^* \quad -11.42RR_2^N \\ (.104) \quad (.015) \quad (7.47) \quad R^2=.705 \quad S_e=.133 \quad DW=2.34 \quad (5.3)$$

$$\Delta B^C = +.026 \quad +.044s_2 \quad -.011s_3 \quad +.034s_4 \quad -.299B_{-1}^C \quad +.055ACL^C \quad -.040(r_d - r_s) \\ (.013) \quad (.013) \quad (.019) \quad (.060) \quad (.020) \quad (.016) \\ +.061dp \quad -.0064D^* \quad -.022AT^C \\ (.019) \quad (.002) \quad (.013) \quad R^2=.722 \quad S_e=.024 \quad DW=2.27 \quad (5.4)$$

^aThese are his final equations as found on page 131.

Identification of Goldfeld's variables:

B_{-1}^N	=borrowings of city member banks
B_{-1}^C	=borrowings of country member banks
s_2, s_3, s_4	=seasonal dummy variables taking on the value of 1 in the quarter indicated by the subscript and 0 elsewhere
CL_{-1}^N	=holdings of commercial loans by city member banks
CL_{-1}^C	=holdings of commercial loans by country member banks
r_d	=Federal Reserve discount rate
r_s	=yield on short-term Treasury bills
dp	=variable representing excess profits tax
D^*	=potential deposits (demand) of the banking system defined as $(R^u - k_T \cdot T)/k_D$ where R^u is unborrowed reserves, k_T and k_D are the reserve requirements on time and demand deposits respectively and T is the volume of time deposits
RR^N	=reserve requirement variable for city member banks
T	=time deposits of country member banks

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