1978

An Empirical Investigation into the Determinants of the Federal Funds Rate with Special Emphasis on Trends in Market Participation

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AN EMPIRICAL INVESTIGATION INTO THE DETERMINANTS OF THE FEDERAL FUNDS RATE WITH SPECIAL EMPHASIS ON TRENDS IN MARKET PARTICIPATION

BY

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B.S.B.A., Florida Technological University, 1973

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Arts in Economics
in the Graduate Studies Program of
Florida Technological University

Fall Quarter
1978

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

The Federal Funds market is a segment of the country's financial mechanism that has received increasingly more attention, as it has undergone accelerating structural changes. Federal Funds has traditionally been defined as a money market instrument facilitating the sale of excess reserves, on deposit in the Federal Reserve system, from a commercial bank with a surplus to a commercial bank that needs these balances to cover a deficiency. However, the structural changes affecting the market is making this definition obsolete. The growing emphasis on efficient money management, and the increasing importance to the market of the participation of smaller banks, non-member banks, non-bank financial institutions, and other non-financial entities, has necessitated a more liberal definition. The Federal Funds market can be more precisely defined as a market facilitating the sale of immediately available funds, between institutions who have the ability to transact in this fashion. By Federal Reserve definition, these entities include commercial banks, federal agencies, savings and loan associations, mutual savings banks, domestic

agencies, branches of foreign banks, and government securities dealers.[1]

Historically, the Federal Funds market was initiated between the New York banks in the 1920's. It developed as an alternative to the more common methods of augmenting reserves: borrowing at the discount window, and exercising call options on broker's loans. In lieu of the cumbersome administration attached to either of these alternatives, the banks determined that it would be much less trouble to simply swap checks. The lender would exchange his draft on his Federal Reserve account for the borrowers check payable the next day in clearing house funds. As a natural result of this, the brokers realized that a bank with excess reserves was less likely to exercise the call option on a loan than was one in need of reserves. Consequently, the brokers attempted to create a market by uniting suppliers and users of funds.

This loose, over the counter type organization is, in foundation, unchanged. However, a trend in market participation has been occuring over the past few decades that has affected the market both geographically and institutionally. Originally, the market was predominately

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[1]Charles M. Lucas, Marcos T. Jones, and Thom B. Thurston, "Federal Funds and Repurchase Agreements," The Federal Reserve Bank of New York, Quarterly Review 2 (Summer 1977): 34.

utilized by the New York banks with little input by regional or country banks. This has changed considerably in the last twenty years. A 1970 study states that during the period 1965 to 1970, the banks in the 10-15 million dollar deposit range increased their participation relative to other classes of banks. Even towards the end of this period, however, the trend of accelerating participation was shifting towards still smaller banks.[1] There is no reason to suspect that this trend has been aborted. The increased yields in the money market, relative to other markets, the increased role of accomodating banks in lubricating the market mechanism and catering to the needs of the smaller banks, and the increased efficiency of the Federal Reserve wire system, have all had an affect in eliminating the barriers to entry that had previously restricted participation in the market to the large, centrally located institutions.

Intradistrict studies since this time confirm the perpetuation of this trend. A 1973 study of market participation in the Seventh District, reports that the daily average net sales for small and medium sized district banks

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[1]Parker B. Willis, The Federal Funds Market: Its Origin and Development (Boston: The Federal Reserve Bank of Boston, 1970), p. 57.

increased approximately 40% from 1970 through 1972.[1] A 1973 study of Sixth District banks grouped all member banks into six categories based on the extent of market participation. Approximately 75% of the member banks fell into categories whose market participation conformed to that expected for small and medium sized banks. Banks categorized in the group whose extent of participation is most identifiable with small and medium sized banks rose from 52.4% in 1969 to 63.5% in 1972, with a high in 1971 of 66.5%. Banks classified in those groups reflecting little or no participation in the market fell from 26.8% in 1969 to 8.4% in 1970.[2] A 1974 study in the Eleventh District revealed that banks that had deposits of less than $10 million increased participation from 55% in 1970 to 80% in 1973. For this same period, banks whose deposits ranged from $10 million to $50 million increased their participation from 65% to 82%.[3] These results are typical of the trend in market participation that is being experienced throughout the country. Other intradistrict studies,

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[1]"Banking Developments," The Federal Reserve Bank of Chicago, Business Conditions, April 1973, p. 14.

[2]Arnold A. Dill, "Another Look at the Southeast's Fed Funds Market," The Federal Reserve Bank of Atlanta, Monthly Review 58 (August 1973): 127.

[3]Edward E. Veazey, "Market Expansion Aids Mobilization of Funds," The Federal Reserve Bank of Dallas, Business Review, January 1975, pp. 2-3.

available for review, are included in the bibliography.

The purpose of this inquiry is dichotomous in nature. Initially, it is desired that the model being tested will adequately explain the variations in the Federal Funds rate. Secondly, it is hoped that by testing the model in pre-defined time periods, the changes in market participation that have been evidenced in the previously documented regional studies can be empirically identified.

CHAPTER 2

REVIEW OF PREVIOUS STUDIES

An attempt to investigate the elements contributing to changing participation in the Federal Funds Market, with special emphasis on the response of the rate to these influences, was undertaken by Robert B. Platt in 1968.[1] He modified a study by Goldfeld and Kane[2] and constructed a model designed to explore three different aspects of the Federal Funds Market. First, he wanted to evaluate the importance of Federal Funds as an investment alternative in a bank's portfolio. Second, he wanted to empirically test the importance of eight large money market institutions, existing at that time, in the interaction of supply and demand of bank reserves, the commodity being traded. Finally, he wanted to identify the structural changes influencing the market during the course of his study.[3]

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[1]Robert B. Platt, "The Interest Rate On Federal Funds: An Empirical Approach," The Journal of Finance 25 (June 1970): 585-96.

[2]S.M. Goldfeld and Edward J. Kane, "The Determinants of Member Bank Borrowing: An Econometric Study," The Journal of Finance 21 (September 1966): 499-514.

[3]Platt, "The Interest Rate On Federal Funds," p. 585.

The work of Goldfeld and Kane explored the contribution of certain alternative sources and uses of bank reserves, on the propensity that a bank would borrow reserves. Platt algebraically restructured the model to allow it to determine the relative effect of these various elements on the Federal Funds rate itself. This restructured model he labeled the "reserve buffer model" because it was based on the change in non-borrowed reserves from week to week. He then further modified this model, by substituting actual levels of the variables for the weekly change in the variables. This revised model he entitled the "portfolio model."[1]

The basic form of the equations for these two models are described by the following notation:

$$rf = rf\ (R, rd, rs, Cl),$$

where,

rf = the interest rate on Federal Funds

R = reserve needs, in the aggregate

rd = the discount rate

rs = the interest rate on ninety day Treasury Bills

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[1] Ibid., p. 587.

Cl = the level of commercial and industrial loans, in the aggregate

This notation precisely describes the portfolio model. In the reserve buffer model, the changes in reserve needs and in commercial and industrial loans are substituted for the actual levels of these variables.[1]

The equations in this study were estimated using weekly data for the period 1960-1968.[2] The criteria that determined the specific periods for the regressions was the relationship of the Federal Funds rate to the Bank Discount Rate. Historically, it was thought that borrowings from the federal funds market, and borrowings from the discount window were perfect substitutes for each other. This would imply that the potential borrower would simply borrow from the source that would minimize the cost of borrowing. It then evolved that, due to the relative ease of borrowing from the Federal Funds market as compared to the cumbersome formality of the discount window, and the ability to avoid the regulatory scrutiny inherent in the process of borrowing from the discount window, banks were willing to pay a premium to borrow from the market rather than the discount window. The definition of Platt's time structure resulted from this metamorphesis.

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[1] Ibid., pp. 586-87.

[2] Ibid., p. 585.

During the entire time period of his study, the relationship between the Federal Funds rate and the discount rate fell into three unique periods. In the first period, from 1960 through mid-1962, the Federal Funds rate remained well below the discount rate, perhaps as a result of non-participation in the market. In the second period, from the middle of 1962 through the early part of 1966, the Federal Funds rate approached but would not exceed the discount rate. This apparent ceiling would indicate that these two sources of reserves were indeed perfect substitutes for one another. In the final period, from early 1966 through the end of 1968, the Federal Funds rate habitually exceeded the discount rate supporting the contention that banks were willing to pay a premium to borrow from the market.[1]

The dominant role of the New York City Banks in the volume of transactions effecting the Federal Funds market was very graphic during the time frame of Platt's study. This dominance caused him to hypothesize that the reserve needs of the New York City Banks were a primary determinant of the Federal Funds Rate.[2] To test this hypothesis, he included in his equation two variables designed to differentiate between reserve needs of New York City Banks,

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[1] Ibid., p. 589.

[2] Ibid., p. 588.

and other large banks outside the New York City market area. The results obtained supported his hypothesis. In both the reserve buffer model and the portfolio model the coefficient for the unborrowed reserves at New York City Banks had the hypothesized negative signs and significant t values, while the coefficients of the variables for banks outside the New York City area did not have correct signs in all cases and were shown to be insignificant.[1]

During the course of his study, a trend began to evolve in that participation in the market had changed to include more large accomodating banks outside the New York City area, and even smaller banks who had found the Federal Funds market an ideal outlet for excess reserves that otherwise would have been left as idle cash balances on deposit in the Federal Reserve System or at an upstream correspondent. To attempt to empirically identify this trend, the time span of this study was further divided into a number of sub-periods allowing for comparison of the coefficients to identify changes in significance over the years. From his results he was able to conclude that the dominance of the New York City Banks did not change in any real sense, but the contribution of banks outside of New York City did increase relative to their contribution in

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[1] Ibid., p. 591.

the earlier years.[1]

The final hypothesis tested was that reserve needs and loan demand were important determinants of the Federal Funds rate during the first and third regression periods when the Federal Funds rate was both below and above the Discount Rate but were relatively unimportant during the third period when it was equal to the Discount Rate. To test this, he defined the previously described sub-periods based on the relationships between the Federal Funds rate and the Discount Rate. These three periods were labeled "pre-ceiling", "ceiling", and "post-ceiling", to describe the prevailing relationship. The results of this test indicate that reserve needs as a determinant was much more significant during the pre-ceiling period. This confirmed the hypothesis. Loan demand, however, was shown to be more significant during the ceiling period indicating that as a source of reserves to support loan expansion, the Federal Funds market was considered more viable than the discount window.[2]

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[1]Ibid., p. 593.

[2]Ibid., p. 590.

CHAPTER 3

THE RESTRUCTURED MODEL

In attempting to accomplish the dual objectives of this study, as previously defined, Platt's model has been restructured to provide for increased stratification in the supply and demand variables; to present variables pertaining to the rate on ninety day Treasury Bills, and the Discount Rate, in terms relative to the Federal Funds rate; and finally, to include variables measuring the importance of open market activity and expectations, on the determination of the Federal Funds rate. The revised model in functional form is as follows:

FFR = FFR (RN, RO, RS, LN, LO, TB, DR, FOMC, EX)

where,

FFR = weekly average Federal Funds rate

RN = Surplus Reserves of New York City Banks

RO = Surplus Reserves of other large banks

RS = Surplus Reserves of small banks

LN = Loan volume, New York City Banks

LO = Loan volume, other large banks

TB = Average weekly Treasury Bill rate as a percentage of the weekly average Federal Funds rate

DR = Discount rate as a percentage of the average weekly Federal Funds rate

FOMC = the holdings by the Federal Reserve banks of U.S. Treasury securities, securities of other government agencies, and bankers acceptances

EX = the rate on long term U.S. Treasury securities, ninety days in the future, as a percentage of the current weekly average Federal Funds rate

The variables indicating the level of surplus reserves are included in the equation as a measure of the supply of Federal Funds to the market. The variable is further stratified to identify those reserves supplied by large banks in New York City, other large banks, and small banks. This separation is made to allow an observation of the coefficients over time, in an effort to identify the structural changes that have taken place in the market.

The variables indicating the level of loan volume are included in the equation as a measure of the demand for Federal Funds from the market. The primary purpose of the legal reserve limitation imposed on a bank is that it allows the regulatory authorities to maintain a constraint on credit. Since the Federal Funds market is the most readily accessible source for borrowed bank reserves, it is felt that the level of loans will serve as a measure of the demand for borrowed bank reserves, which can most easily be satisfied by borrowing from the Federal Funds market. As was the case with the supply variables, the division of this variable into two measures representing loan

demand for New York City banks, and loan demand for other large banks, was made to allow for comparisons over time in an effort to identify structural changes in the market.

The context of a portfolio approach to this inquiry would imply that the attractiveness of Federal Funds at any given time must be assessed relative to the existing alternative sources and uses of these surplus reserves. The variable reflecting the average ninety day Treasury Bill rate expressed as a percentage of the average weekly Federal Funds rate is designed to measure the attractiveness of the Federal Funds rate relative to an alternative investment vehicle, short term Treasury Bills. The variable is expressed as a ratio, relegating the individual movements in the two rates to a common index to allow the change to be measured in relative terms. The ninety day Treasury Bill was chosen as the most likely alternative investment because it is the money market instrument that most satisfied this need in a bank's portfolio prior to the advent and the increased utilization of the Federal Funds market. It is, therefore, considered to be the most likely alternative investment, over the course of this study, although, it is not identical in risk or maturity.

In contrast, the Federal Reserve Discount Rate, expressed as a percentage of the Federal Funds rate is designed to measure the attractiveness of the Federal Funds

market as a source of needed reserves relative to other avenues of relief. Prior to the widespread acceptance of the Federal Funds market, the Discount Window was the primary alternative source of reserves, consequently, the relationship between these two alternative costs of borrowing should provide a reasonable measure of the relative attractiveness of the market as a borrowing mechanism.

Over the course of this study, the Federal Open Market Committee has become increasingly more active in its attempt to counterbalance the growing monetary aggregates by the buying and selling of securities in the open market. In March, 1970, they chose as their immediate objective, the control of the Federal Funds rate by allowing it to fluctuate within a predefined range.[1] When the Federal Funds rate moved outside of these bands, they would move to either inject or drain reserves from the system, with the result being a controlled growth of the monetary aggregates that is consistent with established policy objectives.

The variable that measures the holdings of securities by the Federal Reserve system is an attempt to measure the

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[1]Paul Meek and Rudolf Thunberg, "Monetary Aggregates And Federal Reserve Open Market Operations," The Federal Reserve Bank of New York, Monthly Review 53 (April 1971): 82-83.

effects of Open Market intervention in a given period. These holdings consist of U.S. Treasury securities, federal agency securities, and bankers acceptances. An increase in these holdings would indicate an injection of reserves into the system. A decrease, conversely, would indicate a drain of reserves from the system.

Expectations play an important part in any portfolio decision. The inclusion in the model of an expectations variable is an attempt to measure the effects of expectations on the portfolio decision to stay short or to extend maturities, which, in turn, should have ramifications on the Federal Funds rate, which is the most liquid, short term, earning asset in a bank's portfolio.

The expectations variable is unique among the variables in the model in that it is an attempt to measure an intangible influence in the decision making process. The most ideal measurement of this influence would be the long term interest rate futures which accurately measure what the traders believe will be the position of interest rates at a given time in the future. Unfortunately, for the purposes of this study, this market has not been in existence long enough to employ it in the model that is now being tested. As a proxy, the long term rate on U.S. Treasury securities, ninety days in the future, expressed as a percentage of the current Federal Funds rate will be

used to measure this influence. Although it is the best avaliable proxy, it is imperfect in that there is an inherent assumption that in all cases the expectations were correct. This, of course, is invalid, but it is not considered to be fatal.

The equation resulting from this restructured model can be specified as follows, using the notation as previously defined:

$$FFR = A_1 + B_2RN + B_3RO + B_4RS + B_5LN + B_6LO + B_7TB + B_8DR + B_9FOMC + B_{10}EX + e.$$

The range of this study is from 1960 through 1977. To allow for interperiod comparisons, this time span was further divided into four unique periods. As one objective of this inquiry is to compare this modified equation to the equations estimated by Platt in his study, the first three time periods were, when possible, constructed to be comparable to the periods under comparison in his original study. The periods, defined, are from January 1960 through July 1962; from August 1962 through June 1966; from July 1966 through February 1970; and from March 1970 through December 1977.

The first period is identical to that used by Platt in his study. The second period was extended to July 1966 because of a heterogeneity in the continuity of the data (see Appendix A for a discussion of the scope and limitations of the data base). The third period was

extended beyond December, 1968, the termination of Platt's study, to March, 1970. The final period begins in March, 1970, because it was at this time that the Federal Open Market Committee began attempting to control the money aggregates with intervention dictated by the behavior of the Federal Funds rate. To update this line of inquiry, the termination date was chosen to be December, 1977.

The variables quantifying the level of surplus reserves in the banking system are in reality the supply constraints on the Federal Funds market. In this context, it would be expected that the signs of these variables would be negative, indicating that as surplus reserves become more abundant, the cost of these reserves should decline. Inversely, since the legal reserve limitations are imposed on the banking system as a check against credit, those variables quantifying the level of loan demand would serve as a measure of market demand for Federal Funds. If this relationship is true, the signs of these variables should be positive, indicating that as loan demand increases, the demand for borrowed reserves will also rise, thereby increasing the cost of these borrowed reserves.

The variable measuring the effects of the relationship between the Treasury Bill rate and the Federal Funds rate is designed to view the Federal Funds rate as it is related to an alternative use of surplus reserves. It is

expected therefore, that as the ratio of the Treasury Bill rate to the Federal Funds rate becomes increasingly larger, surplus reserves would be replaced in a bank's portfolio by holdings of U.S. Treasury Bills and, consequently, become unavailable to the Federal Funds market. As this happens, the supply of reserves to the market would be diminished and the cost of these funds should increase. The sign of this variable, therefore, should be positive.

The variable quantifying the relationship between the Discount Rate and the Federal Funds rate is designed to complement the preceeding variable in that it measures the Federal Funds rate relative to an alternative source of reserves. As the ratio of the Discount Rate to the Federal Funds rate becomes increasingly higher, potential borrowers, wishing to minimize their cost of borrowing, will rely on the Federal Funds market to satisfy their short term needs. Consequently, demand will increase and the cost of these reserves should rise as a result. The sign of this variable, therefore, will be positive.

The variable measuring the extent of Federal Open Market activity is thought to have an inverse relationship to the Federal Funds rate. Securities that are purchased by the Federal Reserve are paid for by deposits into the broker's accounts at commercial banks. The effect of this is that reserves are injected into the banking system which increases the supply of reserves and reduces the

cost of borrowing these reserves from the market. The sign of variable, therefore, should be negative.

The nature of the open market mechanism utilized since March, 1970 may render results that are somewhat unanticipated in that by only allowing the Federal Funds rate to fluctuate within a narrow range, a positive policy action will only be initiated when the rate is expected to fluctuate more than is desirable. A positive action in the open market will, then, result in little apparent change in the Federal Funds rate. The results in this case will be significant in the first three periods and not significant in the fourth period, although, in fact, it should be most significant during this period given its critical role in dictating open market activity. It is questionable, therefore, that the true effects of this stimulus can be identified in a regression analysis.

The final variable, attempting to measure the effects of expectations on the Federal Funds rate, is predicted to have an inverse relationship. If a bank is in a position where it is thought preferable to extend the average maturity of its portfolio and realize an increased yield on its investment, it would be desirable that this maneuver take place when the spread between short and long term interest is at a maximum, to render the fullest possible compensation for the sacrificed liquidity. If it

is believed, then, that long term rates in the future will be greater than long term rates today, relative to short term rates today, the probable action would be to stay short and wait for interest rates to reach the point of advantage that is anticipated. As the ratio of long term U.S. Treasury rates, ninety days in the future, to the Federal Funds rate today is increasing, then the decision to extend would most likely be postponed, which would serve to maintain the supply of reserves to the market, causing the rate to stabilize or decline.

To attempt to measure the significance of the coefficients estimated by the regressions, the t values of the coefficients, which measure the likelihood that the relationship between the dependent variable and the independent variable is important enough that it could not have been caused by chance alone, will be scrutinized in all cases to determine the relative importance of the results. This will be especially relevant in the attempt to empirically identify the changes in market participation, which will be measured by observing the t values for the stratified variables concerning supply and demand of reserves. In these cases, the expected results would be increasing significance in the later years in those variables pertaining to banks outside of New York City.

CHAPTER 4

RESULTS OF THE REGRESSION

Initially, the four equations were estimated using actual weekly data. These results can be seen in Table 3, Appendix B. The results were considered unacceptable due to the low Durbin-Watson statistics of 1.35, .65, .31, and .24 for the four equations respectively. In all cases this points to the existence of a significant amount of autocorrelation, and for this reason the values of the coefficients could not be accepted as accurate.

To correct the problem of autocorrelation, the parameters were recalculated using the first differences instead of actual data. The improved Durbin-Watson statistics of 2.53, 2.43, 2.26, and 2.06 demonstrate that the problem of autocorrelation has been successfully circumvented. The results of these regressions can be seen in Table 1.

The problem of autocorrelation caused a change in the structure of the regressions from the use of actual data to the use of weekly changes in the data. Since first differences actually measure the rate of change

TABLE 1

FIRST DIFFERENCES

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
RN	.000517	.000017	.000133	.000053
	(.4605)	(.1736)	(.8596)	(.9321)
	/.00112/	/.000098/	/.000155/	/.000057/
RO	-.001325	-.000157	.000165	.0000843
	(-1.5694)	(-1.2091)	(.9243)	(1.4112)
	/.000844/	/.00013/	/.000179/	/.0000597/
RS	.000738	.0000584	-.000148	.0000057
	(3.2059)	(2.69)	(-1.9474)	(.0361)
	/.000230/	/.0000217/	/.000076/	/.00016/
LN	-.1036	.00436	-.0348	-.0193
	(-.9559)	(.4019)	(-1.4234)	(-1.8372)
	/.1084/	/.0108/	/.0245/	/.0105/
LO	.1364	.00607	.03808	.0405
	(1.056)	(.5454)	(2.1172)	(4.0977)
	/.1291/	/.0111/	/.01799/	/.00989/
TB	-1.7476	-1.591	-1.515	-1.222
	(-3.6728)	(-6.6446)	(-3.1787)	(-5.2166)
	/.4758/	/.2394/	/.4767/	/.2344/
DR	2.2467	.0665	-2.802	-.1055
	(2.3394)	(-.4221)	(-4.5098)	(-.8859)
	/.9603/	/.1575/	/.6214/	/.1191/
FOMC	.2194	.000485	.07755	.000462
	(2.7885)	(.9627)	(3.9329)	(.3043)
	/.0787/	/.000504/	/.0197/	/.0015/
EX	-1.096	-1.356	-1.184	-2.912
	(-1.46)	(-5.8537)	(-2.0272)	(-13.4472)
	/.7506/	/.2317/	/.5841/	/.2166/
$\bar{R}^2$	.80	.71	.94	.65
DW	2.53	2.43	2.26	2.05

Legend: Coefficient (T-Value) / St. Dev. /

in a variable between time T and time T + 1,[1] the hypothesized signs of the variables, as were outlined in the previous chapter, need to be redefined to accomodate this change in formulation.

The relationship that must be considered in this redefinition is the effect of the rate of change of the independent variable (i.e. increasing or decreasing) on the rate of change of the dependent variable, regardless of direction. In the interest of brevity, the cause and effect relationship between the variables will be outlined in one direction only. There is no rationale to suspect that the converse example would change the hypothesis. The first set of variables, those measuring levels of surplus reserves, were originally hypothesized to have a negative sign. As the level of surplus reserves increase at an increasing rate, the Federal Funds rate should decrease at an increasing rate, consequently in this new context, the expected sign of these variables should be positive rather than negative.

The variables in the equation aggregating the level of loan demand were previously hypothesized to have a positive sign. As loans increase at an increasing rate, reserve needs should also increase at an increasing rate,

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[1]Michael J. Brennan, Preface to Econometrics (Cincinnati: South-Western Publishing Company, 1973), p. 361.

consequently, supply of reserves should be absorbed at an increasing rate and the cost of borrowing these reserves should increase at an increasing rate. The expected sign of this variable, then, remains positive.

The variable relating the ninety day Treasury Bill rate to the Federal Funds rate was initially hypothesized to have a positive sign. As this ratio increases at an increasing rate, funds should move from the Federal Funds market to the Treasury Bill market at an increasing rate. This would imply that the supply of funds to the Federal Funds market would be reduced at an increasing rate, and the cost of borrowing should increase at an increasing rate. The anticipated sign of the variable, then, remains positive.

The variable measuring the ratio of the discount rate to the Federal Funds rate was originally predicted to have a positive sign. As this ratio increases at an increasing rate, potential borrowers will shift from the discount window to the Federal Funds market at an increasing rate. Demand for reserves would, therefore, increase at an increasing rate and the cost of borrowing these reserves would also increase at an increasing rate. The expected sign of this variable remains positive.

The variable intended to measure the effects of Federal Reserve open market activity was initially hypothesized to have a negative sign. As the holdings of

securities by the Federal Reserve increases at an increasing rate, reserves are injected into the system at an increasing rate which have the effect of increasing the supply of funds to the market at an increasing rate and reducing the cost of these funds at an increasing rate. The expected sign of this variable also is positive.

The expectations variable was previously expected to have a negative sign. This variable is unique among the variables in that the result of a movement in the independent variable is a lack of movement in the dependent variable. If the ratio of long term bond rates in the future to the current Federal Funds rate is increasing at an increasing rate, the funds available to the market should decrease at a decreasing rate, consequently, the supply of these funds would either remain the same or decrease at a decreasing rate. The sign of this variable is expected to be negative.

To further test various combinations of variables in the regression equations, parameters were estimated for a number of different equations designed to satisfy the dual objectives of finding an equation that both adequately explains the fluctuations in the Federal Funds rate and identifies the shifts in market influences over time.

As can be seen in the results listed in Table 1, in a number of cases, the signs of the coefficients were not in accord with the previously defined hypotheses. As it was

thought that a possible cause of this was the apparent strength of the expectations variable and its effect on the coefficients of the other variables, the equations were reestimated with the expectations variable omitted. As can be seen in Table 4, in Appendix B, this revision had little discernable effect on the signs of the variables.

The next experiment was to consolidate the supply and demand variables into one variable representing each. The results of this computation can be seen in Table 5, Appendix B, using the following revisions in the notation:

R = Surplus Reserves of all reporting banks

L = Loan Volume of all reporting banks

It appeared to make a positive difference in regards to the signs of the supply and demand variables corresponding to the hypotheses, and in terms of an increase in the significance of these variables. The signs of the interest rate variables relating both the ninety day Treasury Bill rate and the discount rate to the Federal Funds rate did not correspond to the hypothesis in the majority of the cases. The Treasury Bill variable appeared to be highly significant, however, the discount rate variable did not.

To test the importance of the discount rate variable to the model, the immediately preceding formulation was reestimated eliminating the discount rate. These results can be seen in Table 2. The most noteworthy difference

was that the $\bar{R}^2$ did not fluctuate a significant amount in the reformulation, indicating that the relationships between the discount rate and the Federal Funds rate did not make a significant contribution to the explanations of the variations in the Federal Funds rate.

In these last two formulations, the consolidated supply and demand variables greatly aided the outcome of the regressions in corresponding to the hypotheses. In order to renew the attempt to empirically identify the trends in market participation, separate supply and demand equations were estimated to allow these market shifts to be identified. These results can be seen in Table 6 and 7 in Appendix B. While these results were not necessarily in accord with the stated hypothesis, it is felt that the model, as originally stated has been thoroughly tested, and any further restructuring is not warranted in this study.

TABLE 2

CONSOLIDATED SUPPLY AND DEMAND WITHOUT DISCOUNT VARIABLE

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
R	.00029	.00004	-.0000004	.00005
	(1.5652)	(2.1627)	(-.007)	(1.8219)
	/.00018/	/.00002/	/.00006/	/.00003/
L	.012	.0041	.01	.01
	(.2735)	(1.2774)	(1.1033)	(1.8917)
	/.0439/	/.0032/	/.0098/	/.0055/
TB	-2.035	-1.638	-2.461	-1.215
	(-4.4094)	(-7.0497)	(-5.2257)	(-5.1508)
	/.461/	/.232/	/.470/	/.2359/
FOMC	.1766	.0005	.0846	.002
	(2.2267)	(1.0002)	(4.0952)	(1.368)
	/.0793/	/.0005/	/.0206/	/.00146/
EX	.7354	-1.448	-2.434	-3.052
	(2.7005)	(-7.4724)	(-5.0007)	(-14.7906)
	/.2723/	/.1938/	/.4867/	/.2063/
$\bar{R}^2$	.69	.94	.78	.64
DW	2.61	2.45	2.23	2.06

Legend: Coefficient
(T-Value)
/ St. Dev./

CHAPTER 5

ANALYSIS AND SUMMARY

The results obtained in the estimation of these equations were generally consistent with the expectations outlined previously and are considered satisfactory, however, given the revised hypotheses on which this study was structured, a few of the results were unexpected and require justification. The variable reflecting the ratio between the Treasury Bill rate and the Federal Funds rate was originally hypothesized to have a coefficient value that was positive, supporting the contention that as the spread between the rate of return on these two instruments widens at an increasing rate, money would flow from the Federal Funds market to the Treasury Bill market at an increasing rate and have the resulting effect of diminishing supply to the Federal Funds market and cause the cost of borrowing from this market to increase at an increasing rate. As can be seen in Table 2, the sign of the coefficient of this variable was negative in all cases, and highly significant as was evidenced by the t values. No acceptable explanation can be suggested.

It was also not expected that the ratio of the

Treasury Bill rate to the Federal Funds rate would be as significant as it is shown to be, in all four periods. It was originally hypothesized that for institutional employment, these two markets were not perfect substitutes, primarily due to differences in maturity between these two instruments. The high significance of the variable will not support this contention. It appears that the placement of funds is highly sensitive to the differences in these two rates, consequently, the spread between the ninety day Treasury Bill rate and the Federal Funds rate is a significant determinant of the supply of funds available to the Federal Funds market.

The coefficients of the variable reflecting the effect of open market activity on the Federal Funds rate confirmed the hypotheses in that the signs of the variable were positive as anticipated, and the variable was not significant in the fourth period. In the first and the third period, the variable was shown to be significant, as expected, however, in the second period it was not. To justify these results it must be concluded that although the Federal Funds rate can be effectively controlled by the intervention of the central bank in the open market, it may be that this influence, although very strong, can not be effectively identified in an empirical analysis because if the intervention is successful, the

Federal Funds rate will remain stable. Thus, a change in the independent variable will result in little change in the dependent variable.

The lack of significance in the second period did not conform to the initial expectations. It was not until March, 1970 that the Federal Reserve began its attempt to control the monetary aggregates by monitoring the Federal Funds rate in the belief that it will effectively indicate an undesirable change in the rate of growth. It can only be concluded, therefore, that some action of the Federal Reserve, in the second period, simulated the policy actions of the fourth period although the Federal Funds rate was not of immediate concern. This is a contention that warrants additional research.

The estimates measuring the effects of the expectations variable were surprising in that it was not expected that this variable would be as significant as it turned out to be. With the exception of the first period, the results confirmed the initial hypothesis that an expected rise in long term rates in the future would result in funds remaining in the Federal Funds market that otherwise might have been moved to a higher yielding instrument by extending the maturity of the investment. The limitations of this variable, that being the implication of perfect expectations may lead one to question the extraordinary significance reflected in the t values.

The variables reflecting the supply and demand of reserves corresponded to the hypothesis in all cases except one, that being surplus reserves in the third period. In trying to empirically identify the changes in market participation over the course of this study, the results of the individual supply and demand equations must be scrutinized. The t values of these coefficients did not confirm the changes in significance that were expected. It was expected that the influence of the banks outside New York City would prove to be greater in the later years than in the earlier years. There is some support for this on the demand side, but the results of the supply measures appear to be opposite to what was expected.

There is no explanation for this that is consistent with the facts. It is possible that while the volume of activity has grown in absolute terms, the activity in New York City still dominates the market to such an extent that it overwhelms any contributions by other sectors and, hence, distorts the results. Another possibility is that due to interaction between these market stratifications, it is impossible to get a valid measurement that is unique to each class of banks.

The effectiveness of the model in explaining the changes in the Federal Funds rate can best be illustrated by reviewing the calculated adjusted coefficient of determination ($\bar{R}^2$) of the equation for each period. As

can be seen in Table 2, the figures for the four periods were .69, .94, .78, and .64 respectively. It is interesting to compare these to those figures calculated from Platt's equations for his portfolio model, which are roughly comparable to the first three figures listed above. He obtained figures of .74, .92, and .78 respectively.[1] A comparison of these figures would indicate that in terms of the ability to explain the variation in the Federal Funds rate, these two models are about equal. The Durbin-Watson's for the revised model, however, are much more acceptable and for this reason it would appear to be preferable.

An interesting observation is the fall in the $\bar{R}^2$ in the fourth period. A possible reason for this is that the intervention by the central bank in the open market, which defies identification in the equations, might serve to mitigate the relative contribution of the other variables toward the effectiveness of the model in its ability to explain the fluctuation in the rate.

The limitations of this study dicate that several of the observations emanating from these results must be left without the advantage of full exploration. The variable reflecting the relationship between the ninety

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[1]Platt, "The Interest Rate On Federal Funds: An Empirical Approach," p. 592.

day Treasury Bill rate and the Federal Funds rate leaves an open field for investigation. An attempt should be made to more precisely identify the causes of the apparent rigidity that was shown to exist in the intermarket flow of funds. This would necessitate an in depth investigation into the comparability of the qualities of both Treasury Bills and Federal Funds as investment alternatives in an institution's portfolio. An analysis should then be made of the participants in these markets with the emphasis on investment objectives and the volume of participation. Finally, the effects of these considerations on the supply of funds to the various markets can be analyzed to identify the implied rigidity.

Another area that merits attention is the inability to empirically identify the influence of open market activity on the fluctuations in the Federal Funds rate. That the influence is indeed strong is very evident to any student who has observed the market since 1970. Since there is no doubt that this control is real, it would seem that a test could be structured that would be successful in empirically identifying it.

Finally, the unexpected strength of the expectations variable in the model makes this a fertile field for further investigation. As was previously mentioned, this variable suffered from a severe limitation due to the

inherent implication that in all cases the expectations were correct. This could not be resolved at the time that this study was completed. In the near future, however, the interest rate futures market will provide an accurate measure of expectations that has no relation to the actual future market performance. When this market has been in existence long enough to provide an acceptable data base, this study should be updated to see if the strength of the expectations variable remains consistent.

As the trend towards increased attention to money management continues, it is probable that the entire money market will be dynamic in its flexibility to adapt to the needs of its customer base. As the Federal Funds market is the pulse of the money market, it follows that as the money market continues to broaden, the elements that will effect the Federal Funds market will become more varied and complex. An acute understanding of the Federal Funds market and those factors that influence it is critical in laying the foundation for analyzing the changes to come. This study, it is hoped, has made a contribution in that direction.

APPENDIX A

SCOPE AND LIMITATIONS OF THE DATA BASE

Prior to transforming the variables into final form, ten data sets were required to test the model. Due to the large number of observations comprising the time series, it was difficult, in some cases, to find consistent data that would not distort the parameters estimated by the regression as a result of a lack of homogeneity. The purpose of this appendix is to review the types of data collected, and explain any inconsistencies that could not be avoided.

The Federal Funds rate was computed two different ways over the course of this study. Prior to the statement week ending July 25, 1973, the rate used to represent the actual average rate was the "effective" rate on Federal Funds calculated by the Federal Reserve Bank of New York. This rate is calculated from data submitted daily by active money market participants. It represents the rate that was in effect when the majority of the transactions occured.[1]

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[1]Board of Governors of The Federal Reserve System, Banking and Monetary Statistics 1941-1970 (Washington D.C.: Board of Governors of the Federal Reserve System, 1976), p. 640.

Beginning with the statement week of July 25, 1973 through the most recent data available, the reported Federal Funds rate was a weighted average obtained by averaging the number of transactions that were consummated at different rates, and weighting these transactions by the volume of reserves traded.[1]

The data for the Federal Funds rate from 1965 through 1977 was obtained from the Federal Reserve Bulletins covering the respective periods. The data prior to 1965 was obtained from Banking and Monetary Statistics 1941-1970.[2] It is felt that both of these methods of representing the Federal Funds rate are the best available estimates for the periods for which they were utilized. Any unavoidable inconsistencies will be slight, and will have little discernable effect on the estimation of the regression parameters.

The variable used to reflect the reserve position of the banking system over the period of the study is the "excess reserve" figure in the "Reserves and Borrowings of Member Banks" table reported in the monthly Federal Reserve Bulletin. This particular report was chosen because it allowed figures to be constructed which

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[1]Federal Reserve Bulletin 59 (August 1973): A33, (see footnote 3).

[2]Board of Governors of the Federal Reserve System, Banking and Monetary Statistics, pp. 690-92.

represent New York City banks, other large banks, and small banks.

In July 1972, the Board of Governors altered Regulation J, having to do with the collection of checks, and Regulation D, having to do with reserve requirements. Prior to this change the categories entitled "large banks" and "all others" were reported as "reserve city" and "country" banks. The Federal Reserve timed the change to occur when there was a normal seasonal expansion in reserve needs. This, reinforced by the use of monetary policy, mitigated the effects of any excess reserves generated by this change. At this time, Regulation D was ammended to base reserve requirements on the size of deposits rather than geographic location. This necessitated the previously described change in the category titles. The series, however, remains continuous over time.[1]

No attempt was made to net out the effects of changes in the reserve requirements. The rationale behind this is that a bank's excess reserves are determined by the reserve requirement that is in effect at a given point in time. These excess reserves constitute the supply of Federal Funds available to the market. It would, therefore, be inconsistent to regress adjusted excess reserves against

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[1]"Recent Regulatory Changes in Reserve Requirements and Check Collections," Federal Reserve Bulletin 58 (July 1972): 626-30.

an unadjusted Federal Funds Rate.

The data reflecting loan volume of large commercial banks was taken from the "Weekly Condition Report of Large Commercial Banks" which is published in the Federal Reserve Bulletin. Prior to the week ending July 6, 1966, the report took into consideration data submitted by only member banks. At this time the series was revised to include all commercial banks with deposits in excess of $100 million, regardless of member bank status. Continuous data, therefore, was unavailable over the entire period under study. To mitigate the effects of the heterogenity, the second of the four time periods under study was extended through the week ending June 29, 1966. With this modification, all the figures compiled are felt to be homogeneous within the period that they are regressed. Interperiod comparisons are still considered to be valid because Federal Reserve affiliation is not a condition that is being tested in the model.

As different banks are added to, or deleted from the pool of banks aggregated in this report, inconsistencies may be inherent in the figures. A system has been devised where these figures are adjusted at year end to reflect these changes.[1] It is felt that these adjustments are not

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[1] "Revision of Weekly Reporting Member Bank Series," Federal Reserve Bulletin 52 (August 1966): 1137-40.

of significant magnitude to distort the parameters estimated by the regression.

The yields reported for the ninety day Treasury Bill rate were obtained from the monthly Federal Reserve Bulletins. The yields reported are obtained from closing bid prices supplied by the government securities dealers to the Federal Reserve Bank of New York. These rates are reported as a discount rate rather than an equivalent bond yield.[1]

The yields on U.S. Government securities are reported for a week ending on Friday. The Federal Funds rate and all the data emanating from aggregated bank statements are reported for a week ending Wednesday. These figures, therefore, are not identically comparable. To mitigate any inconsistencies resulting from this, the Treasury Bill rates reported for the week ending on a given Friday were regressed against the Federal Funds rate and statement data reported for the week ending the following Wednesday. The rationale behind this manipulation is that while a comparison based on a simultaneous market mechanism was not readily available, it would be valid to assume that the previous knowledge of the Treasury Bill rate might, in itself, have an effect on the Federal Funds rate. This

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[1]Board of Governors of the Federal Reserve System, Banking and Monetary Statistics, p. 641.

avoids a situation where the Federal Funds rate would be regressed against a Treasury Bill rate that had not yet been entirely determined. There were no apparent inconsistencies in the data over time.

Figures for the Federal Reserve Bank of New York discount rate are reported in the monthly Federal Reserve Bulletins. Changes in these figures are reflected in the statement week during which they occured. As this is a declared rate, as opposed to a market rate, there are no inconsistencies in the data.

To establish a measure of Federal Reserve open market activity, data reflecting the holdings of U.S. Treasury, and government agency securities, and bankers acceptances, by the Federal Reserve system were compiled. These figures were obtained from the "Consolidated Statement of Condition" of the twelve federal reserve banks, reported in the monthly Federal Reserve Bulletin. Since this variable is reported as a gross figure, and there were no announced changes in the reporting mechanism, there are no apparent inconsistencies in this data.

To assess the effects of expectations in the model, a leading variable representing long term government bond rates was employed. The series used for this proxy was the U.S. Government long term bond series. Yields in this series are computed daily from closing bid prices. For

bonds selling at or below par, the yields are computed to maturity. For bonds trading above par, the yields are computed to the first call date. Since April 1953, this series includes bonds with maturities of ten years or more, however, the number of bonds employed in the calculation at any given time may vary.[1] Despite changes in the method of computation necessitated by time and movements in the market, this series is felt to be consistent over time.

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[1] Ibid., p. 648.

APPENDIX B

SUPPLEMENTARY TABLES

TABLE 3

ACTUAL DATA

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
RN	.000686	-.0019	.00016	.0004136
	(.412)	(-3.5369)	(.3356)	(.5452)
	/.0016/	/.000539/	/.000479/	/.000758/
RO	-.0029	-.000496	.00068	-.00188
	(-2.2938)	(-.685)	(1.0687)	(-2.467)
	/.00126/	/.000725/	/.000636/	/.000765/
RS	-.000121	.00066	-.000056	.00511
	(.411)	(4.9967)	(-.2267)	(4.66)
	/.00029/	/.000132/	/.000251/	/.00109/
LN	.2465	.07124	.0717	-.1185
	(3.057)	(3.1859)	(1.3696)	(-5.47)
	/.0806/	/.0223/	/.0523/	/.0216/
LO	-.0473	.03078	.0701	.0878
	(-1.159)	(3.0916)	(3.78)	(10.782)
	/.0408/	/.00995/	/.0185/	/.00814/
TB	.5158	-.01472	.4204	6.674
	(2.05)	(-.0302)	(1.076)	(10.1338)
	/.2515/	/.4871/	/.3907/	/.6586/
DR	3.844	-.0311	-4.937	3.7537
	(9.731)	(-.0745)	(-9.865)	(4.618)
	/.395/	/.4188/	/.5004/	/.8128/
FOMC	.0577	.00057	.0192	-.0451
	(.943)	(.1924)	(1.03)	(-4.27)
	/.06125/	/.00296/	/.0187/	/.0105/
EX	-3.755	.3798	-1.747	-8.666
	(-14.4587)	(-1.899)	(6.15)	(-16.0421)
	/.2597/	/.2000/	/.2839/	/.5402/
$\bar{R}^2$	.87	.92	.95	.71
DW	1.35	.65	.31	.24

Legend: Coefficient (T-Value) / St. Dev./

TABLE 4

FIRST DIFFERENCES WITHOUT EXPECTATIONS

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
RN	.000574	.000048	.00013	.0000111
	(.5092)	(.4585)	(.8311)	(.1612)
	/.001127/	/.000105/	/.000156/	/.000068/
RO	-.001228	-.00023	.000124	.00011
	(-1.4517)	(-1.6496)	(.6930)	(1.5414)
	/.000846/	/.00014/	/.000179/	/.0000718/
RS	.000706	.0000546	-.000138	.0000593
	(3.0661)	(2.3269)	(-1.805)	(.3076)
	/.00023/	/.000023/	/.0000765/	/.000192/
LN	-.11513	-.002643	-.03584	-.02235
	(-1.0600)	(-.2266)	(-1.4501)	(1.7594)
	/.1086/	/.011668/	/.024722/	/.0127/
LO	.13025	.01251	.03623	.05738
	(1.0044)	(1.0436)	(1.9997)	(4.8584)
	/.12969/	/.01199/	/.01812/	/.01181/
TB	-1.9073	-2.6138	-1.9374	-3.1411
	(-4.0999)	(-14.7533)	(-4.4798)	(-14.0247)
	/.4652/	/.1771/	/.4324/	/.2239/
DR	.9381	-.55307	-3.5544	-.62675
	(2.6910)	(-3.8180)	(-7.0661)	(-4.6208)
	/.3486/	/.1448/	/.5030/	/.1356/
FOMC	.21188	.000338	.07837	.000643
	(2.6858)	(.6215)	(3.9416)	(.3523)
	/.07889/	/.000545/	/-.01988/	/.00182/
$\bar{R}^2$	.71	.94	.80	.50
DW	2.51	1.97	2.19	1.73

Legend: Coefficient (T-Value) / St. Dev./

TABLE 5

CONSOLIDATED SUPPLY AND DEMAND WITH DISCOUNT VARIABLE

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
R	.00028	.00004	-.00002	.00005
	(1.5764)	(2.0853)	(-.4479)	(1.8684)
	/.00018/	/.00002/	/.00006/	/.00003/
L	.02266	.00409	.0082	.0104
	(.517)	(1.2685)	(.87)	(1.9026)
	/.04384/	/.003/	/.009/	/.0055/
TB	-2.195	-1.621	-1.754	-1.191
	(-4.7336)	(-6.8947)	(-3.6283)	(-5.0199)
	/.4637/	/.2351/	/.4835/	/.2372/
DR	1.945	-.0861	-2.61	-.1172
	(1.9686)	(-.5467)	(-4.1118)	(-.9927)
	/.9881/	/.1576/	/.6349/	/.118/
FOMC	.1736	.0005	.0821	.002
	(2.213)	(1.0232)	(4.1422)	(1.4122)
	/.07846/	/.0005/	/.0198/	/.00146/
EX	-.0668	-1.38	-.0934	-2.982
	(-.8771)	(-5.982)	(-1.5779)	(-13.6739)
	/.7625/	/.23/	/.5925/	/.2181/
$\bar{R}^2$	.70	.94	.79	.64
DW	2.61	2.44	2.27	2.06

Legend: Coefficient
(T-Value)
/ St. Dev./

TABLE 6

SUPPLY SIDE

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
RN	-.0017	.00008	.0002	.0002
	(-1.1426)	(.2546)	(.6210)	(3.1373)
	/.00157/	/.0003/	/.0003/	/.00009/
RO	-.00346	-.0022	.0002	.0002
	(-3.0025)	(-5.1779)	(.4766)	(2.746)
	/.00115/	/.0004/	/.0003/	/.00009/
RS	.00131	.0004	.0006	.000003
	(4.2201)	(6.4689)	(4.3248)	(.0166)
	/.0003/	/.00007/	/.0001/	/.00024/
$\bar{R}^2$	.36	.32	.08	.05
DW	2.33	2.74	2.45	2.11

Legend: Coefficient
(T-Value)
/ St. Dev./

TABLE 7

DEMAND SIDE

Variable	60 thru 62	62 thru 66	66 thru 70	70 thru 77
LN	.014	.1132	-.052	-.0376
	(.0742)	(2.5925)	(-.0973)	(-2.4433)
	/.1892/	/.0436/	/.0542/	/.0154/
LO	.274	-.0096	.0477	.0821
	(1.184)	(-.2177)	(1.1926)	(5.2643)
	/.2314/	/.0453/	/.04/	/.0156/
$\bar{R}^2$	.02	.075	.001	.061
DW	2.66	2.95	2.61	2.20

Legend: Coefficient
(T-Value)
/ St. Dev./

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