FEDERAL RESERVE POLICIES AND VARIABILITY OF THE MONEY SUPPLY

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OF THE MONEY SUPPLY

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CHAPTER I

PURPOSES OF ANALYSIS

Introduction

It is generally agreed that changes in the supply of money are an important determinant of short-run changes in economic activity and prices. The degree to which money matters, and the relevant channels through which money affects the economy are, however, still debated. Studies of the interrelationship between money and economic activity can be divided into at least two classes; first, studies concerned primarily with the secular and cyclical covariation of movements in money, economic activity and prices, such as those by Phillip Cagan, and Milton Friedman and Anna Schwartz;[1] and secondly, those concerned with determining the economic consequences of short-run variability or instability of the money supply, for example, studies by Leonall Andersen and Denis Karnosky, James Pierce and Thomas Thomson, Milton Friedman

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[1]Phillip Cagan, Determinants and Effects of Changes in the Stock of Money, 1875-1960 (New York: Columbia University Press, 1965); Milton Friedman and Anna J. Schwartz, A Monetary History of the United States 1867-1960 (Princeton, N.J.: Princeton University Press, 1963); Milton Friedman and Anna J. Schwartz, "Money and Business Cycles," in The Optimum Quantity of Money and Other Essays, ed. Milton Friedman (Chicago: Adline Publishing Company, 1969).

and Edward Gramlich.[2] It is with fluctuations in the money supply of the latter type that this thesis is primarily concerned.

Andersen and Karnosky, utilizing the St. Louis Model, conducted simulation experiments designed to determine the effects on output of increased variability in the rate of growth of the money supply about trend. Starting from an initial equilibrium in which output is growing at its trend rate, they found that a one percentage point deviation in the quarterly rate of change in the money supply, maintained for as little as two quarters, has a substantial impact on the growth of output. And, if the initial deviation in the rate of growth in money is offset by an opposite deviation, variations in output will be even greater.

Pierce and Thomson, also utilizing the St. Louis Model, attempted to determine the effects on the level of GNP of "erratic" movements in the money supply. They ran a control simulation for two years in which the rate of growth of the money supply was kept at a constant six percent. From this simulation they obtained control values for GNP, real GNP and other relevant variables. They then ran a series of additional simulations in which the rate of growth of the money supply was allowed to fluctuate for various time periods. They found that

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[2]Leonall C. Andersen and Denis S. Karnosky, "The Appropriate Time Frame for Controlling Monetary Aggregates: The St. Louis Evidence." Controlling Monetary Aggregates II: The Implementation (Boston: Federal Reserve Bank of Boston, 1972); James L. Pierce and Thomas D. Thomson, "Some Issues in Controlling the Stock of Money," Controlling Monetary Aggregates II: The Implementation (Boston: Federal Reserve Bank of Boston, 1972); Milton Friedman, "The Effects of a Full Employment Policy on Economic Stability: A Formal Analysis," in Essays in Positive Economics, ed. Milton Friedman (Chicago: The University of Chicago Press, 1953); E. M. Gramlich, "The Usefulness of Monetary and Fiscal Policy as Discretionary Stabilization Tools," Journal of Money, Credit and Banking 3 (May 1971): 506-32.

when the money supply is allowed to increase at a higher than trend rate of growth for three or more quarters and then increase at a lower than trend rate for three or more quarters "the absolute values of output, prices and employment vary substantially from the values of the variables in the control simulation."[3]

They also conclude that "the money stock can wander off path for up to two consecutive quarters without materially effecting the expected impact upon the economy."[4] This conclusion was derived from a comparison of the control and solution simulation results in which the latter was determined by allowing the money supply to increase for two quarters at a rate of ten percent, then increase for two quarters at a rate of two percent, and finally increase for four quarters at a rate of six percent. The results of those simulations for real output are reproduced in Table I.

Whether or not the solution values are substantially different from the control values seems to be a matter of interpretation. It does appear, however, that even a two quarter deviation of the rate of growth of the money supply from trend induces a certain amount of variability in the behavior of real output. An alternative way of presenting the foregoing simulation results is to show the effects of the variability of the money supply on the rate of growth of real output. These results are presented in Table II. Here the effects of the increased variability of the money supply may be seen more clearly.

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[3]Pierce and Thomson, "Some Issues in Controlling the Stock of Money," p. 131.

[4]Pierce and Thomson, "Some Issues in Controlling the Stock of Money," p. 131.

TABLE I

CONTROL AND SOLUTION VALUES FOR REAL GNP,
BILLIONS OF DOLLARS

	Quarters							
	1972				1973			
	I	II	III	IV	I	II	III	IV
Control (Steady 6% Money Growth)	753.3	757.1	762.4	769.8	778.3	787.4	797.0	807.1
Solution (10,10,2,2,6)	755.0	762.7	770.3	776.2	781.0	786.7	794.9	804.8
Solution minus Control	1.7	5.6	7.9	6.9	2.7	-.7	-2.1	-2.3

Source: James L. Pierce and Thomas D. Thomson, "Some Issues in Controlling the Stock of Money," Controlling Monetary Aggregates II: The Implementation (Boston: Federal Reserve Bank of Boston, 1972), p. 134.

TABLE II

RATES OF GROWTH OF REAL GNP

	Percentage Change from Previous Quarter						
	1972			1973			
	II	III	IV	I	II	III	IV
Control (Steady 6% Money Growth)	2.02	2.80	3.88	4.42	4.68	4.88	5.07
Solution (10,10,2,2,6)	4.08	3.99	3.06	2.47	2.92	4.17	4.98

(This statement is with reference to the last five rates of change in which the change from ten percent to two percent begins to affect economic activity.)

Both Friedman and Gramlich found that due to the long and variable outside lags of monetary policy, it is quite possible that countercyclical discretionary monetary policy might be destabilizing rather than stabilizing. For this reason Friedman argues that monetary policy, as measured by the rate of change in the money supply, should be determined by the long-run growth of the economy; the rate of growth of the money supply should be constant.

A common result of the four foregoing studies is that under certain initial conditions, a sufficiently large increase in the variability of the money supply leads to measurable instability in economic activity.

Money Supply Variability, 1952-1973

Data for the period 1952-1973 show a substantial increase in the variability of the monthly rate of change of the money supply during the latter half of the 1960's and early 1970's. In Figure 1 the 60-month moving variance of the rate of change in the money supply for this period is illustrated.[5,6] Analysis of these data indicates three

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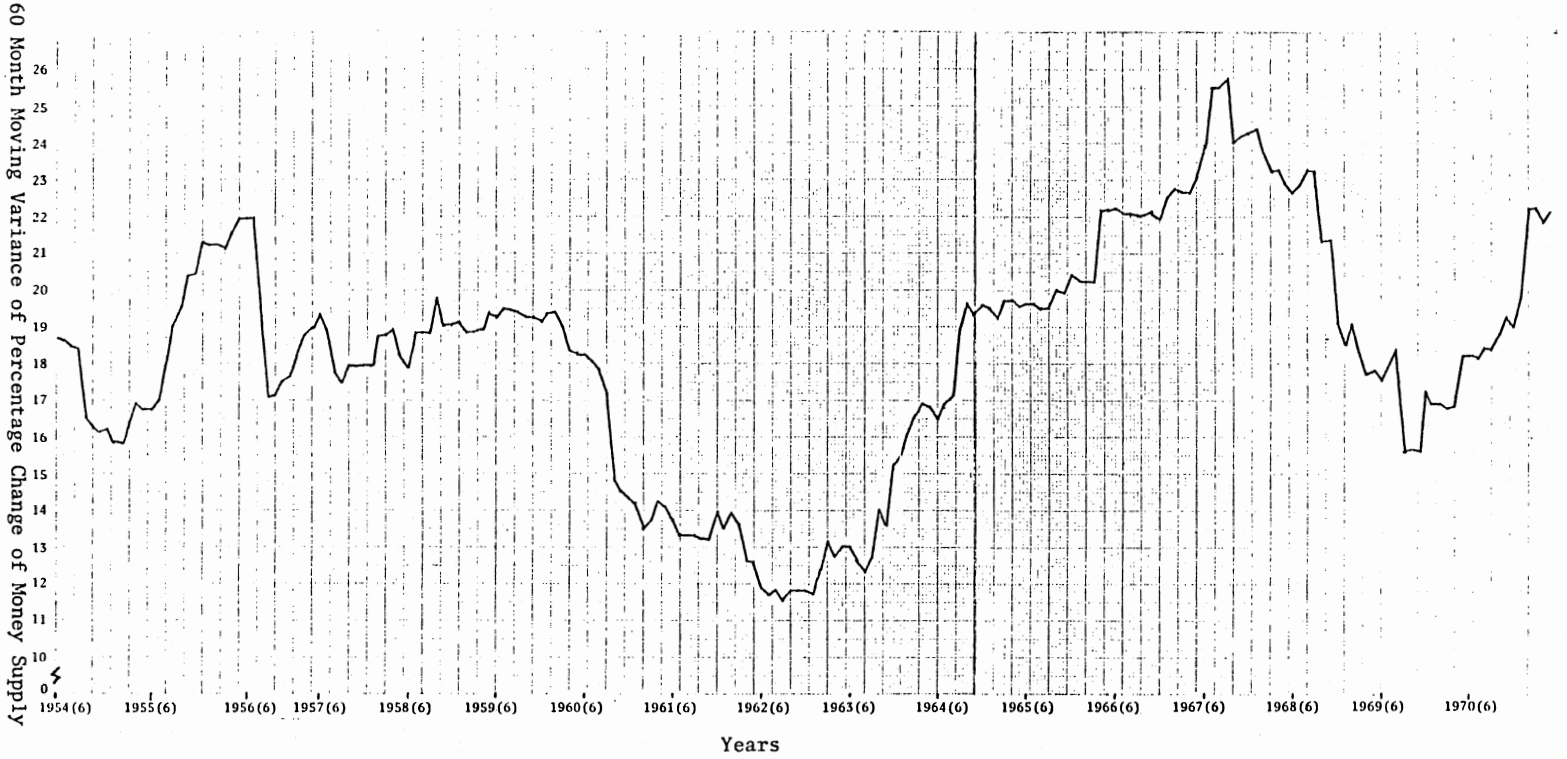
[5]The 60-month moving variance was computed as follows. The logarithmic first differences of the money supply were computed, i.e., $\ln M_t - \ln M_{t-1}$, where M_t is the money supply in month t and M_{t-1} is the money supply in month t-1. These are estimates of the monthly rates of change in the money supply. The first 60 rates of change were then utilized to compute the initial variance dated 1954(6). Then, the initial monthly rate of change 1952(2)-1952(1) was dropped and one 1957(2)-1957(1) was added and the variance was computed for the resulting 60 rates of change and dated 1954(7); and so on. As such, the variances were dated at the mid-point of the computation period.



Source: Money figures are seasonally adjusted figures based upon data taken from various issues of the Federal Reserve Bulletin. The seasonal adjustment procedure utilized is described in Chapter III of this text. Computation of the moving variance of percentage changes is described in footnote 5, p. 5.

Figure 1. Sixty Month Moving Variance of Percentage Change of Money Supply, SA, Annual Rates, 1952-1973

discernible step levels of variation; a moderate level of variability for the period dated 1954(6) through 1960(6) with an average variance of 18.71; a period of lesser variability, period dated 1960(7) through 1965(6) with an average variance of 14.81; and a period of relatively high variability, period dated 1965(7) through 1971(5) with an average variance of 20.70. It is interesting to note the rising level of variation for the period dated 1969(12) through 1971(5). This is inclusive of the years 1970 through 1973; a period in which the Federal Reserve was working under the regime of its announced policy to place greater emphasis on monetary aggregates as targets of monetary policy.

Analysis of the quarterly data reveals a somewhat similar pattern. In Figure 2 the 20-quarter moving variance of the rate of change in the money supply is illustrated. It is computed and dated utilizing a procedure similar to that used for the monthly data as explained in footnote 5. The average variance during the period dated 1954(2) through 1960(2) was 5.53; 5.32 for the period dated 1960(3) through 1965(2); and 6.58 for the period dated 1965(3) through 1971(1). It should be noted, however, unlike the monthly series variability of the quarterly rates of change in the money supply declined during

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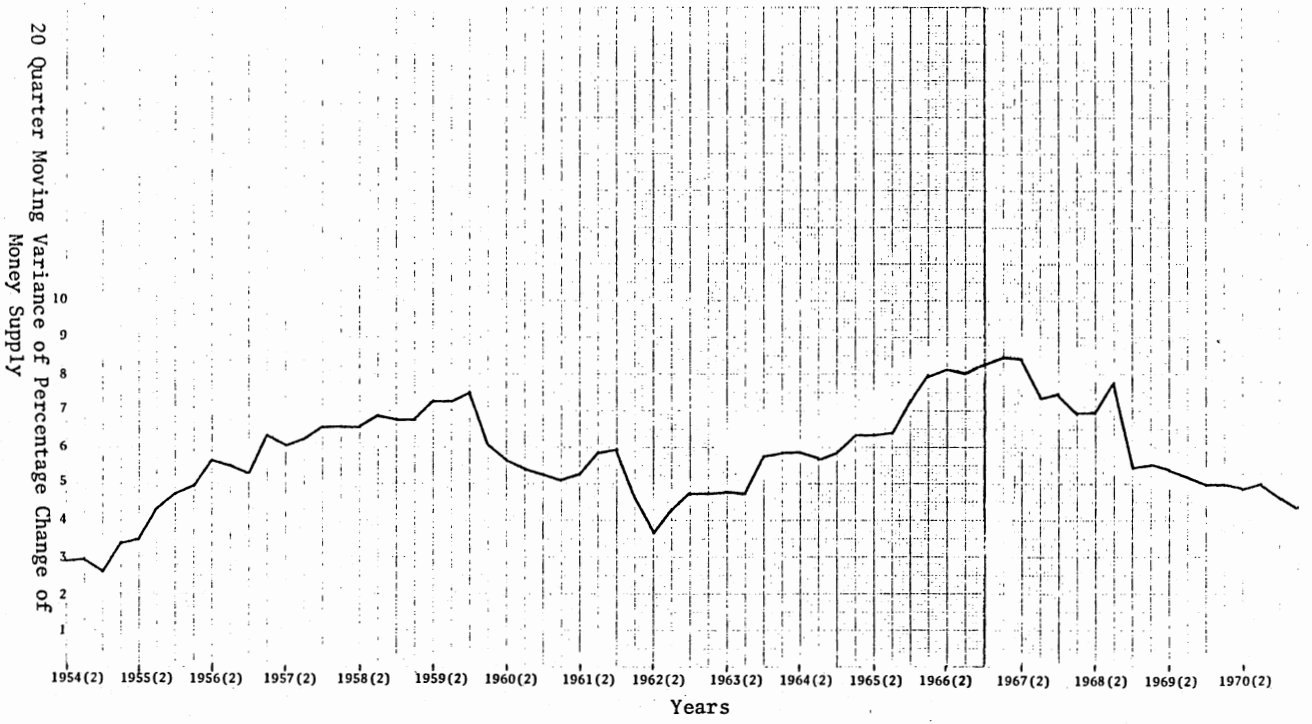
[6]Other time periods were experimented with and their patterns were similar to those presented in this section. It should be noted, however, that the five-year moving variance series exhibited less variability than did moving variance series for shorter time periods. Figures for annual variances of monthly rates of change in the money supply are presented in Appendix A.



Source: Money figures are seasonally adjusted figures based upon data taken from various issues of the Federal Reserve Bulletin. The seasonal adjustment procedure utilized is described in Chapter III of this text. Computation of the quarterly moving variance of percentage changes is described in this section.

Figure 2. Twenty Quarter Moving Variance of Percentage Change of Money Supply, SA, Annual Rates, 1952-1973

the latter years of the analysis.[7] Nonetheless, the average level of variability during the second half of the 1960's was substantially higher than in the earlier period.

A variety of reasons has been given for this marked increase in the variability of the money supply during the period 1966 through 1973. In the first instance, the Federal Reserve has enacted policies which have, some content, increased the variability of the money supply expansion multiplier, and hence the supply of money. These policies include: more frequent changes in reserve requirements, splintering of reserve requirements, introduction of lagged reserve requirements in 1968, and allowance for Regulation Q to become effective.[8] Secondly, Federal Reserve monetary policy through open market operations and discount rate changes has become more variable since 1966.[9]

Purposes of Study

The primary purpose of this thesis is to investigate the sources of the recent increase in the variability of the money supply. This

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[7]An examination of the annual variances of the quarterly rates of change in the money supply, as presented in Appendix A, reveals that the 20-quarter moving variance series conceals the higher than average annual variance of the money supply during both 1969 and 1971.

[8]For example see, Albert E. Burger, Lionel Kalish III, and Christopher T. Babb, "Money Stock Control and Its Implications for Monetary Policy," Federal Reserve Bank of St. Louis Review 53 (October 1971): 11; Peter A. Frost, "Short-Run Fluctuations in the Money Multiplier and Monetary Control," Journal of Money, Credit and Banking, Vol. 9, Pt. 2 (February 1977), p. 175; George G. Kaufman, "Federal Reserve Inacility to Control the Money Supply: A Self-Fulfilling Prophecy," Financial Analysts Journal 28 (September/October 1972): 20.

[9]George G. Kaufman, Money, the Financial System, and the Economy (Chicago: Rand McNally College Publishing Company, 1973), pp. 477-78.

increase in money supply variability may have led to an increase in the variability of economic activity.[10] The major hypothesis of this study is that Federal Reserve policy measures adopted during the latter half of the 1960's contributed to an increase in the variability of the rate of change of the money supply. Specifically, the measures adopted were: more frequent reserve requirement changes, splintering of reserve requirements, introduction of lagged reserve requirements, allowance for Regulation Q to become effective, and a more active monetary policy since 1966.

Concomitantly, this study attempts to determine the major contributors to the level of variability in the rate of change of the money supply during the period 1952 through 1973 and selected sub-periods. Determination of the major contributors to the variability of the money supply gives an indication of which variables the Federal Reserve needs to have the greatest concern with if it desires to control monthly and/or quarterly rates of change in the money supply.

The very fact that the determinants[11] of the money supply are variable or increase in variability does not necessarily mean that the Federal Reserve cannot control the money supply. For the ability of the Federal Reserve to control the money supply is predicated upon at least two factors: one, the variability of the money supply determinants; and two, the predictability of movements in those determinants.

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[10]Some evidence of this contention is presented by Allan H. Meltzer, "Public Policies as Causes of Fluctuations," Journal of Money, Credit and Banking 2 (February 1970): 50.

[11]A determinant of the money supply is taken to be the source base or a parameter of the money supply expansion multiplier.

No matter how variable a determinant is, if its movements are predictable, its potential effects on the money supply can be exactly offset by open market operations; these are referred to as defensive open market operations. This study is somewhat limited in that it does not address the issue of the predictability of money supply determinants. It is simply contended that absolute control of the money supply may not be achieved by the Federal Reserve because of the existence of variable determinants. And, as the variability of the money supply determinants increases, for whatever reason, the ability of the Federal Reserve to control the money supply may decrease. As such, to control better the money supply, and hence economic activity, identification of the factors contributing to the variability of the money supply is desirable.

The foregoing analysis utilizes both monthly and quarterly rates of change in the money supply. As both the Andersen and Karnosky, and Pierce and Thomson studies suggest, variations in the quarterly rates of change in the money supply may contribute to variability in economic activity. In an attempt to decrease fluctuations in economic activity, the Federal Reserve may desire to control the variability of the quarterly rates of change in money. It appears that the Federal Reserve considers this a desirable goal since it currently specifies monetary growth targets in terms of quarterly rates of change.

An analysis of the monthly data is important for two reasons. First, the Federal Reserve at the end of the current quarter will specify a specific target rate of growth of the money supply for the next quarter. There are many combinations of monthly rates of change which will satisfy that target. However, only two of the three

monthly rates of change are independent; given the first two monthly rates of change and the target quarterly rate of change, the third monthly rate of change is predetermined. The ability of the Federal Reserve to achieve its quarterly target then depends upon its ability to achieve a given monthly target. That, in turn, depends in part upon the variability of the monthly rates of change in the money supply. Secondly, it is possible that an increase in the variability of the monthly rates of change in the money supply could lead to an increase in the variability of economic activity. This may be true, even in the absence of a rise in the variability of quarterly rates of change. Whether or not this is the case is an empirical issue; one, which in the absence of monthly models, has not been adequately analyzed. If monthly rates of change are important determinants of variability in economic activity, then the Federal Reserve may choose to focus on them as well as quarterly rates of change.

Plan of Study

In Chapter II a framework for explaining changes in the money supply is presented. Also, hypotheses of how policy actions undertaken by the Federal Reserve during the latter half of the 1960's and early 1970's affect the variability of the money supply are developed. Chapter III presents the methodology employed to estimate 1) the contribution of each money supply determinant to the variability of the money supply during a given period, and 2) the effects of specific Federal Reserve policy actions on the variability of the money supply. Chapter IV reports the empirical evidence on the hypotheses developed, and Chapter V presents the conclusions of the study.

CHAPTER II

DEVELOPMENT OF MONEY SUPPLY VARIABILITY HYPOTHESES

Introduction

The purpose of this chapter is to present the framework utilized in this thesis to examine changes in the money supply which occur as a result of policy actions undertaken by the Federal Reserve during the latter half of the 1960's and early 1970's. Essentially, the framework utilized is the Brunner-Meltzer non-linear money supply hypothesis.[1]

Money Supply Determination

Determination of the money supply is summarized by the identity

$$M = mS \tag{1}$$

where M is the money supply, narrowly defined, m is the money supply expansion multiplier and S is defined as the source base. This identity is derived from a system of definitional and behavioral equations which summarize the behavior of the non-bank public, the commercial banking system, and the monetary authority. The system of equations utilized is:

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[1]Karl Brunner and Allan H. Meltzer, "Liquidity Traps for Money, Bank Credit, and Interest Rates," Journal of Political Economy 76 (January/February 1968): 1-37.

$$M = D + C \tag{2}$$

$$S = R + C \tag{3}$$

$$R = r(D+T+G) + e(D+T+G) + v(D+T+G) \tag{4}$$

where $e = f(i,V,a)$

$v = f(i,V,a,X)$

$$C = kD \tag{5}$$

where $k = f(Y,i,u)$

$$T = tD \tag{6}$$

where $t = f(Y,i_{TD},i_a)$

$$G = gD \tag{7}$$

Each of these variables is defined in Table III. Equation 2 defines the money supply as the sum of adjusted demand deposits plus currency held by the non-bank public. As defined in equation 3, the source base is the sum of reserves held by all commercial banks (member bank deposits at district Federal Reserve Banks plus vault cash of member and non-member banks) and currency held by the non-bank public. As such, the source base represents total reserves of the economic system; reserves upon which the money supply can be expanded. Changes in the source base are substantially under the control of the monetary authority through execution of either active or passive monetary policies.[2]

Total reserves of the commercial banking system (R) consist of three components; required reserves of member banks, excess reserves

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[2]Leonall Andersen and Jerry L. Jordan, "The Monetary Base-Explanation and Analytical Use," Federal Reserve Bank of St. Louis Review 50 (August 1968): 8-9; Karl Brunner, "An Appraisal of Federal Reserve Policy and Some Proposals Bearing on Policymaking Procedures" Subcommittee on Domestic Finance, Committee on Banking and Currency, House of Representatives, 88th Cong., 2nd Sess., February 10, 1964.

TABLE III

ALPHABETICAL LIST OF SYMBOLS

Symbol	Definition
a	Investment-Loan ratio of Commercial Banks (measure of bank liquidity).
C	Currency held by the non-bank public.
D	Adjusted demand deposits; total demand deposits at all commercial banks minus inter-bank demand deposits, treasury demand deposits, and float.
e	Ratio of excess reserves of member banks to total adjusted deposits of all banks.
G	Treasury demand deposits at all commercial banks.
g	Ratio of treasury demand deposits at all commercial banks to total adjusted deposits of all commercial banks.
i	Vector of interest rates.
i_a	Vector of interest rates other than interest paid on time deposits.
i_{TD}	Vector of interest rates on time deposits.
k	Ratio of currency held by the non-bank public to adjusted demand deposits.
M	Narrow money stock; currency held by the non-bank public plus adjusted demand deposits.
R	Total reserves held by commercial banks; deposits of member banks at Federal Reserve Banks plus vault cash at all commercial banks.
r	Ratio of required reserves of member banks to total adjusted deposits of all commercial banks.
S	Source base; the sum of Federal Reserve credit outstanding (Reserve holdings of U.S. Government Securities, discounts and advances to member banks, float, other Federal Reserve assets), the nations gold stock and SDR certificate account, and Treasury currency outstanding minus Treasury cash holdings, deposits other than member banks reserves with Federal Reserve Banks and other Federal Reserve liabilities and capital.
T	Adjusted time deposits at all commercial banks.
t	Ratio of adjusted time deposits to adjusted demand deposits.
u	Institutional factors affecting the demand for currency held by the non-bank public, urbanization, public's perception of solvency of banking system, etc.
V	Variability of deposit withdrawals from commercial banks.
v	Ratio of vault cash held by non-member banks to total adjusted deposits of all commercial banks.
X	Institutional factors affecting the demand for vault cash held by non-member banks; reserve requirements set by state banking authorities.
Y	Income.
Y_p	Permanent Income.

of member banks, and vault cash held by non-member banks (equation 4). The reserve requirement ratio for member banks (r) is a weighted average ratio, reflecting different reserve requirements for different categories of deposits weighted by the distribution of deposits per category. If only one deposit category, i.e., demand deposits existed, and only one reserve requirement ratio applied to that category, the r-ratio would be under the absolute control of the monetary authority, the Federal Reserve. Such is not the case, however, as there are a number of different categories of deposits and more than one reserve requirement ratio applicable to each category. The r-ratio, therefore, is a function of legal reserve requirements of the Federal Reserve and the distribution of deposits among deposit categories.

The amount of excess reserves held by member banks, and hence the e-ratio, is specified to be a function of: interest rates, variability (and uncertainty of variability) of deposit withdrawals, and the liquidity position of member banks.[3] It is assumed that there is an inverse relationship between interest rates and the demand for excess reserves. As interest rates increase, the opportunity cost of holding excess reserves increases, and hence excess reserves become a less attractive asset to hold vis-a-vis alternative assets. As both the variability and uncertainty of variability of deposit withdrawals increase, the demand for excess reserves increases as banks attempt to protect themselves from a deficient required reserve position resulting from unexpected deposit withdrawals. Lastly, it is assumed that as

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[3]An excellent analysis of the demand for excess reserves is given by Peter A. Frost, "Banks' Demand for Excess Reserves", Journal of Political Economy 79 (July/August 1971): 805-25.

banks become more liquid the demand for excess reserves decreases. As the liquidity position of member banks increases, they are better able to meet unexpected deposit withdrawals by selling financial investments on the open market, hence decreasing the need to hold non-interest bearing assets as excess reserves. In summary,

$$\partial e/\partial V > 0; \quad \partial e/\partial i, \quad \partial e/\partial a < 0.$$

The third component of reserves of the commercial banking system is specified as vault cash of non-member banks. Vault cash of non-member banks is a composite of two elements: required reserves and excess reserves. Reserve requirements of non-member banks are specified by state banking authorities and the amount of excess reserves held by non-member banks is a function of the same factors influencing the amount held by member banks.[4] As discussed above,

$$\partial v/\partial V > 0; \quad \partial v/\partial i, \quad \partial v/\partial a < 0.$$

It is assumed in this analysis that the amount of currency held by the non-bank public is linearly related to demand deposits; the amount of currency held being some specified proportion, k, of demand deposits (Equation 5). The k-ratio is expressed as a function of income, interest rates, and institutional factors. In an effort to explain cyclical fluctuations in the currency-deposit ratio, Alan Hess formulated a cost minimization model to derive demand for currency and

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[4]It is recognized that assets other than vault cash are eligible to meet reserve requirements in all states specifying statuary reserve requirements. In the absence of reserve pyramiding, however, the amount of reserves available to non-member banks is equal to vault cash held by non-member banks.

demand deposit functions.[5] The demand for currency is expressed as a function of interest rates and consumption expenditures, the latter in turn being a function of permanent income, while the demand for demand deposits is a function of interest rates and nominal income. Empirically, Hess found that changes in the k-ratio are positively associated with changes in interest rates. This derives from the result that interest rates do not have any significant effect on the demand for currency, whereas they are inversely associated with demand deposits.[6] Hess also concluded that the k-ratio is inversely related to income in the early stages of an expansionary period, since an increase in income leads to an increase in demand deposits while initially having little effect on currency holdings. As the expansion continues, household's permanent income increases leading to an increase in consumption expenditures. Now equal increases in the growth rates of nominal income and consumption raise currency holdings more than demand deposit holdings resulting in a rise in the currency deposit ratio. During the contractionary periods, the k-ratio initially increases then falls. Changes in the currency-deposit ratio may also result from seasonal factors such as Christmas shopping or vacation schedules, changes in population mobility or changes in the public's confidence in the solvency of the banking system. In summary,

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[5]Alan C. Hess, "An Explanation of Short-Run Fluctuations in the Ratio of Currency to Demand Deposits," Journal of Money, Credit and Banking 3 (August 1971): 666-79.

[6]In other words, the elasticity of currency holdings with respect to interest rates is less than the elasticity of demand deposit holdings with respect to interest rates; $E[C,i] < E[D,i]$.

$$\partial k/\partial i > 0; \quad \partial k/\partial (Y/Y_p) < 0$$

Equation 6 expresses the amount of time deposits held as being proportional to demand deposits where the proportionality factor, t, is a function of income, interest rates paid on time deposits and interest rates of alternative assets. As income increases, holding other factors constant, it is postulated that individuals increase the portion of bank deposits that they hold as time deposits, hence the t-ratio increases.

An increase in i_{TD}, holding all other factors constant, is hypothesized to lead to an increase in the proportion of deposits held as time deposits, hence t would increase. If i_a increases, holding all other factors constant, the proportion of deposits held as time deposits would decrease, hence t would decrease. Similarly, we could express the relationship as:

$$t = f(i_D)$$

where i_D is equal to $i_a - i_{TD}$. As i_D decreases, time deposits become a more attractive asset to hold vis-a-vis other assets, and hence the proportion of deposits held as time deposits increases. If i_D increases, the opportunity cost of holding time deposits increases and t decreases.

It is postulated that as interest rates on alternative assets increase, interest rates paid on time deposits would likewise increase, should they be free to do so. But given the existence of Regulation Q, commercial banks may be constrained from increasing interest rates paid on time deposits as interest rates on alternative assets increase. If Regulation Q prevents i_{TD} from rising as i_a rises then i_D will

increase; t will decrease. If on the other hand, i_{TD} would always increase as i_a increases so as to keep i_D constant, t would likewise remain constant, ceteris paribus.[7] As such, the t-ratio is viewed as being jointly determined by time deposit holders as they adjust their asset portfolio to changes in income and interest rates and commercial banks as they adjust the rate of interest paid on time deposits. Thus,

$$\partial t/\partial Y,\ \partial t/\partial i_{TD} > 0;\ \partial t/\partial i_a < 0$$

Equation 7 views Treasury demand deposits (G) at all commercial banks to be linearly related to demand deposits (D). This relationship when incorporated in the money supply determination model reflects the effects of the Treasury's management of its cash balances on the money supply process.

Solving equation 2 through 7 for M, the money supply, we derive the relationship:

$$M = \frac{1+k}{(r + e + v)\ (1 + t + g) + k}\ S \qquad (8)$$

where $\dfrac{1+k}{(r + e + v)\ (1 + t + g) + k}$ is referred to as the money supply expansion multiplier, m in equation 1, and S is the source base.

As formulated, the money supply expansion multiplier reflects the behavior of: the non-bank public as it influences the k and t ratios; commercial banks as they influence the behavior of the e, v, and t

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[7] It is recognized that the validity of this statement depends upon the values of (1) the elasticity of the t-ratio with respect to i_{TD}, (2) the elasticity of i_{TD} with respect to i_a and (3) the elasticity of the t-ratio with respect to i_a. See Albert E. Burger, The Money Supply Process (Belmont, CA: Wadsworth Publishing Company, Inc., 1971), pp. 74-79.

ratios; the treasury as it influences the g-ratio; and, the Federal Reserve as it influences the r-ratio and through Regulation Q the t-ratio. Changes in the value of any of the parameters of the money supply expansion multiplier or the source base will, ceteris paribus, lead to changes in the money supply as reflected below:

$$\partial M/\partial k, \quad \partial M/\partial r, \quad \partial M/\partial e, \quad \partial M/\partial v, \quad \partial M/\partial t, \quad \partial M/\partial g \quad < 0$$

Conversely, there is a direct relationship between the source base, S, and the money supply, M.

Effects of Federal Reserve Policy Actions

The following section describes Federal Reserve policies enacted during the latter 1960's and early 1970's which, it is hypothesized, contributed to an increase in the variability of the monthly and quarterly rates of change in the money supply. These policies include: more frequent reserve requirement changes, splintering of reserve requirements, introduction of lagged reserve requirements in 1968, allowance for Regulation Q to become effective during 1966 and again in 1969, and a more active, aggressive stabilization policy since 1966.[8]

Reserve Requirement Changes

During the period 1952 through 1965, the Federal Reserve changed reserve requirement ratios against demand and time deposits on six

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[8]An aggressive stabilization policy was conducted in part through dynamic open market operations designed to influence the behavior of the source base.

separate occasions; a change in reserve requirements once each 2.3 years.[9] The average change in required reserves as a result of such changes was $933 million, with a standard deviation of $551 million. On the other hand, during the period 1966 through 1973, reserve requirements against demand and time deposits were altered on ten separate occasions, a change once each 0.8 years. The average change in required reserves for this latter period was $819 million, with a standard deviation of $851 million.[10] Even though the average change in required reserves was smaller during the 1966-1973 period, they occurred approximately three times more frequently as compared with the 1952-1965 period. The more frequently reserve requirements are changed, the more frequently bank's reserve positions are altered and hence the money supply changes.

Splintering of Reserve Requirements

Whereas there were four deposit categories for reserve requirement purposes in 1960, there were nine such categories at the end of 1973 as shown in Table IV. As deposits are transferred among deposit categories, the reserve positions of commercial banks are altered, precipitating changes in the money supply. The greater the number of deposit categories for reserve requirement purposes, the greater the probability

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[9]Changes in reserve requirements were often made effective in a series of steps. The author has considered each series of steps to be a separate occasion. Dates and effects of reserve requirement changes for the period 1952 through 1973 are presented in Appendix B.

[10]The large standard deviation for the 1966-1973 period was a result of reserve requirement changes during 1972 which released approximately $3.2 billion of reserves. The average change for the period excluding the 1972 change was $515 million.

TABLE IV

RESERVE REQUIREMENTS ON DEPOSITS OF MEMBER BANKS

(Deposit intervals are in millions of dollars. Requirements are in percent of deposits.)

Date	Net Demand Deposits					Time		
	Country	Reserve City	Central Reserve City			(All classes of banks)		
31 Dec. 1960	12	16	16½			5		
	Country		Reserve City			Other Time		
	0-5	Over 5	0-5	Over 5	Savings	0-5	Over 5	
31 Dec. 1963	12		16½		4			
31 Dec. 1966	12		16½		4	4	5	
31 Dec. 1968	12	12½	16½	17	3	3	6	
	0-2	2-10	10-100	100-400	Over 400	Savings	Other Time 0-5	Other Time Over 5[a]
31 Dec. 1973	8	10½	12½	13½	18	3	3	5

[a]As of 31 December 1973, member banks were subject to an 8 percent marginal reserve requirement against increases in the aggregate of (1) outstanding time deposits of $100,000 and over, (2) outstanding funds obtained by the bank through issuance of a bank's affiliate of obligations subject to the existing reserve requirements on time deposits, and (3) funds from sales of finance bills. The 8 percent requirement applies to balances above a specified base, but is not applicable to banks that have obligations of these types aggregating less than $10 million.

Source: Selected Issues, Federal Reserve Bulletin.

that as deposits are transferred from one bank to another the reserve position of the banking system is altered, hence, the money supply changed. William Poole and Charles Lieberman found that shifts in deposits between deposit categories do contribute to the variability of the reserve requirement ratio. A major source of such variability is shifts in funds between demand, treasury and time deposits;[11] shifts in funds among demand deposit categories contributed little.[12] They did not determine, however, the effect of variability of the reserve requirement ratio on the variability of the money supply during the time frame of their analysis.

Lagged Reserve Requirements[13]

Reserve equilibrium in the banking system is established when surplus reserves are equal to zero: that is, actual reserves held are equal to the sum of required reserves plus desired excess reserves.

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[11]Poole and Lieberman estimated that the variance of the weekly average required reserve-demand deposit ratio of member banks for the period October 7, 1970, through November 3, 1971, was 0.1403. Decomposing this variance in terms of required reserves against selected bank liabilities it was found that the major source of variability was the time deposit required reserve ratio with a variance of 0.1101. The variances of the treasury and demand deposit required reserve ratios were 0.0308 and 0.0021, respectively. In terms of weekly first differences the time, treasury and demand deposit reserve ratios' variances were 0.0091, 0.0306, and 0.0020, respectively, compared with a variance of 0.0931 for the total required reserve ratio. William Poole and Charles Lieberman, "Improving Monetary Control," Brookings Papers on Economic Activity 2:1972, pp. 304-5.

[12]George Benston also finds this to be true. George J. Benston, "An Analysis and Evaluation of Alternative Reserve Requirement Plans," Journal of Finance 24 (December 1969): 849-70.

[13]This section relies heavily on Warren L. Coats, "Lagged Reserve Accounting and the Money Supply Mechanism," Journal of Money, Credit and Banking 8 (May 1976): 167-80.

Until 1968, required reserves in period t were a specified proportion of daily average deposits in the same period. This is stated as:

$$RR_t = r\ D_t$$

where RR_t are required reserves in period t, D_t are daily average deposits in period t and r is the reserve requirement ratio. The method of calculating reserve requirements was altered with the adoption of lagged reserve requirements in September of 1968. Since that date, required reserves in period t were computed as a specified proportion of daily average deposits in period t-2 (two weeks earlier).[14]

$$RR_t = r\ D_{t-2}$$

One effect of this change, it is hypothesized, has been to increase the variability of the excess reserve-deposit ratio, and hence variability of the money supply.

An individual commercial bank holding surplus reserves attempts to achieve reserve equilibrium in a given reserve settlement time period (one week) by expanding earning assets, whereby reserves are lost to other commercial banks and to the non-bank public. Reserves lost to the non-bank public lead directly to a reduction in surplus reserves in the banking system. But, the reserves transferred to other commercial banks simply represent a reallocation of reserves. The surplus reserves left in the banking system are eliminated only as the amount of desired reserves is increased. Prior to the introduction of

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[14]For other provisions of the September 1968 change in Regulation D and a statement of justification for lagged reserve requirements see Warren L. Coats, "The September 1968 Changes in Regulation D and Their Implications for Money Supply Control" (Ph.D. dissertation, University of Chicago, 1971).

lagged reserve requirements, this increase in desired reserves resulted from an increase in both desired excess reserves and required reserves. As earning assets of commercial banks were expanded, interest rates were depressed and deposits rose. Both of these occurrences led to an increase in the demand for desired excess reserves. Furthermore, as deposits expanded, required reserves increased. The major channel of extinguishing surplus reserves in a given week was the rise in required reserves.

With the introduction of lagged reserve requirements, this latter channel of decreasing surplus reserves in a given reserve settlement period is permanently lost.[15] The amount of required reserves to be held this week is now some specified proportion of daily average deposits of two weeks earlier; required reserves are exogenous for this period. Surplus reserves for the banking system are now eliminated only insofar as interest rates decrease and deposits expand such that desired excess reserves and currency held by the non-bank public increase. The expected result is that deposits and interest rates will have to change by greater amounts to extinguish surplus reserves in a given week as compared with the pre-lagged reserve requirement rules. Consequently, the variability of the excess reserve-deposit ratio and the money supply increases.[16]

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[15]For an explanation of the effects of lagged reserve requirements over a series of reserve settlement periods see Appendix C.

[16]Faced with a reserve deficiency, the commercial banking system could attempt to reachieve equilibrium by contracting earning assets held, leading to an increase in interest rates and decreases in desired excess reserves, demand deposits, and currency held by the non-bank public. Additionally, if the marginal cost of borrowing

It is also expected that, as a result of the introduction of lagged reserve requirements, variability of the actual required reserve-deposit ratio, r, will increase. In that required reserves for a given reserve settlement period, week t, are a specified proportion of average deposits held two weeks earlier, week t-2, the actual reserve requirement ratio will not necessarily be equal to the weighted average legal reserve requirement ratio, as was the case prior to the introduction of lagged reserve requirements.[17] For now, the reserve requirement ratio is a function of not only the legal reserve requirement ratio but also the relationship between deposits held during week t with deposits held in week t-2.[18] For instance, if surplus reserves are injected into the banking system during a given week, the banking system will attempt to reachieve reserve equilibrium by expanding earning assets, expanding deposits. Since required reserves are fixed but deposits change, the actual required reserve ratio will be altered. As such, whenever the amount of deposits held during week t is different from the amount held in week t-2, the r-ratio will change. This is an additional source of variability in the money supply process.

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reserves from the Federal Reserve is less than the marginal loss of revenues from selling earning assets, commercial banks may choose to increase their borrowing from the Federal Reserve. In any event, by fixing reserve requirements this period, currency held by the non-bank public, demand deposits, desired excess reserves and borrowing from the Federal Reserve will have to change by greater amounts to extinguish deficient reserves as compared with the pre-lagged reserve requirement period.

[17]This assumes banks achieve reserve equilibrium instantaneously.

[18]For a mathematical demonstration of this proportion see Appendix C.

Utilizing weekly data, both Burger and Coats found that the excess reserve-deposit ratio was more volatile subsequent to the adoption of lagged reserve requirements.[19] And, Poole and Lieberman estimated that the variance of the non seasonally adjusted weekly percentage change in the money supply increased from 1.02 to 1.14 with the introduction of lagged reserve requirements.[20] (Poole and Lieberman's before introduction period was January 1, 1964, through September 11, 1968, and the after introduction period was September 25, 1968, through June 28, 1972).

Regulation Q

It was previously hypothesized that the allowance for Regulation Q to become effective may lead to a greater variability in the t-ratio as market rates change relative to ceiling rates. Greater variability in the t-ratio, ceteris paribus, leads to greater variability in the money supply.

Figure 3 depicts on a monthly basis relationships of the t-ratio, the rate of return of newly issued 3-month Treasury Bills and Regulation Q (ceiling rate applicable to "other time deposits with denominations of $100,000 and over").[21] The Treasury Bill rate represents the rate of return on alternative assets, i_a, competitive with time deposits (specifically, certificates of deposit). The period of analysis can be broken down into two sub-periods: 1952 through 1960 (period prior to the introduction of certificates of deposit), and 1961 through 1973

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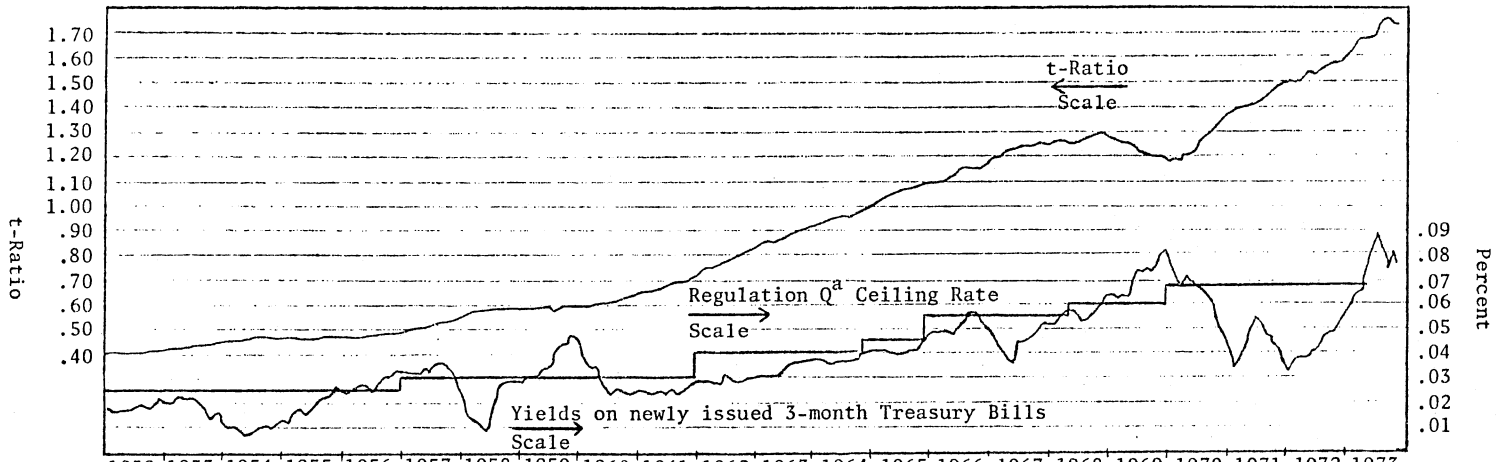
[19]Burger, The Money Supply Process, pp. 53-56.; Coats, "Lagged Reserve Accounting and the Money Supply Mechanism," p. 173.

[20]Poole and Lieberman, "Improving Monetary Control," p. 310.

[21]Bill rates quoted are investment yield equivalents.



a Ceiling rate applicable to "other time deposits with denominations of $100,000 and over."
b Investment yield equivalents of newly issued 3-month Treasury Bills.
Source: Federal Reserve Bulletin.

Figure 3. Relationships Among the t-Ratio, Short-Term Interest Rate, and Regulation Q Ceiling Rate

(period in which certificates of deposit were issued). During the first sub-period, the Federal Reserve allowed the market rate of interest to rise above ceiling rates on two occasions: 1956-1957 and 1959-1960. However, this action exerted little influence on the behavior of the t-ratio. This results primarily from the fact that the rate of interest paid by commercial banks on time and savings deposits were consistently below ceiling rates, and hence Regulation Q was not binding.[22]

During February of 1961, commercial banks announced the issuance of negotiable certificates of deposit, designed to be competitive with treasury bills and commercial paper. Concomitant with the announcement of CD issuance, a secondary market was established for CD's which enhanced their acceptability. Since the demand for negotiable certificates of deposit is highly interest sensitive, their introduction increased the interest sensitivity of the t-ratio.[23]

An analysis of the second sub-period reflects that prior to 1966 each time interest rates paid on time deposits approached Regulation Q ceilings, the Federal Reserve raised Regulation Q rates. This allowed commercial banks to offer yields on time deposits which were competitive

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[22]Average interest rates payable on time and savings deposits for each year were:

1952 - 1.15%	1955 - 1.38%	1958 - 2.11%
1952 - 1.24%	1956 - 1.58%	1959 - 2.36%
1954 - 1.32%	1957 - 2.08%	1960 - 2.56%

Source: Phillip Cagan, Determinants and Effects of Changes in the Stock of Money, 1875-1960 (New York: Columbia University Press, 1965) p. 318.

[23]Thomson, Pierce, and Parry found "that a permanent 50 basis point rise in the CD rate, other rates constant, will result in a $10 billion rise in CD's. If the CD rate is held constant and all other rates are raised 50 basis points, a $9.3 billion dollar decline is estimated to result." Thomas D. Thomson, James L. Pierce, and Robert T. Parry, "A Monthly Money Market Model," Journal of Money, Credit and Banking 7 (November 1975): 420.

with alternative assets.[24] However, during the second half of 1966, yields on alternative assets surpassed Regulation Q ceiling rates. The Federal Reserve held Regulation Q ceiling rates constant. In fact, during July and September ceiling rates were lowered on multiple maturity and single maturity (less than $100,000) time certificates, respectively. It was not until April 1968 that ceiling rates were raised. Again, in 1969, yields on alternative assets were allowed to surpass ceiling rates. As a result of the increased sensitivity of the t-ratio to interest rate changes (due to the introduction of negotiable certificates of deposit), the t-ratio was influenced significantly, as shown in Figure 3. Thus, during the latter half of the 1960's, partially as a result of Regulation Q, the t-ratio became more volatile, hence contributing to a greater variability in the money supply. According to Burger, Kalish and Babb,

> In the 1962-65 period the t-ratio follows a steady upward trend with only a small amount of variation about the trend. In contrast the t-ratio during the 1966-69 period exhibits wide and erratic fluctuations about the trend line. In the 1966-69 period the contribution of the t-ratio to the month-to-month percentage change in the historical money stock had a mean of -.57 percent and a variance of 4.48 compared to a mean of -2.29 percent and a variance of .76 in the 1962-65 period. There are pronounced changes in the pattern of the t-ratio in the last half of 1966, in 1968 and during 1969. These changes reflect primarily the constraint of Regulation Q, which was an additional factor influencing the money supply process in the latter period.[25]

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[24]Since CD's are competitive with treasury bills, it is expected the rate of return on negotiable certificates of deposit would follow closely the rate of return on treasury bills if they are free to do so.

[25]Albert E. Burger, Lionel Kalish III, and Christopher T. Babb, "Money Stock Control and Its Implications for Monetary Policy," Federal Reserve of St. Louis Review 53 (October 1971): 11.

More Aggressive Monetary Policy

The Federal Reserve's instruments of monetary policy are open market operations, discount rate changes and legal reserve requirement changes. The first two instruments have their effects on the total amount of reserves in the economic system, the source base, while reserve requirement changes affect only the composition of reserves. An aggressive monetary policy can be conducted utilizing any combination of these three instruments.

Monetary policy during the latter half of the 1960's and early 1970's was more aggressive and more variable than during the 1950's and early 1960's. In fact, according to Richard Thorn, "The monetary authorities were more active in the 1960's than in any period since the 1920's and early 1930's."[26]

As discussed earlier, the Federal Reserve during the period 1966-1973, employed legal reserve requirement changes more frequently than in previous periods. Expected results of this action were analyzed above. Furthermore, the Federal Reserve also utilized open market operations and discount rate changes more aggressively so as to influence the behavior of the money supply and interest rates, and hence economic activity during the 1966-1973 period. An examination of Federal Reserve policy statements as recorded in various Annual Reports of the Board of Governors together with movements in the money supply reveals that during the period 1966-1973 Federal Reserve monetary policy shifted directions at least eight times. More importantly, during the

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[26]Richard S. Thorn, Introduction to Money and Banking (New York: Harper and Row, Publishers, 1976), pp. 445-46.

relatively short span of four years, 1966-1969, monetary policy shifted directions five times. According to Allan Meltzer, these shifts in policy may have reinforced, perhaps even induced, fluctuations in nominal output during the latter half of the 1960's.[27] These shifts in monetary policy contrast with six changes in policy during the entire period of 1952-1965. (A brief review of these changes follows below.) As the source base becomes more variable, ceteris paribus, variability of the money supply increases.

The principal goal of monetary policy during the year 1952 and the first half of 1953 was to moderate inflationary pressures stemming from the Korean Conflict; the Federal Reserve pursued a policy of restraint. Whereas the rate of growth of the money supply had increased at an average annual rate of 5.1 percent during 1951, it slowed to 3.6 percent over the first nine months of 1952. From October 1952 through June 1953 the rate of growth of the money supply slowed even further to an average annual rate of 1.6 percent. This contrasts with an average annual rate of 2.4 percent for the period 1952-1965.

With the prospects of a recession occurring as a result of a winding-down of the Korean Conflict and the sharp rise in interest rates during 1952 and early 1953, the Federal Reserve shifted to an expansionary posture. This was accomplished in part by decreasing the discount

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[27]Allan H. Meltzer, "Public Policies as Causes of Fluctuations," Journal of Money, Credit and Banking 2 (February 1970): 45-52. It should be noted, however, that not all economists view the Federal Reserve's behavior during this period as adversely affecting economic activity. For instance, see Paul A. Samuelson, "Reflections on Recent Federal Reserve Policy," Journal of Money, Credit and Banking 2 (February 1970): 33-44.

rate in two steps from 2 to 1½ percent in February and May 1954.[28] The expansionary stance of the Federal Reserve is reflected by the acceleration of the rate of growth of the money supply at an average annual rate of 2.5 percent from the second half of 1953 through February 1954.

With the advent of a vigorous recovery in 1955, monetary policy again shifted to restraint; a posture which was maintained until late October 1957. During this period the discount rate was increased from 1½ to 3½ percent and the money supply was virtually unchanged, increasing at an average annual rate of growth of only 0.7 percent. Although the money supply increased from $133.702 billion in March 1955 to $136.838 billion in December 1956, it was allowed to decrease slightly to $136.386 billion by October 1957.

During the third quarter of 1957 the economy had entered another recession, thus monetary policy once again reversed direction. In November 1957 the Federal Reserve lowered the discount rate from 3½ to 3 percent and during 1958 in four steps it further reduced the discount rate to 1 3/4 percent. In October 1957 the Federal Reserve also began to pursue expansive open market operations "to ease restraint on bank credit expansion."[29] These actions, reflecting a sharp reversal in policy, produced an increase in money supply, which rose at an average annual rate of growth of 3.9 percent over the first seven months of 1958.

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[28]Legal reserve requirements were also changed during this period; these changes and their effects were discussed in a previous section.

[29]Board of Governors of the Federal Reserve System, Forty-Fourth Annual Report, Covering Operations for the Year 1957 (Washington, D.C.: Government Printing Office, 1958), p. 6.

The recession of 1957-1958 was short-lived, lasting only until the summer of 1958. With the onset of a recovery the Federal Reserve shifted back to restraint raising the discount rate to 2½ percent by mid autumn. This action was followed with further increases during 1959, whereby at the end of 1959 the discount rate stood at 4 percent. As a result, the rate of growth of the money supply slowed to an average annual rate of 1.2 percent from August 1958 to June 1960. In fact, the money supply was allowed to decrease from $145.081 billion in July 1959 to $142.814 billion in June 1960.

Partially as a result of restrictive monetary policies taken to abate inflationary pressures during 1959 and 1960 the economy entered a mild recession in mid-1960, and again monetary policy reversed direction from restraint to expansion. In June the discount rate was reduced to 3½ percent and subsequently to 3 percent in September 1960. This policy of moderate expansion was continued virtually uninterrupted until December 1965 with a dual goal of expanding employment and accelerating economic growth.[30] As such the Federal Reserve sought to accommodate moderate growth in the reserve base and the money supply primarily through open market operations. During this period the source base and the money supply increased at average annual rates of growth of 3.2 and 3.3 percent, respectively.

By the end of 1965 the Federal Reserve was beginning to shift towards restraint as inflationary pressures began to build due to increasing aggregate demand as a result of rising government expenditures

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[30]The discount rate was raised from 3 to 3½ percent in 1963 and from 3½ to 4 percent in 1964 to help alleviate unfavorable balance of payments deficits. These actions did not represent a change in policy.

for the war in Viet Nam. This policy was implemented by raising the discount rate from 4 to 4½ percent. However, it was not until February 1966 that the Federal Reserve reduced "the rate at which it supplied reserves to commercial banks through operations of the System Open Market Account."[31] From March 1966 to November 1966 the average annual rate of growth of the money supply was constrained to only 0.9 percent. This policy of restraint designed to retard bank credit expansion was continued until the economy began to falter, led initially by a contraction in residential construction and then a leveling off of industrial production.

In November 1966, the Federal Reserve shifted policy direction from restraint to "relative ease." It continued to pursue a course of "relative ease" through the first ten months of 1967 by employing open market operations and reducing the discount rate from 4½ to 4 percent. Evidence of this shift in policy is given by the behaviors of the money supply and source base, which rose at rates of growth of 6.6 and 4.8 percent, respectively.

But then towards the end of the year with inflationary pressures reappearing, the Federal Reserve again shifted monetary policy away from "ease" by raising the discount rate back to 4½ percent and adjusting open market operations in the direction of restraint. Restraining inflationary pressures continued to be the principal goal of monetary policy during the first half of 1968. Open market operations were restrictive in nature and the discount rate was raised in two steps during March

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[31]Board of Governors, Annual Report for 1966, p. 3.

and April from 4½ to 5½ percent. The average annual rate of growth of the money supply fell to 4.4 percent over the first five months of 1968.

With the passage of the 10% surtax in June 1968 monetary policy again shifted directions towards moderation; "a large volume of reserves was provided during the summer through System Open Market Operations"[32] and the discount rate was lowered from 5½ to 5¼ percent. The source base was allowed to increase from June 1968 to December 1968 at an average annual rate of growth of 7.0 percent; the money supply rose at an annual rate of 7.7 percent.

Towards the end of 1968 with the demand for goods and services being stronger than anticipated monetary policy once again shifted to restraint. In December the discount rate was raised back to 5½ percent. During 1969 the Federal Reserve pursued "a very restrictive monetary policy in an effort to slow the expansion of aggregate money demands in the economy and to dissipate deeply rooted expectations of continuing inflation."[33] This policy was affected through a further increasing of the discount rate to 6 percent and restrictive open market operations. As a result the money supply expanded during 1969 at an annual rate of only 2.7 percent.

With the downturn in the economy during the last quarter of 1969 and early 1970 monetary policy shifted from the posture of restraint that had prevailed during 1969 to moderation. This policy was pursued initially through more expansive open market operations then supplemented

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[32]Board of Governors, Annual Report for 1968, p. 5.

[33]Board of Governors, Annual Report for 1969, p. 3.

with a reduction in the discount rate from 6 to 5½ percent. "In 1971 monetary policy encouraged further substantial growth in bank reserves, money, and bank credit..."[34] by reducing the discount rate further to 4½ percent and providing reserves "at a substantial rate."[35] From January 1970 to June 1971 the money supply and source base grew at average annual rates of 6.2 and 6.3 percent, respectively. Although the Federal Reserve continued to seek moderate expansion in reserves and money throughout the year, there appeared a noticeable decline in the rate of growth of both during the second half of 1971, in which the rates of growth of the money supply and source base were reduced, respectively, to 1.6 and 3.8 percent. This action was taken to offset the rapid expansion of M during the first two quarters of the year. In spite of the decrease in the rate of growth of the money supply during the second half of 1971, the money supply expanded at an annual rate of 5.5 percent from the beginning of 1970 to the end of 1971.

For most of 1972 monetary policy continued "in a moderately stimulative posture"[36] as the Federal Reserve sought to achieve growth in economic activity. This policy was implemented primarily through open market operations, whereby the source base increased at an average annual rate of 6.7 percent over the first ten months of 1971. The money supply rose at an average annual rate of 7.4 percent. Towards the end of 1972 the Federal Reserve began to resist excessive expansion in bank reserves and the money supply. This policy was carried forward

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[34]Board of Governors, Annual Report for 1971, p. 3.

[35]Board of Governors, Annual Report for 1971, p. 6.

[36]Board of Governors, Annual Report for 1972, p. 9.

into 1973 as monetary policy "became progressively more restrictive"[37] as inflation again began to accelerate. This restrictive posture was implemented primarily through the use of open market operations and was supplemented by a rise in the discount rate in a series of steps from 4½ percent at the end of 1972 to 7½ percent at the end of 1973. The rate of growth of the money supply fell from the 7.4 percent rate of the first ten months of 1972 to 4.1 percent over the first ten months of 1973.

Shortcomings of Previous Studies

In the two foregoing sections a framework for determining the level of and changes in the money supply was outlined, and the effects on the money supply of Federal Reserve policy actions undertaken during the latter half of the 1960's and early 1970's were hypothesized. Previous studies, which attempted to determine the effects of these policy actions on the money supply, were cited and their empirical results briefly summarized. These and other empirical analyses of the effects of Federal Reserve policy actions on the money supply generally have compared the pre-policy variation of the effected money supply determinant (e.g., excess reserve-deposit ratio for lagged reserve requirements) with its post policy variation; and, given the change in the variation of the affected determinant inferred the effect of the policy action on the variability of the money supply.[38] This procedure

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[37]Board of Governors, Annual Report for 1973, p. 5.

[38]For example, see Albert E. Burger, "Money Stock Control," Federal Reserve Bank of St. Louis Review 54 (October 1972): 13; Peter A. Frost, "Short-Run Fluctuations in the Money Multiplier and Monetary

generates an accurate measure of the analyzed determinant's contribution to a change in the variability of the money supply if and only if the covariation of the affected determinant with all other determinants is either unchanged or zero. Such, however, was not normally the case. The increase in the variance of the affected determinant may or may not contribute to an increase in the variance of the money supply depending upon the size and sign of the covariation of the affected determinant with all other determinants. Whether or not an increase in the variance of a given determinant contributes to an increase in the variance of the money supply can be tested utilizing the procedure outlined in the following chapter.

Control," Journal of Money, Credit and Banking, vol. 9, pt. 2 (February 1977), p. 175; Burger, Kalish and Babb, "Money Stock Control and Its Implications for Monetary Policy," p. 11; Coats, "Lagged Reserve Accounting and the Money Supply Mechanism," p. 173; Poole and Lieberman, "Improving Monetary Control," pp. 304-5.

CHAPTER III

METHODOLOGY

Introduction

The task of this chapter is to outline the methodology employed to estimate 1) the contribution of each money supply determinant to the variability of the money supply during a given period, and 2) the effects of specific Federal Reserve policy action on the variability of the money supply. The major problem encountered in estimating the contribution of each money supply determinant to the variability of the money supply is the allocation of the covariation which exist among determinants. The methodology outlined below resolves in part this problem.

In this analysis the measure of variability of the money supply is its variance. In computing the variance of the money supply, monthly and quarterly rates of change - rather than levels - are utilized. There are two reasons for this procedure. First, there exists an upward trend in the money supply. This leads to an increase in the variance of the money supply even in the absence of increased cyclical or random variation.[1] Expressing the money supply in terms of rates of

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[1]This statement is predicated upon the existence of a non-linear trend relationship.

change eliminates this trend. Secondly, rates of change allow for a more tractable and exact treatment for decomposing variability.[2]

Model

Equation (8) can be expressed in terms of rates of change by first taking natural logarithms of both sides, then differentiating with respect to time, τ:

$$\frac{d\ln M}{d\tau} = \frac{d\ln S}{d\tau} - \frac{1+t+g}{X}\frac{de}{d\tau} - \frac{1+t+g}{X}\frac{dr}{d\tau} - \frac{1+t+g}{X}\frac{dv}{d\tau} + \frac{X-1-k}{X(1+k)}\frac{dk}{d\tau} \qquad (9)$$

$$- \frac{r+e+v}{X}\frac{dt}{d\tau} - \frac{r+e+v}{X}\frac{dg}{d\tau}$$

where $X = (r + e + v)(1 + t + g) + k$.

Equation (9) expresses the rate of change of the money supply as the aggregate of the contributions of each of the parameters of the money supply expansion multiplier and the source base. Since the data exist only for discrete time periods equation (9) must be approximated. The approximation is given in equation (9').

$$\Delta\ln M = \Delta\ln S - \frac{1+t+g}{X}\Delta e - \frac{1+t+g}{X}\Delta r - \frac{1+t+g}{X}\Delta v + \frac{X-1-k}{X(1+k)}\Delta k \qquad (9')$$

$$- \frac{r+e+v}{X}\Delta t - \frac{r+e+v}{X}\Delta g + \varepsilon$$

where $X = (r + e + v)(1 + t + g) + k$; $\Delta\ln M$ and $\Delta\ln S$ are logarithmic first differences in the money supply and source base, respectively; Δe, Δr, Δv, Δk, Δt, and Δg are first differences of the respective variables; and, the multiplier parameters k, r, e, g, t, and v, in the weighting terms are approximated by their average values over each period for

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[2]The exact formula for the variance of the money supply function in terms of rates of change is much simpler than in terms of first differences or deviations from trend.

which first differences are computed. ε is the approximation error due to the estimation procedure utilized. Equation (9'') can be summarized as:

$$r_m = \sum_{i=1}^{7} r_i + \varepsilon \qquad (9'')$$

where $r_m = \Delta \ln M$ $\qquad r_1 = \Delta \ln S$

$$r_2 = -\frac{1+t+g}{X}\Delta e \qquad r_3 = -\frac{1+t+g}{X}\Delta r$$

$$r_4 = -\frac{1+t+g}{X}\Delta v \qquad r_5 = \frac{X-1-k}{X(1+k)}\Delta k$$

$$r_6 = -\frac{r+e+v}{X}\Delta t \qquad r_7 = -\frac{r+e+v}{X}\Delta g$$

The variance of the rate of change of the money supply series (r_m) is defined as:

$$\sigma_m^2 = \sum_{i=1}^{7} \sigma_i^2 + 2 \sum_{i=1}^{6} \sum_{j=i+1}^{7} R_{ij}\sigma_i\sigma_j \qquad i \neq j \qquad (10)$$

where σ_i^2 is the variance of the i^{th} variable and the term R_{ij} is the simple correlation coefficient of r_i and r_j. As such $R_{ij}\sigma_i\sigma_j$ is equal to the covariance of $r_i r_j$.

Given equation (10) the variance of the money series can be decomposed in terms of the multiplier parameters and base series' variances and the covariation between series. As of a specific time period, the direct contribution of each explanatory variable $[r_i]$ to the level of variation in the money series can be measured as:

$$\sigma_i^2 \qquad (11)$$

The indirect contribution of the i^{th} explanatory variable is the set of covariations of the i^{th} variable with the remaining j variables, where the covariation is expressed as:

$$R_{ij}\sigma_i\sigma_j \qquad j = 1.....6 \qquad (12)$$

Combining the i^{th} variable's direct and indirect contributions gives an estimate of that variables total contribution to the variance of the money supply during a given time period. These exist, however, alternative procedures of combining the indirect contributions to the i explanatory variables. One option is to sum the direct and indirect contributions of each explanatory variable as

$$\sigma_i^2 + \sum_{j=1}^{6} R_{ij}\sigma_i\sigma_j \qquad i \neq j,$$

and let this represent the i^{th} variables total contribution to the variance of the money supply. This procedure is neutral with respect to the direction of the relationship between each pair of explanatory variables.[3] As such, utilization of this option is preferable if cause and effect relationships between explanatory variables do not exist[4] or, at least, are not known.

Alternatively, the interrelationship between two explanatory variables can be assigned in full to a given i^{th} variable by allocating to it two times its covariation with another variable.[5] This procedure purports that specific relationships exist between explanatory variables,

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[3]The contribution of the interrelationship between two explanatory variables to the variance of the money supply is equal to twice the covariance of the two variables. Assigning simply the covariation between two variables to each variable as a measure of their indirect contribution is neutral in the sense that exactly one-half of the contribution of the interrelationship is assigned to each variable.

[4]The absence of a cause and effect relationship does not necessarily mean the covariation between two variables is zero. Two variables may have a non-zero covariation if both are functions of a third variable.

[5]In an analysis of the variability of member bank reserves Poole and Lieberman utilized a similar procedure. William Poole and Charles Lieberman, "Improving Monetary Control," Brookings Papers on Economic Activity 2:1972, pp. 293-335.

and these relationships are known. Furthermore, it is implicitly assumed that the cause and effect relationships between explanatory variables are unidirectional, and hence 100 percent of the interrelationship between variables should be assigned to one of the two variables.

In many instances the relationship between explanatory variables are known or can be hypothesized. For example, the interrelationship between the contributions of the required reserve and time deposit ratios is primarily the result of the structure of reserve requirements. In the absence of differential required reserve ratios against demand and time deposits, shifts in funds between deposit categories would have no effect on the required reserve ratio. Consequently, the source of this interrelationship can be attributed to r_3, the contribution of the required reserve ratio.

Additionally, since the source base is under the control of the Federal Reserve, interrelationships of the source base with the contributions of the multiplier parameters should be attributed to the source base.

While recognizing that all interrelationships between pairs of explanatory variables are not unidirectional or even known, the second option was adopted as the procedure for combining the direct and indirect contributions. The primary justification for selecting this alternative was that many of the interrelationships are known and are unidirectional. For these interrelationships utilization of the first option would understate the contribution of the cause variable and overstate that of the effect variable.

A shortcoming of this procedure, on the other hand, is that judgments must be made as to the best allocation of covariations. The fact that some of the interrelationships are not known or known but not unidirectional means this procedure will distort the estimated contributions of some explanatory variables. In light of the finding, however, that the covariances of the majority of pairs of explanatory variables are relatively small as compared with their variances - with the exception of the covariances of the source base with the other explanatory variables and the contributions of the required reserve and time deposit ratios - this distortion should be relatively insignificant.

From equation (10) sources of the change in the variance of the money series from one time period to another can also be estimated. To find the sources of change, the partial derivatives of equation (10) with respect to each of the explanatory variables' variance and covariation is taken. These partials are given in equations (13) and (14).

$$\frac{\partial \sigma_m^2}{\partial \sigma_i^2} = 1 + \sum_{j=1}^{6} R_{ji} \frac{\sigma_j}{\sigma_i} \qquad i \neq j \qquad (13)$$

$$\frac{\partial \sigma_m^2}{\partial R_{ij}} = 2\sigma_i \sigma_j \qquad i \neq j \qquad (14)$$

With the partial derivatives, the predicted contribution of each explanatory variable to a change in the variance of the money series from one time period to another as expressed in equations (15) and (16) can be calculated:

$$\partial \sigma_m^2 = \left[1 + \sum_{j=1}^{6} R_{ji} \frac{\sigma_j}{\sigma_i}\right] \partial \sigma_i^2 \qquad i \neq j \qquad (15)$$

$$\partial \sigma_m^2 = [2\sigma_i \sigma_j] \partial R_{ij} \qquad i \neq j \qquad (16)$$

Equation (15) allows for the covariation of the multiplier parameters and base series in determining the predicted sources of change in the level of money series variation from one time period to another. This equation is intuitively appealing. For instance, it can be rewritten as:

$$\partial\sigma_m^2 = \partial\sigma_i^2 + \partial\sigma_i^2 \sum_{j=1}^{6} \hat{b}_{ji} \qquad i \neq j \qquad (15')$$

where $\hat{b}_{ji}$ is the simple regression coefficient estimated by regressing the j^{th} variable on the i^{th} variable. Equation (15') states that if the variance of any r_i increases, the variance of r_m will necessarily increase by an equal amount (this is the meaning of the first term to the right of the equality sign). As r_i changes it may also be associated with changes in the values of each of the other explanatory variables. That relationship is expressed by the $\hat{b}$ coefficients. The r_i's may be correlated for two reasons. First, a change in any r_i may lead to changes in the values of each of the other explanatory variables. For instance, if the t-ratio increases (r_6 decreases) less reserves will be required to be held by commercial banks since the weighted average reserve requirement against time deposits is less than that against demand deposits, hence, the r-ratio will decrease (r_3 increases). Secondly, changes in any two r_i's may be correlated if both are functions of the same variable, such as income. These induced or associated changes will likewise contribute to a change in the variance of r_m. If $\Sigma\hat{b}$ is greater than zero, the induced change will contribute positively to a change in σ_m^2. If $\Sigma\hat{b}$ is less than zero, the induced change will be offsetting. And, if $\Sigma\hat{b}$ is equal to zero, there is no induced change.

Equation (16) reflects the change in the variance of r_m given a change in the relationships between each pair of explanatory variables. It in essence represents errors in estimating $\partial\sigma_m^2$ from changes in the explanatory variables.

Data

Data utilized in the analysis were obtained from selected issues of the Federal Reserve Bulletin. The monthly data were seasonally adjusted utilizing a 12-month moving average seasonal adjustment procedure.[6] In attempting to remove seasonal variation from the data, it was found that seasonal patterns were not constant for all variables during the time period 1952-1973. As such, the total period was broken down into three sub-periods: 1952-1959, 1958-1966, 1965-1973 and seasonal indexes for all variables were computed for each sub-period. These computed indexes are presented in Appendix D, Tables XIX - XXI. Indexes for the overlapping years were averages of the two sub-period indexes. This latter procedure was utilized to smooth the transition from one sub-period to another.

Vault cash held by non-member banks for the period 1961 through 1973 was obtained from data published in the Federal Reserve Bulletin. It was calculated as currency in circulation minus the sum of currency held by the non-bank public plus vault cash held by member banks. Prior to 1961, the Federal Reserve did not publish a monthly average estimate

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[6]Movements in the time series for the money supply and its determinants can be decomposed into trend, seasonal, cyclical and random elements. The principal concern of this study is to examine the variability of the cyclical and random elements of the money supply series, thus the data were seasonally adjusted. Trend was removed for the reason discussed on pp. 41-42.

of vault cash held by member banks. To obtain such a series, the amount of vault cash held by all banks for each month during the years 1952-1960 was first estimated as averages of the semimonthly totals published by the Federal Reserve.[7] The average proportion of vault cash held by member banks to vault cash held by all banks for each month during the years 1961-1963 was then calculated. The proportionality factors were then applied to vault cash held by all commercial banks for the 1952-1960 period, obtaining vault cash held by member banks.[8] Vault cash held by non-member banks then was computed as the difference between vault cash held by all commercial banks and estimated vault cash held by member banks.

The third adjustment made was for excess reserves held by member banks. Prior to December, 1959, member banks were not allowed to include any vault cash as legal reserves. A portion was allowed as reserves for the period December 1, 1959, to November 23, 1960; all allowed thereafter. Even though vault cash held by member banks was not a means of satisfying legal reserve requirements, it was held by commercial banks, and hence, was not available (if desired holdings were equal to actual holdings) for expansion of earning assets and the money supply. Since vault cash held by member banks is included in the

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[7]"Basic Data for Money Supply Series - Table 2", Federal Reserve Bulletin 46 (October 1960): 1116-1121.

[8]Implicitly it is assumed that the monthly proportionality factors were constant for the two periods 1952-1960 and 1961-1963. The average proportionality factors computed from the 1961-1963 data were:

Jan. 0.760	May. 0.744	Sep. 0.760
Feb. 0.762	Jun. 0.750	Oct. 0.757
Mar. 0.746	Jul. 0.753	Nov. 0.757
Apr. 0.752	Aug. 0.759	Dec. 0.761

source base and since that held by member banks is not available for support of additional demand deposits, it must be accounted for in the money supply expansion multiplier; vault cash held by member banks must be considered a drain in the money supply function. As such, prior to December, 1959, vault cash held by member banks was added in full to excess reserves of member banks.[9] For the period December 1, 1959, to November 23, 1960, a proportion of vault cash held by member banks was added to excess reserves of member banks. Proportions were computed by first solving for e;

$$e = \frac{(1+k)S - [(r+v)(1+t+g)+k]M}{M(1+t+g)}$$

Given the amount of total deposits existing in the banking system each month, the amount of excess reserves held by member banks could be found as:

$$\text{Excess Reserves} = e(D+T+G)$$

The difference between estimated excess reserves and published excess reserves is the amount of vault cash held by member banks not included as legal reserves.[10] After November, 1960, no adjustments were made. The seasonally adjusted data for variables utilized in this analysis (equation 8) are presented in Appendix E.

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[9]An alternative procedure would have been to subtract vault cash held by member banks from the source base. The former procedure was selected so that movements in vault cash held by member banks, which were considered to be excess reserves, would be captured in the money supply expansion multiplier.

[10]It represents the following proportions of vault cash held by member banks:

Dec. 59	0.9697	Apr. 60	0.8797	Aug. 60	0.7898
Jan. 60	0.9695	May. 60	0.8502	Sep. 60	0.6068
Feb. 60	0.9083	Jun. 60	0.8424	Oct. 60	0.5856
Mar. 60	0.8772	Jul. 60	0.8329	Nov. 60	0.4500

CHAPTER IV

EMPIRICAL RESULTS

Contributions to the Level of Variance

Utilizing statements (11) and (12) the direct and indirect contributions of each explanatory variable to the variance of the monthly and quarterly rates of change in the money supply during the period January 1952 through December 1973 were calculated. From these calculations a matrix of factors contributing to the variance of the money supply series for the period January 1952 through December 1973 was constructed. These are shown in Table V. In the construction of this matrix the covariations between the parameters of the money supply expansion multiplier and the source base were allocated in full to a given variable. Allocations made were based upon the best judgment of the author, designed to attribute covariations to the variables deemed responsible for the interrelationships. For instance, two times the sum of the covariation between the source base and each of the multiplier parameters was allocated to the contribution of the source base. Hence, the total contribution of the source base (r_1) to the variance of the money supply series was the sum of the source base's direct contribution plus two times its covariation with each multiplier parameter. Justification for this allocation is that the source base is under the control of the Federal Reserve, and hence the Federal Reserve can

TABLE V

MATRIX OF FACTORS CONTRIBUTING TO THE VARIANCE OF MONEY SUPPLY, SELECTED PERIODS [MONTHLY RATES OF CHANGE, SA DATA]

Period and Variables	Variance of Money Supply Series	Variables[a] r_1	r_2	r_3	r_4	r_5	r_6	r_7
			Period: January 1952-December 1973[b]					
	22.556							
r_1		30.979						
r_2		- 5.065	2.427					
r_3		-30.012	0.528	16.832				
r_4		- 0.537	0.227	-0.056	1.580			
r_5		- 0.642	0.190	0.206	-0.476	4.471		
r_6		- 0.976	-0.012	-3.270	0.283	3.034	3.002	
r_7		- 4.510	-0.589	-0.170	0.065	1.140	0.676	3.228
Total Contribution		-10.763	2.771	13.542	1.452	8.645	3.678	3.228
			Period: January 1952-May 1966[b]					
	18.215							
r_1		22.711						
r_2		- 3.788	2.682					
r_3		-20.406	-0.290	11.439				
r_4		- 0.132	0.001	0.086	1.436			
r_5		- 0.138	0.068	-0.336	-0.522	3.912		
r_6		0.608	-0.221	-2.876	0.069	2.536	1.816	
r_7		- 5.740	-1.214	0.438	0.192	1.194	0.746	3.941
Total Contribution		- 6.885	1.026	8.751	1.175	7.642	2.562	3.941
			Period: June 1966-December 1973					
	23.370							
r_1		33.160						
r_2		- 6.092	1.935					
r_3		-45.422	1.916	27.035				
r_4		- 1.316	0.657	-0.326	1.869			
r_5		0.640	0.308	0.982	-0.392	5.487		
r_6		- 3.323	0.348	-4.124	0.690	3.958	5.266	
r_7		- 2.589	0.604	-1.280	-0.174	1.078	0.559	1.916
Total Contribution		-24.942	5.768	22.287	1.993	10.523	5.825	1.916

[a] r_1= Rate of Change in Source Base (S)
r_2= Contribution of Excess Reserve-Deposit Ratio (e)
r_3= Contribution of Required Reserve-Deposit Ratio (r)
r_4= Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5= Contribution of Currency-Deposit Ratio (k)
r_6= Contribution of Time Deposit-Deposit Ratio (t)
r_7= Contribution of Government Deposit-Deposit Ratio (g)

[b] Rate of change of all variables from November 1960 to December 1960 excluded due to change in definition of legal reserves, effective December 1960.

utilize it to conduct both dynamic and defensive (offset unwanted changes in the multiplier parameters) policies. As it conducts defensive policies, the variability of the source base would increase; but the source base's contribution to the variability of the money supply may be less than its direct contribution if it offsets changes in the other variables (this would be reflected as a negative covariation between the source base and the applicable variable). The second column provides an estimate of the total contribution of the excess reserve ratio (r_2) to the level of variance of the money supply series. The other columns are constructed similarly. The matrix diagonal is the set of r_i variances and the off diagonal terms are twice the covariances of the respective r_i's. This same procedure was utilized to develop a matrix of factors contributing to the variance of the quarterly rates of change in the money supply as shown in Table VI.

Tables V and VI are broken down into three time periods: the full period of analysis, 1952-1973, and two sub-periods. The sub-periods were defined such that the second sub-period, June 1966-December 1973, would reflect the effects of Federal Reserve policies enacted during the second half of the 1960's, when compared with the sub-period, January 1952-May 1966.

The total contribution of each explanatory variable was then divided by the variance of the money supply series for each respective time period and multiplied by 100 to express the percent of variance of the money supply contributed by each explanatory variable.[1] These

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[1]The money supply utilized was estimated as the product of the source base times the estimated money supply expansion multiplier (Equation 8).

TABLE VI

MATRIX OF FACTORS CONTRIBUTING TO THE VARIANCE OF MONEY SUPPLY, SELECTED PERIODS [QUARTERLY RATES OF CHANGE, SA DATA]

Period and Variables	Variance of Money Supply Series	Variables[a] r_1	r_2	r_3	r_4	r_5	r_6	r_7
		Period: 1st Quarter 1952-4th Quarter 1973[b]						
	8.312							
r_1		12.373						
r_2		-0.350	0.138					
r_3		-7.388	-0.114	5.188				
r_4		-0.138	0.037	0.372	0.086			
r_5		-2.244	0.124	1.418	0.060	1.112		
r_6		-1.803	0.185	-2.182	-0.059	0.380	1.433	
r_7		-0.091	-0.091	-0.658	-0.169	0.044	0.105	0.546
Total Contribution		0.359	0.279	4.138	-0.082	1.536	1.538	0.546
		Period: 1st Quarter 1952-2nd Quarter 1966[b]						
	5.705							
r_1		8.705						
r_2		-0.059	0.147					
r_3		-6.244	-0.100	4.028				
r_4		-0.083	0.022	0.348	0.098			
r_5		-2.506	0.198	1.244	-0.044	1.055		
r_6		-1.196	0.125	-1.024	-0.032	0.724	0.766	
r_7		-0.218	-0.145	-0.788	-0.253	0.072	0.100	0.768
Total Contribution		-1.601	0.247	3.808	-0.231	1.851	0.866	0.768
		Period: 3rd Quarter 1966-4th Quarter 1973						
	6.417							
r_1		6.099						
r_2		0.041	0.108					
r_3		-6.554	-0.258	7.336				
r_4		-0.182	0.065	0.420	0.068			
r_5		0.526	-0.094	1.514	0.246	1.154		
r_6		-1.959	0.268	-4.538	-0.114	-0.336	2.705	
r_7		0.064	0.009	-0.430	-0.018	0.004	0.121	0.152
Total Contribution		-1.965	0.098	4.302	0.182	0.822	2.826	0.152

[a] r_1= Rate of Change in Source Base (S)
r_2= Contribution of Excess Reserve-Deposit Ratio (e)
r_3= Contribution of Required Reserve-Deposit Ratio (r)
r_4= Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5= Contribution of Currency-Deposit Ratio (k)
r_6= Contribution of Time Deposit-Deposit Ratio (t)
r_7= Contribution of Government Deposit-Deposit Ratio (g)

[b] Rates of change of all variables from 3rd Quarter 1960 to 1st Quarter 1961 excluded due to change in definition of legal reserve, effective December 1960.

results are given in Table VII. The sum of each row may not total exactly 100 percent due to rounding.

Analysis of Table VII clearly indicates that for the period 1952-1973 the major contributors of short run money supply variability, measured as the variance of monthly rates of change, were the currency ratio (r_5) and the required reserve ratio (r_3). Also, of particular interest was the finding that in spite of the relatively large variance of the source base (30.98%), its estimated total contribution to the monthly variability of the money supply was overwhelmingly negative, reflecting short run changes in the source base are largely defensive, offsetting undesired changes in bank reserves due to fluctuations in the multiplier parameters.

It is estimated that the currency ratio accounted for 38 percent of the variability of the monthly rate of change of the money supply. This is fairly consistent with an estimate made by Cagan in which he found that 46 percent of the cyclical fluctuations in the rate of growth of the money supply was accounted for by movements in the currency ratio.[2]

The single most important contributor to fluctuations in the monthly rate of change of the money supply was r_3, accounting for approximately 60 percent of money supply variability. Variability in the required reserve ratio emanated from three sources: one, changes in legal reserve requirements; two, changes in the reserve requirement ratio as a result of shifts in deposits from one deposit category to

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[2]Phillip Cagan, Determinants and Effects of Changes in the Stock of Money, 1875-1960 (New York: Columbia University Press, 1965), p. 26.

TABLE VII

PERCENT OF VARIANCE OF MONEY SUPPLY ACCOUNTED FOR BY EXPLANATORY VARIABLES[a]

Period and Variables	r_1	r_2	r_3	r_4	r_5	r_6	r_7
Monthly Rates of Change							
January 1952 - December 1973	-47.7%	12.3%	60.0%	6.4%	38.3%	16.3%	14.3%
January 1952 - May 1966	-37.8%	5.6%	48.0%	6.4%	42.0%	14.1%	21.6%
June 1966 - December 1973	-106.7%	24.7%	95.4%	8.5%	45.0%	24.9%	8.2%
Quarterly Rates of Change							
1st Quarter 1952 - 4th Quarter 1973	4.3%	3.4%	49.8%	-1.0%	18.5%	18.5%	6.6%
1st Quarter 1952 - 2nd Quarter 1966	-28.1%	4.3%	66.7%	-4.0%	32.4%	15.2%	13.5%
3rd Quarter 1966 - 4th Quarter 1973	-30.6%	1.5%	67.0%	2.8%	12.8%	44.0%	2.4%

[a] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio (k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

another, where the legal reserve requirement ratio differed for the two deposit categories; and three, changes in the reserve requirement ratio as a result of the introduction of lagged reserve requirements. To determine the significance of legal reserve requirement changes, the monthly data were adjusted such that observations in which changes became effective were omitted. The matrix of factor contributions was then recomputed. These results are presented in Tables VIII - X. It was found that when legal reserve requirement changes were ignored the contribution of the reserve requirement ratio was reduced to 14 percent. Hence, of the three sources of variability of the required reserve ratio (r_3), legal reserve requirement changes were the most important.

Furthermore, as reflected in Table VII, other important sources of variability of the money supply series for the 1952-1973 period were the time deposit (r_6), government deposit (r_7), and excess reserve (r_2) ratios accounting for 16.3 percent, 14.3 percent and 12.3 percent, respectively.

Similar to the results utilizing monthly data, the major contributor to the quarterly variability of the money supply series for the period January 1952 through December 1973 was the required reserve ratio (r_3). It accounted for approximately 50 percent of quarterly variability as shown in Table VII. However, the quarterly findings are substantially different from the monthly results. Of particular interest is the finding that the contributions of the currency (r_5), government deposit (r_7), and excess reserve (r_2) ratios were substantially less than those computed utilizing monthly rates of change. At least for the excess reserve and government deposit ratios, it appears

TABLE VIII

MATRIX OF FACTORS CONTRIBUTING TO THE VARIANCE OF THE MONEY SUPPLY, ADJUSTED FOR RESERVE REQUIREMENT CHANGES[a], SELECTED PERIODS [MONTHLY RATES OF CHANGE, SA DATA]

Period and Variables	Variance of Money Supply Series	Variables[b] r_1	r_2	r_3	r_4	r_5	r_6	r_7
		Period: January 1952-December 1973[c]						
	22.222							
r_1		21.605						
r_2		- 3.640	2.055					
r_3		-10.164	0.364	6.394				
r_4		- 0.315	0.228	-0.384	1.224			
r_5		0.804	0.424	-1.180	-0.524	4.340		
r_6		- 2.138	0.244	-2.734	0.232	3.026	2.895	
r_7		- 5.748	-0.801	1.070	-0.060	1.088	0.760	3.156
Total Contribution		0.404	2.514	3.166	0.872	8.454	3.655	3.156
		Period: January 1952-May 1966[c]						
	17.924							
r_1		17.433						
r_2		- 3.181	2.268					
r_3		- 7.830	0.266	3.888				
r_4		0.077	-0.098	-0.014	0.931			
r_5		0.764	0.280	-1.450	-0.566	3.884		
r_6		- 0.057	-0.195	-2.230	-0.010	2.898	1.837	
r_7		- 7.783	-1.240	2.528	-0.137	1.216	0.688	3.753
Total Contribution		- 0.577	1.281	2.722	0.218	7.998	2.525	3.753
		Period: June 1966-December 1973						
	22.957							
r_1		20.127						
r_2		- 4.269	1.605					
r_3		-16.266	0.600	12.046				
r_4		- 1.057	0.956	-1.210	1.894			
r_5		2.188	0.724	-0.554	-0.446	5.380		
r_6		- 5.547	1.199	-3.850	0.764	3.280	5.253	
r_7		- 1.632	0.173	-2.172	0.113	0.838	0.951	1.869
Total Contribution		- 6.456	5.257	4.260	2.325	9.498	6.204	1.869

[a] Rates of change of all variables were excluded for months in which legal reserve requirements were changed by the Federal Reserve.
[b] See Footnote "a", Table X.
[c] Rate of change of all variables from November 1960 to December 1960 excluded due to change in definition of legal reserves, effective December 1960.

TABLE IX

MATRIX OF FACTORS CONTRIBUTING TO THE VARIANCE OF THE MONEY SUPPLY, ADJUSTED FOR RESERVE REQUIREMENT CHANGES[a], SELECTED PERIODS [QUARTERLY RATES OF CHANGE, SA DATA]

Period and Variable	Variance of Money Supply Series	Variables[b] r_1	r_2	r_3	r_4	r_5	r_6	r_7
		Period: 1st Quarter 1952-4th Quarter 1973[c]						
	9.091							
r_1		8.893						
r_2		-0.318	0.104					
r_3		-0.584	-0.002	1.200				
r_4		0 179	0.025	0.002	0.076			
r_5		0.114	0.136	0.056	-0.006	0.851		
r_6		-1.856	0.145	-1.432	-0.020	0.508	1.310	
r_7		-1.006	-0.120	0.314	-0.142	0.036	1.103	0.527
Total Contribution		5.422	0.288	0.140	-0.092	1.395	1.413	0.527
		Period: 1st Quarter 1952-2nd Quarter 1966[c]						
r_1	6.020	6.520						
r_2		-0.203	0.113					
r_3		-0.538	0.048	0.821				
r_4		0.088	0.004	0.014	0.081			
r_5		0.898	0.172	-0.132	-0.088	0.823		
r_6		-1.730	0.098	-0.670	-0.015	0.954	0.798	
r_7		-0.955	-0.176	0.280	-0.186	0.068	0.076	0.658
Total Contribution		2.284	0.259	0.313	-0.208	1.845	0.874	0.658
		Period: 3rd Quarter 1966-4th Quarter 1973						
r_1	5.960	3.980						
r_2		-0.138	0.080					
r_3		0.630	-0.186	2.406				
r_4		0.207	0.097	-0.022	0.066			
r_5		2.120	0.064	0.692	0.234	0.970		
r_6		-3.625	0.324	-3.796	-0.048	-0.878	2.938	
r_7		-0.915	0.036	0.416	-0.014	-0.044	0.207	0.160
Total Contribution		2.259	0.415	-0.314	0.238	0.048	3.145	0.160

[a]Rates of change of all variables were excluded for quarters in which legal reserve requirements were changed by the Federal Reserve.
[b]See Footnote "a", Table X.
[c]Rates of change of all variables from 3rd Quarter 1960 to 1st Quarter 1961 excluded due to change in definition of legal reserves, effective December 1960.

TABLE X

PERCENT OF VARIANCE OF MONEY SUPPLY ACCOUNTED FOR BY EXPLANATORY VARIABLES, ADJUSTED FOR RESERVE REQUIREMENT CHANGES[a]

Period and Variable	r_1	r_2	r_3	r_4	r_5	r_6	r_7
Monthly Rates of Change							
January 1952 - December 1973	1.8%	11.3%	14.2%	3.9%	38.0%	16.4%	14.2%
January 1952 - May 1966	- 3.2%	7.2%	15.2%	1.2%	44.6%	14.1%	20.9%
June 1966 - December 1973	-28.1%	22.9%	18.6%	10.1%	41.4%	27.0%	8.1%
Quarterly Rates of Change							
1st Quarter 1952 - 4th Quarter 1973	59.6%	3.2%	1.5%	- 1.0%	15.3%	15.5%	5.8%
1st Quarter 1952 - 2nd Quarter 1966	37.9%	4.3%	5.2%	- 3.5%	30.6%	14.5%	10.9%
3rd Quarter 1966 - 4th Quarter 1973	37.9%	7.0%	- 5.1%	4.0%	0.1%	52.8%	2.7%

[a] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio (k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

that the monthly rates of change cancel each other out, and hence these variables are relatively insignificant in explaining variability of quarterly rates of change in the money supply. By excluding rates of change for which legal reserve requirement changes became effective, it was also found that splintering of reserve requirements and reserve requirement changes resulting from the introduction of lagged reserve requirements exerted little influence on the quarterly variability of the money supply series. This is seen in Table X. The quarterly data likewise suggest that short run changes in the source base (r_1) were to some extent defensive. However, as evidenced in Table VII, defensive operations were apparently less important for quarterly changes than for monthly changes; 4.3% for the quarterly data as compared with -47.7% utilizing monthly rates of change. Comparing the contributions of r_1 in Tables VII and X, it is also evident that defensive open market operations were often employed to mitigate the blunt effects of legal reserve requirement changes. In fact, in the absence of legal reserve requirement changes, the source base appears to be the most important contributor to the quarterly variability of the money supply.

Analysis of the two sub-periods (as reflected in Table V) shows a substantial but not statistically significant increase in the variability of the monthly rate of change in the money supply from 18.215 for the period January 1952-May 1966 to 23.270 for the period June 1966-December 1973.[3] An examination of Table VII shows that

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[3]Testing the null hypothesis of equality of the two variances, the F-statistic was found to be 1.28. Given degrees of freedom of 91/171, the null hypothesis was not rejected at the 5% level of significance.

the major contributors to this increase were the excess reserve (r_2), required reserve (r_3) and time deposit (r_6) ratios.

The observed increase in the contribution of the excess reserve ratio supports the hypothesis that the adoption of lagged reserve requirements in September of 1968 has led to an increase in the variability of the money supply. Although the contribution of the excess reserve ratio increased, the variance of r_2 was less during the June 1966-December 1973 period than for the period January 1952-May 1966. This is opposite of what would be expected given the foregoing hypothesis of the effects of lagged reserve requirements. A possible explanation for this occurrence is that the variance of r_2 for the period 1952-1966 is an overstatement due to the change in the definition of excess reserves (for this study) in 1960 as explained in Chapter III. To eliminate the possible effect of the change in definition, the variance of the excess reserve ratio was recomputed utilizing only date for five years before and after the introduction of lagged reserve requirements. The pre- and post-lagged variances were found to be 1.108 and 2.421, respectively, supporting the hypothesis that the excess reserve ratio has become more variable with the adoption of lagged reserve requirements.

Furthermore, it is expected that the covariation of the excess reserve with other variables might also change. For instance, if the time deposit ratio increases, we would expect the desired excess reserve ratio to decrease since the variability of deposit withdrawals (V in equation 4) for time deposits is less than that for demand deposits. Hence, r_6 and r_2 would be negatively related. As the time deposit ratio

increases, surplus reserves are created in the banking system. Prior to the introduction of lagged reserve requirements desired reserves would increase through the three channels previously outlined, the major channel being an increase in required reserves. With the introduction of lagged reserve requirements this latter channel was lost. Hence, desired excess reserves would have to increase by a greater amount. The increase in desired excess reserves could now swamp its initial decrease due to the increase in the t-ratio. Hence, it may now be expected that r_6 and r_2 be positively related, which they are as shown in Table V.

The observed positive covariation between r_6 and r_2 for the period 1966 through 1973 may, on the other hand, result from both r_2 and r_6 being positively related to interest rate changes. As interest rates increase the demand for desired excess reserves falls, contributing to an increase in the money supply. And, if as interest rates rise, the spread between the rate of return on alternative assets, i_a, and the interest rate paid on time deposits, i_{TD}, increases (due perhaps to a stickiness in i_{TD} as a result of Regulation Q becoming effective), r_6 will increase.[4] This, ceteris paribus, also contributes to an increase in the money supply. Thus r_2 and r_6 would move in the same direction.

Given the framework of this analysis, it is impossible to determine which explanation accounts for the positive correlation between r_2 and

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[4]For a statement of the procyclical contribution of the t-ratio, see Robert Weintraub, "The Time Deposit - Money Supply Controversy," in Targets and Indicators of Monetary Policy, ed. Karl Brunner (San Francisco: Chandler Publishing Company, 1969), pp. 305-6.

r_6 during the second sub-period. Consequently, it is not clear which variable should be assigned the covariation between r_2 and r_6: r_2 because of the introduction of lagged reserve requirements or r_6 to reflect Regulation Q becoming effective. It was the author's judgment to allocate it to r_2. This decision was reached prior to computations being made. Fortunately, it made no difference with respect to qualitative results which variable was assessed the positive covariation. It should be noted, however, this was not the only instance in which a conflict in proper allocation arose.

As previously suggested, there are three major reasons for anticipating an increase in the contribution of the required reserve ratio to the variability of the monthly rate of change in the money supply: one, more frequent reserve requirement changes; two, a greater proliferation of reserve requirement categories; and three, reserve requirement changes emanating from the introduction of lagged reserve requirements. As indicated in Table X, splintering of reserve requirements accounted for 15.2 percent of the variability of the money supply series in the January 1952 through May 1966 period and the combination of splintered reserve requirements and lagged reserve requirements accounted for 18.6 percent during the June 1966 through December 1973 period. These results indicate that splintering of reserve requirements contributed to the monthly variability of the money supply series during both sub-periods; and furthermore, proliferation of reserve requirements and the introduction of lagged reserve requirements during the second sub-period conduced an even greater instability in the money supply. The residual contribution of r_3 can be attributed to

legal reserve requirement changes; 32.8 percent and 76.8 percent for the two sub-periods, respectively.[5]

The predominant cause for the increase in the contribution of the time deposit ratio from 14.1 percent to 24.9 percent, it is hypothesized, was the allowance for Regulation Q to become effective during the second half of 1966 and again in 1969.

In comparing the two sub-periods shown in Table VII, the only explanatory variable showing a substantial increase in its contribution to the variability of the quarterly rates of change of the money supply was the time deposit ratio (r_6). Again, the dominant reason appears to be the effectiveness of Regulation Q during the latter half of the 1960's.

Analysis Utilizing Five Year Moving Variance

Supplemental to the foregoing analysis, the preceding methodology was modified by dividing the 1952-1973 period into a moving series of short-run periods so that the stability of the explanatory variables' contributions to the variability of the rate of change in the money supply could be ascertained. By determining the stability (or lack thereof) of each explanatory variables' contribution, insight can be gained as to whether observed differences in contributions between the two sub-periods are a manifestation of structural changes (i.e., proliferation of reserve requirements) or the result of random shocks affecting the money supply process.

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[5]Residual contributions were computed as unadjusted contributions of r_3 (Table VII) minus adjusted contributions (Table X).

The time period utilized in calculating the variance of the money supply series was five years (60 observations for the monthly series and 20 observations for the quarterly series).[6] The variance of the money series and its explanatory variables were calculated utilizing the first 60 observations of each series, reflecting the time period January 1952 through January 1957,[7] and from these calculations a matrix of factors contributing to the variance of the money series was constructed. The total contribution of each explanatory variable was calculated, divided by the variance of the money series, and then multiplied by 100 to express the percent of variance of the money supply contributed by each explanatory variable. This procedure then was repeated by first adding one observation to the data set, February 1957, and dropping the first observation, January 1952, then reconstructing the matrix of factor contributions. By a reiteration process, a series of moving variances was generated and a series of factor contributions was constructed. This same procedure was utilized to develop a 20 quarter moving variance and factor contribution series. Table XI presents the results for the monthly data; Table XII shows the results for the quarterly data. Both Tables XI and XII are broken down into two sub-periods: "Period A" which extends from January 1952, to May 1966; and "Period B" which extends from June 1966, to December 1973. Again, the tables are split so that the second period, "Period B", may reflect effects of Federal Reserve policies enacted during the second half of the 1960's.

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[6]Other time periods were experimented with and the results were similar to those presented in this section.

[7]This is a set of 60 observations since one month is lost in computing rates of change.

TABLE XI

PERCENT OF VARIANCE OF MONEY SUPPLY CONTRIBUTED BY EACH EXPLANATORY VARIABLE, SELECTED PERIODS [MONTHLY RATES OF CHANGE, SA DATA; VARIANCE COMPUTED OVER 60 MONTH PERIOD.]

Monthly Periods	Variables[a] Variance of Money Supply Series	r_1 %	r_2 %	r_3 %	r_4 %	r_5 %	r_6 %	r_7 %
				Period A				
Jan. 52-Jan. 57	18.638	- 74.0	6.8	90.4	1.0	36.8	5.5	33.5
May, 52-May, 57	16.272	- 99.9	7.8	109.0	0.7	36.8	6.0	39.7
Jan. 53-Jan. 58	16.745	- 86.2	19.7	87.0	-0.3	36.7	6.8	36.4
May, 53-May, 58	19.544	- 88.3	17.7	86.2	15.0	31.5	8.3	29.6
Jan. 54-Jan. 59	21.975	- 47.9	14.3	64.2	16.5	26.3	7.8	18.8
May, 54-May, 59	17.089	- 73.7	5.1	88.1	23.6	21.0	9.7	26.3
Jan. 55-Jan. 60	18.953	- 6.9	1.6	30.0	18.3	21.3	15.6	20.2
May, 55-May, 60	17.912	- 13.0	4.4	29.6	13.7	26.2	17.9	21.3
Jan. 56-Feb. 61[b]	18.850	- 10.5	9.2	25.2	15.0	24.8	16.6	19.7
May, 56-Jun. 61[b]	19.044	- 9.2	12.5	24.8	12.7	24.6	15.8	18.8
Jan. 57-Feb. 62[b]	19.520	- 3.9	12.1	19.7	12.6	25.7	16.4	17.4
May, 57-Jun. 62[b]	19.270	- 9.0	15.4	16.3	12.0	31.1	18.5	15.7
Jan. 58-Feb. 63[b]	18.098	- 28.5	9.9	42.3	13.3	31.5	18.5	13.1
May, 58-Jun. 63[b]	14.546	- 19.7	13.6	32.8	-4.4	43.7	20.4	13.6
Jan. 59-Feb. 64[b]	13.770	- 37.4	19.3	39.2	-2.9	46.5	20.7	14.6
May, 59-Jun. 64[b]	13.215	- 43.1	24.8	42.7	-9.2	51.8	20.1	13.0
Jan. 60-Feb. 65[b]	11.741	- 76.9	25.3	64.2	-6.5	66.1	13.4	14.3
May, 60-Jun. 65[b]	11.822	- 73.3	14.5	65.4	5.0	62.1	11.0	15.4
Jan. 61-Jan. 66	13.048	- 45.8	3.8	54.7	4.0	55.7	12.8	14.8
May, 61-May, 66	14.010	- 28.6	-3.9	38.0	6.5	56.5	16.4	15.0
				Period B				
Jul. 66-Jul. 71	19.110	- 47.9	27.2	43.1	10.9	30.0	26.4	10.3
Dec. 66-Dec. 71	17.855	- 62.5	28.9	51.6	8.6	32.5	29.7	11.2
Jul. 67-Jul. 72	17.294	- 82.1	30.8	67.7	10.8	30.5	30.3	11.9
Dec. 67-Dec. 72	18.214	-162.0	32.9	147.4	11.1	30.3	29.6	10.7
Jul. 68-Jul. 73	19.085	-173.2	47.6	132.3	9.8	41.7	32.4	9.5
Dec. 68-Dec. 73	22.167	-158.0	35.1	127.3	9.1	46.1	32.2	8.2

[a] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio (k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

[b] Rate of Change of all variables from November 1960 to December 1960 excluded due to change in definition of legal reserves, effective December 1960.

TABLE XII

PERCENT OF VARIANCE OF MONEY SUPPLY CONTRIBUTED BY EACH EXPLANATORY VARIABLE, SELECTED PERIODS
[QUARTERLY RATES OF CHANGE, SA DATA; VARIANCE COMPUTED OVER 20 QUARTER PERIOD.]

Quarterly Periods	Variance of Money Supply Series	Variables[a] r_1 %	r_2 %	r_3 %	r_4 %	r_5 %	r_6 %	r_7 %
				Period A				
1st 52-1st 57	2.901	-212.2	7.7	220.1	-12.2	38.3	4.9	53.4
3rd 52-3rd 57	2.581	-255.1	20.9	230.4	-13.8	47.0	12.6	58.1
1st 53-1st 58	3.500	-174.2	16.9	170.9	- 7.2	34.6	16.6	42.4
3rd 53-3rd 58	4.753	-145.0	13.6	181.0	- 2.4	20.4	16.7	15.8
1st 54-1st 59	5.670	-112.8	14.4	149.5	0.9	19.6	16.1	12.4
3rd 54-3rd 59	5.317	- 31.2	15.1	68.0	0.4	15.3	19.9	12.6
1st 55-1st 60	5.064	8.1	6.1	53.5	0.6	8.8	16.9	6.0
3rd 55-3rd 60	6.536	8.6	8.9	52.0	1.4	9.7	14.2	5.2
1st 56-3rd 61[b]	6.543	4.1	8.5	53.7	1.1	12.9	13.1	6.6
3rd 56-1st 62[b]	6.764	6.7	4.9	51.9	0.4	15.9	13.3	7.0
1st 57-3rd 62[b]	7.282	- 5.4	5.3	49.1	1.0	27.2	16.9	5.9
3rd 57-1st 62[b]	7.501	1.0	3.1	45.5	0.9	27.8	17.2	4.5
1st 58-3rd 63[b]	5.656	- 30.7	3.7	60.9	- 0.3	38.7	21.6	6.1
3rd 58-1st 63[b]	5.276	8.7	9.4	8.8	0.6	47.5	19.7	5.2
1st 59-3rd 64[b]	5.289	31.3	6.3	9.3	- 7.3	39.9	15.6	4.8
3rd 59-1st 64[b]	5.947	39.1	6.7	14.7	- 1.3	28.4	8.1	4.3
1st 60-3rd 65[b]	3.662	- 16.0	12.6	37.2	- 4.4	51.5	10.4	8.7
				Period B				
3rd 66-3rd 71	5.436	17.4	8.0	13.3	4.8	-12.3	66.7	2.1
1st 67-1st 72	5.379	11.5	8.9	12.7	3.8	- 8.0	68.9	2.2
3rd 67-3rd 72	4.976	9.5	8.1	13.5	3.2	- 9.2	72.0	2.9
1st 68-1st 73	4.887	- 38.6	1.7	61.9	0.2	- 6.8	78.6	3.1
3rd 68-3rd 73	4.582	- 70.9	4.9	81.2	0.6	- 0.7	81.0	3.9

[a] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio(k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

[b] Rate of Change of all variables from November 1960 to December 1960 excluded due to change in definition of legal reserves, effective December 1960.

The contribution of the source base to the variability of the monthly rate of change in the money supply was overwhelmingly negative, reflecting the predominantly defensive nature of short run changes in the source base. During both sub-periods the covariation between the source base and the contributions of the government deposit-deposit ratio (r_7), required reserve-deposit ratio (r_3), and the excess reserve-deposit ratio (r_2) were consistently negative. The negative covariances of r_1 with r_3 and r_7, no doubt, are the results of defensive operations. The explanation for the negative covariation between r_1 and r_2 is not so clear. It can be argued that in utilizing "money market conditions" as a target and indicator of monetary policy during the 1950's and 1960's the Federal Reserve conducted open market operations which exacerbated the pro-cyclical influence of the excess reserve-deposit ratio on the money supply.[8] For instance, if an increase in interest rates is interpreted as restrictive monetary policy and the Federal Reserve does not desire a restrictive policy, it would engage in open market operations designed to increase the source base, hence increase the money supply. But as interest rates rise the demand for desired excess reserves decreases, contributing to a rise in the money supply. As such we would expect the covariation between r_1 and r_2 to

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[8]Phillip Cagan examined the consequences on the behavior of the money supply of utilizing "money market conditions" as an indication of monetary policy during the 1960's in Phillip Cagan et al., Economic Policy and Inflation in the Sixties, with an Introduction by William Fellner, Domestic Affairs Study, No. 4 (Washington, D. C.: American Enterprise Institute for Public Policy Research, 1972), pp. 89-153. See also Thomas Mayer, Monetary Policy in the United States (New York: Random House, 1968), pp. 194-95. For a statement of the pro-cyclical behavior of the excess reserve ratio, see Richard S. Thorn, Introduction to Money and Banking (New York: Harper and Row, Publishers, 1976), pp. 99-100.

be positive. Two possible explanations can be given for the observed negative relationship. First, if instead of utilizing interest rates as a target of monetary policy, the Federal Reserve relies on free reserves (excess reserves minus borrowed reserves), and when interest rates are increasing, the Federal Reserve consistently sets its target below the desired level of free reserves, r_1 and r_2 will be negatively correlated.[9] Second, an increase in the source base, contributing to an increase in the money supply, would in the short run depress interest rates; but as interest rates fall, the demand for desired excess reserves will rise, hence contributing to a decrease in the money supply.[10] This latter argument becomes more plausible with the adoption in 1968 of lagged reserve requirements whereby interest rates and excess reserves are forced to vary more as reserves are injected into or withdrawn from the banking system. The data do not indicate, however, that this relationship is stronger since 1968.

The quarterly results as reflected in Table XII likewise suggest that short-run changes in the source base are to some extent defensive. However, defensive operations were apparently less important for quarterly changes than for monthly changes. During sub-period B, the only occasions in which the source base's contribution was negative were when the effects of the frequent reserve requirement changes during late 1972 and 1973 were being mitigated. More significantly, contributions of the

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[9]John D. Rea, "Monetary Policy and the Cyclical Behavior of the Money Supply," Journal of Money, Credit and Banking 8 (August 1976): 350.

[10]Robert Weintraub, "The Stock of Money, Interest Rates and the Business Cycle, 1952-1964," Western Economic Journal 5 (June 1967): 257-70.

source base were positive for 27 of 32 variances computed with observations from 1966 on. Of 34 variances computed from observations prior to 1966, 19 had negative source base contributions. Clearly, the source base during the late 1960's and early 1970's contributed more to the variability of the money supply than in the 1950's.

As indicated in Table XI, the contribution of the excess reserve-deposit ratio (r_2) was consistently positive throughout both sub-periods. And, as the monthly results suggest, the contribution of r_2 increased significantly after the introduction of lagged reserve requirements; 11.27 percent for Period A as compared with 33.65 percent for Period B.[11] However, in comparing these results with those obtained utilizing quarterly data (Table XII), it appears that the increased contribution of r_2 to the variance of the money supply is strictly a very short run phenomenon; monthly movements of r_2 "wash out" during periods as short as one quarter. Utilizing quarterly data, average percentage contributions were found to be 9.16 and 5.62 percent for Periods A and B, respectively.[12]

The contribution of the required reserve ratio (r_3) was positive and substantial for every five year period from 1952 through 1973, utilizing both monthly and quarterly data. During those periods in which legal reserve requirements were changed, the contribution of r_3 rose. Again to determine the significance of legal reserve requirement

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[11]These are averages computed over the estimated percents of variance of the money supply contributed by r_2 utilizing results reflected in Table XI and results for intervening periods not shown.

[12]The relatively higher average contribution for Period A is due in part to the inclusion of vault cash, which was not counted as legal reserves prior to 1960 in the definition of excess reserves.

changes, the monthly data were adjusted such that observations for which changes became effective were omitted. A 60-month moving variance and contribution series was then recomputed. These results are given in Table XIII. By comparing the series of contributions of r_3 in Tables XI and XIII, the effects of legal reserve requirement changes on the behavior of the money supply can be clearly seen. The smaller contributions of r_3 reflected in Table XIII indicate the extent to which splintering of reserve requirements and lagged reserve requirements contribute to short run variability in the money supply.[13]

Again, it was found that on a monthly basis the currency-deposit ratio (r_5) is a major contribution to the short run variability in the money supply, accounting for approximately 34 percent of variability during both sub-periods. It is interesting to note in Table XII, however, the negligible contribution of r_5 on a quarterly basis during Period B.

Also, as previously determined, the behavior of the time deposit ratio as measured by r_6, contributed significantly to the variability of the money supply during both sub-periods, not only utilizing monthly data but also with quarterly data. And, its contribution increased on both a monthly and quarterly basis during the sub-period in which Regulation Q became an effective constraint.

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[13]Its Period A average contribution was 20.1 percent, compared with 35.4 percent for Period B; the latter period reflecting an increased proliferation of reserve requirement categories and introduction of lagged reserve requirements. These figures are substantially higher than those obtained in the previous section, reflecting perhaps the shorter time period over which they were computed.

TABLE XIII

PERCENT OF VARIANCE OF MONEY SUPPLY CONTRIBUTED BY EACH EXPLANATORY VARIABLE, ADJUSTED FOR RESERVE REQUIREMENT CHANGES[a], SELECTED PERIODS
[MONTHLY RATES OF CHANGE, SA DATA; VARIANCE COMPUTED OVER 60 OBSERVATION PERIOD.]

Periods	Variance of Money Supply Series	Variables[b] r_1 %	r_2 %	r_3 %	r_4 %	r_5 %	r_6 %	r_7 %
				Period A				
Jan. 52-May, 57	19.070	-22.8	4.2	46.5	2.5	33.9	4.9	30.9
Jan. 53-Aug. 58	18.862	-18.1	15.0	36.8	0.3	31.8	5.5	28.8
Jan. 53-Jul. 59	19.203	- 6.6	16.5	32.0	3.5	29.1	4.8	20.8
Jan. 55-Apr. 50	15.916	2.6	4.0	25.5	-1.0	31.1	15.8	21.9
Jan. 56-Jul. 61	16.427	5.8	11.1	18.7	-2.1	31.8	14.0	20.6
Jan. 57-Jul. 62	16.291	9.1	13.8	7.7	-2.9	36.4	18.0	18.0
Dec. 57-Aug. 63	15.339	9.4	14.1	4.8	-3.6	43.3	19.1	12.9
Jan. 59-Jun. 53	13.017	- 9.1	24.3	2.0	-9.1	54.0	22.0	15.9
Jan. 60-Jun. 65	12.391	-35.3	21.8	16.6	-2.1	68.6	15.2	15.2
Jan. 61-Mar. 66	13.077	-16.1	12.1	16.4	3.1	57.0	13.0	14.6
				Period B				
Nov. 66-Jul. 72	19.811	-27.4	22.3	24.2	14.9	28.6	27.6	9.8
Jan. 67-Sep. 72	20.298	-32.5	22.4	34.9	12.5	27.2	26.0	9.4
May, 67-Mar. 73	17.053	-65.8	31.8	45.4	16.0	30.4	31.0	11.2
Aug. 67-Jun. 73	17.606	-77.7	32.4	44.8	13.0	40.6	35.5	13.3

[a] Rates of change of all variables were excluded for months in which legal reserve requirements were changed by the Federal Reserve.

[b] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio (k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

Contributions to the Change in Variance

A natural question to ask is what is the effect on the stability of the growth of the money supply of a change in the stability in one of the determinants. The intent of this section is to answer that question. Utilizing equation (15) the predicted contribution of each explanatory variable to a change in the variance of the money series from one time period to another can be estimated. As such, this equation is employed to determine sources of movement in the variability of the money series.

Equation (15) is an approximation formula. To minimize errors in calculating predicted contributions, actual changes in the variances of the explanatory variables must be of small absolute value. However, in examining Tables V and VI, it is found that many of the explanatory variables' variance change substantially between the two sub-periods. Therefore, the predicted contribution of each explanatory variable to a change in the variance of the money series from the first sub-period to the second sub-period could not be estimated utilizing these data. As such, for this analysis the data are grouped in a slightly different manner.

Time periods utilized in calculating the variances of the money and explanatory variable series were five years for the monthly data and three years for the quarterly data.[14] For each sub-period (as defined in Tables XIV and XV) the variances and covariances of each

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[14]A three year variance was computed for the quarterly data so as to generate a larger set of moving variances than generated when computed over a five-year period.

TABLE XIV

AVERAGE PREDICTED CONTRIBUTION OF SOURCE BASE AND MULTIPLIER PARAMETERS TO A CHANGE IN THE 60 MONTH MOVING VARIANCE OF THE MONEY SUPPLY, 1952-1973 (SA)[a]

Period and Variable	Variables[b]						
	r_1	r_2	r_3	r_4	r_5	r_6	r_7
	Period A: 1st Qtr. 1952-4th Qtr. 1973						
	0.035	0.007	0.007	0.015	0.041	0.146*	0.015*
	(0.035)	(0.009)	(0.020)	(0.016)	(0.032)	(0.026)	(0.007)
	Period B: 1st Qtr. 1952-2nd Qtr. 1966						
	-0.094*	-0.005	-0.026*	0.001	-0.003	0.091*	-0.028*
	(0.037)	(0.013)	(0.010)	(0.028)	(0.034)	(0.037)	(0.008)
	Period C: 4th Qtr. 1958-2nd Qtr. 1966						
	-0.092	0.026	0.003	-0.005	-0.058	-0.046	0.012
	(0.050)	(0.014)	(0.004)	(0.004)	(0.039)	(0.049)	(0.015)
	Period D: 3rd Qtr. 1966-4th Qtr. 1973						
	0.028	0.055	0.200	0.016	0.021	0.057*	-0.009
	(0.145)	(0.032)	(0.125)	(0.010)	(0.119)	(0.021)	(0.006)

[a] Values in parentheses are standard errors of the mean.

[b] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio (k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

* Mean Value significantly different from zero at 5% level.

TABLE XV

AVERAGE PREDICTED CONTRIBUTION OF SOURCE BASE AND MULTIPLIER PARAMETERS TO A CHANGE IN THE 12 QUARTER MOVING VARIANCE OF THE MONEY SUPPLY, 1952-1973 (SA)[a]

Period and Variable	Variables[b] r_1	r_2	r_3	r_4	r_5	r_6	r_7
	Period A: 1st Qtr. 1952-4th Qtr. 1973						
	0.084	0.002	-0.051	-0.004	0.000	0.039	0.001
	(0.061)	(0.008)	(0.076)	(0.005)	(0.039)	(0.032)	(0.008)
	Period B: 1st Qtr. 1952-2nd Qtr. 1966						
	0.015	-0.004	-0.229*	-0.007	0.001	0.040*	0.006
	(0.066)	(0.011)	(0.106)	(0.006)	(0.044)	(0.015)	(0.011)
	Period C: 4th Qtr. 1958-2nd Qtr. 1966						
	-0.052	-0.005	-0.196	-0.009	-0.011	0.026	0.014
	(0.079)	(0.006)	(0.129)	(0.009)	(0.037)	(0.024)	(0.022)
	Period D: 3rd Qtr. 1966-4th Qtr. 1973						
	0.094	-0.005	0.134	-0.010	-0.119	-0.041	0.006
	(0.146)	(0.009)	(0.103)	(0.012)	(0.089)	(0.110)	(0.003)

[a] Values in parentheses are standard errors of the mean.

[b] r_1 = Rate of Change in Source Base (S)
r_2 = Contribution of Excess Reserve-Deposit Ratio (e)
r_3 = Contribution of Required Reserve-Deposit Ratio (r)
r_4 = Contribution of Vault Cash of Non-Member Banks-Deposit Ratio (v)
r_5 = Contribution of Currency-Deposit Ratio (k)
r_6 = Contribution of Time Deposit-Deposit Ratio (t)
r_7 = Contribution of Government Deposit-Deposit Ratio (g)

* Mean Value significantly different from zero at 5% level.

explanatory variables were calculated over the first 60 monthly rates of change (12 rates of change for the quarterly data).[15] From these variances and covariances an initial set of $\hat{b}$ coefficients was estimated. Utilizing these $\hat{b}$ coefficients, equation (13) for each explanatory variable was estimated, showing the predicted change in the variability of the money supply growth given a one unit change in the variance of each explanatory variable. For example, the initial estimates covering the first 60 observations of period D are:

$$\partial\sigma_m^2/\partial\sigma_1^2 = 0.2346 \qquad \partial\sigma_m^2/\partial\sigma_5^2 = 1.5569$$

$$\partial\sigma_m^2/\partial\sigma_2^2 = 0.7662 \qquad \partial\sigma_m^2/\partial\sigma_6^2 = 0.3604$$

$$\partial\sigma_m^2/\partial\sigma_3^2 = 0.0807 \qquad \partial\sigma_m^2/\partial\sigma_7^2 = 0.3232$$

$$\partial\sigma_m^2/\partial\sigma_4^2 = 0.9174$$

The interpretation of the first partial is given a one unit change in the variance of r_1, the contribution of the source base, the variance of the rate of change in the money supply will change 0.2346, ceteris paribus. The other partials are interpreted similarly.

The data set was then shifted forward one quarter and the variances and covariances were recomputed. Differences in variances between the two periods were then multiplied by the predicted change

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[15]Sub-periods were defined such that variances computed for Periods B and C would be independent of variances for the same variables for Period D.

in the variance of the money supply series given a one unit change in the variance of each explanatory variable (equation 15), thereby, determining each explanatory variables' predicted contribution to the actual change in the variability of the money supply series.[16] For instance, the observed change in the variance of r_1 was -1.7624. Multiplying this by 0.2346 suggests that given the actual decrease in the variance of r_1, the variance of the money supply series will decrease 0.4135.[17]

From the second set of variances and covariances, a second set of $\hat{b}$ coefficients was computed. The procedure was then repeated for all observations within each sub-period generating a series of predicted contributions for each variable. From these a mean predicted contribution was computed for each variable per sub-period. These results are shown in Tables XIV and XV. If the sign of the mean was positive, this indicates that on the average changes in the explanatory variable led to increases in the variability of the money supply series, and vice versa.

The average predicted contribution of the monthly rate of change of the source base (r_1) for period B, found in Table XIV, is negative reflecting the influence of defensive operations. During period D, however, it appears that short run changes in r_1 contributed to an increase in the variance of the money supply series. Testing whether

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[16]As these predicted contributions are predicated upon the previous period's variance-covariance matrix, it is assumed the relationship between variables remains constant.

[17]This compares with an observed change of -2.8173 in the variance of the money supply series, suggesting that 14.7 percent of the decrease in the money supply variance between the two periods can be attributed to r_1, ceteris paribus.

the mean predicted contribution of sub-period D was significantly different from sub-periods B and C, values for the t-statistic were found to be 2.15 and 2.09, respectively; the mean values were significantly different at the 5% level.[18] Monetary policy was less defensive, more aggressive in the latter period.

Furthermore, the quarterly data for the overall sample period, shown in Table XV, indicate that defensive operations were of less importance for quarter to quarter changes in the source base. However, it does not appear that the source base was any more destabilizing during sub-period D than for the overall sample period, period A. It was slightly more destabilizing in sub-period D than in the immediately preceding sub-period, although the difference was not significant.

As with the previous results, it is found that the excess reserve ratio (r_2) contributed to an increase in the variance of the money supply series given monthly data (Table XIV) but not quarterly data (Table XV). Furthermore, given the monthly data, the excess reserve ratio's contribution subsequent to the adoption of lagged reserve requirements is greater; significantly greater when comparing sub-periods B and D.

More frequent reserve requirement changes, proliferation of reserve requirement categories and the introduction of lagged reserve requirements appear to have led to an increase in the variance of the money series. This is indicated by a positive mean predicted contribution for period D (utilizing both monthly and quarterly data). This

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[18]All subsequent tests were also made at the 5% level. Appendix F provides a summary of all t-statistics computed.

statement must, however, be somewhat tempered due to small differences between computed means, and in the means themselves from zero. The computed quarterly mean for sub-period D was significantly different from that of sub-period B; not significantly different from sub-period C (t=2.00). Moreover, the monthly mean of sub-period D was not significantly different from those of periods B and C.

The results of Table XIV suggest that the behavior of the time deposit ratio contributed to an increase in the variance of the money series; and, that the contribution was significantly greater than zero for periods A and D. These results support the hypothesis that the allowance for Regulation Q to become effective has led to an increase in the variability of the money supply. The quarterly results (Table XV), however, conflict with those reported in Table XII. The primary reason for the negative mean predicted contribution for r_6 in period D is that the Federal Reserve through defensive open market operations was fairly successful in offsetting the increased variability of quarterly rates of change in the time deposit ratio.[19] In fact, it appears that together with the currency deposit ratio the time deposit ratio was a major contributor to the decrease in the variance of the quarterly money supply series during the latter years of the 1952-1973 period.

The overall mean predicted contribution of the currency ratio (r_5) for both the monthly and quarterly data was positive. As

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[19]Equation (15) allows for the effects of defensive open market operations to be impounded in the predicted contribution of the time deposit ratio, whereas the effects of open market operations were allocated in full to the source base in the preceding procedure.

indicated previously, however, its quarterly contribution was substantially less than its monthly contribution. And last, although the government deposit ratio (r_7) is an important contributor to the monthly variability of the money supply series, its predicted mean contribution is negative. This reflects the fact that the 60-month moving variance of r_7 continually decreased during the 1952-1973 period.

CHAPTER V

SUMMARY AND CONCLUSION

The purposes of this analysis were to isolate the major contributors to the level of variability of the money supply achieved during the period 1952 through 1973 and selected sub periods and determine the sources of the recent increases in its variability. The major hypothesis of this study is that Federal Reserve policy measures adopted during the latter half of the 1960's contributed to an increase in the variability of the rate of change of the money supply. Those measures were: more frequent reserve requirement changes, splintering of reserve requirements, introduction of lagged reserve requirements, allowance for Regulation Q to become effective, and a more active monetary policy since 1966.

In the analysis it was found that the major contributors to the variability of the monthly rates of change in the money supply during the period 1952-1973 were the required reserve and currency ratios, contributing approximately 60 and 38 percent, respectively. With the introduction of lagged reserve requirements in 1968 and the allowance for Regulation Q to become binding, the behavior of the excess reserve and time deposit ratios increased in importance as contributors to the monthly variability of the money supply series. It was also found that month-to-month changes in the source base were largely defensive in nature; and defensive operations had to increase during the latter

half of the 1960's as a result of other Federal Reserve policy actions.

The major contributor to the variance of the quarterly rates of change in the money supply during the 1952-1973 period was the required reserve ratio. While the excess reserve and government deposit ratios were important sources of monthly variability, they were relatively unimportant as contributors to its quarterly variability. Likewise, the splintering of reserve requirements exerted a negligible effect on the variability of the quarterly rates of change in the money supply. It was also found that on a quarterly basis, variability of the source base was less defensive, more dynamic in nature. As with the monthly data, it was found that the contribution of the t-ratio increased as Regulation Q became binding. It was also found that the currency ratio was relatively less important as a contributor to the quarterly variability of the money supply than as a contributor to its monthly variability.

Policy implications of the findings of this study are predicated upon the time frame for which changes in the money supply are relevant. If the covariation of the monthly rates of change in the money supply and economic activity are positive and significant, then a person might argue for policy prescriptions designed to reduce the monthly variability of the money supply. Specific suggestions would include: elimination of reserve requirements against government deposits, repeal of lagged reserve requirements and Regulation Q, and a decrease in the number of deposit categories for reserve requirement purposes. If on the other hand, month-to-month changes in the money supply are not important, it would appear that elimination of reserve requirements

against government deposits and other deposit categories and repeal of lagged reserve requirements would have negligible effects on the variability of economic activity. In either case, however, Regulation Q appears to be an important destabilizing factor.

Furthermore, the foregoing findings have significant implications with respect to the Federal Reserve's ability to control rates of change in the money supply. Arthur Burns in a letter to Senator William Proximire dated November 6, 1973, in answering specific criticisms that monetary policy was too erratic contended that "the Federal Reserve does not have precise control over the money supply."[1] He gave a variety of reasons for this lack of short run control: "international flows of funds, changes in the level of U.S. Government deposits, . . . sudden changes in the public's attitude towards liquidity"[2] and "deposits lodged in non-member banks that are not subject to the reserve requirements set by the Federal Reserve."[3] The results of this analysis confirm that these factors do contribute to the variability of the money supply. And, if their behavior cannot be accurately predicted, then it would be difficult for the Federal Reserve to control the money supply. In fact, given that a major portion of money supply variability is contributed by factors not under the

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[1]Senator William Proxmire charged "that there was too much variation from time to time in the rate of increase in the money supply, that monetary policy was too erratic, too much characterized by stops and starts." Arthur F. Burns, Letter to Senator William Proxmire, dated November 6, 1973, reprinted as "Money Supply in the Conduct of Monetary Policy," Federal Reserve Bulletin 59 (November 1973): 795.

[2]Ibid, p. 794.

[3]Ibid, p. 795.

control of the Federal Reserve suggest that it may be virtually impossible to achieve absolute control of either monthly or quarterly rates of change in the money supply.

With respect to control of the money supply Burns further states, "The conduct of monetary policy could be improved if steps were taken to increase the precision with which the money supply can be controlled by the Federal Reserve. Part of the present control problem stems from . . . the paucity of data on deposits at non-member banks," and the fact that "non-member banks are not subject to the same reserve requirements as are Federal Reserve members."[4] Admittedly, the existence of non-member banks subject to different reserve requirements contributes to the variability of the money supply and hence could decrease the precision with which the money supply can be controlled. This is supported by the finding of a non-zero contribution of the non-member bank vault cash deposit ratio (r_4) to the monthly variability of the money supply.[5] Requiring all banks to be subject to the same reserve requirements, as proposed by Dr. Burns, would certainly reduce money supply variability. But this would only be a small beginning. Of all the variables analyzed, the behavior of r_4 was one of the least important in determining the variability of the money supply.

To the extent that the Federal Reserve desires to control monthly rates of change in the money supply, its own policies introduced during the latter half of the 1960's have increased the difficulty of

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[4]Ibid, p. 798.

[5]See Table VII.

achieving its goal. These policies include: the proliferation of reserve requirement categories, introduction of lagged reserve requirements and allowance for Regulation Q to become an effective constraint.[6]

On the other hand, if the Federal Reserve desires to control only quarterly rates of change in the money supply, then the introduction of lagged reserve requirements and increased splintering of reserve requirements will not significantly affect its ability to accomplish its goal.[7] However, Regulation Q could still adversely affect the ease with which control of the money supply can be obtained.

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[6]Although more frequent reserve requirement changes are a major contributor to the variability of the money supply, they are under the control of the Federal Reserve and hence do not directly diminish its ability to control the money supply. To the extent that frequent reserve requirement changes induce commercial banks to seek non-membership status, however, control of the money supply could be adversely affected.

[7]A caveat to this statement is in order. To control effectively the quarterly rates of change in the money supply, the Federal Reserve must be able to predict monthly variability. For this argument see pages 11-12.

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APPENDIXES

APPENDIX A

ANNUAL VARIANCES OF MONTHLY AND QUARTERLY RATES OF CHANGE IN MONEY SUPPLY, 1952-1973

TABLE XVI

ANNUAL VARIANCES OF MONTHLY AND QUARTERLY RATES OF CHANGE IN MONEY SUPPLY, SA, ANNUAL RATES 1952-1973

Monthly Rates of Change			
Year	Variance	Year	Variance
1952	20.726	1963	6.921
1953	10.177	1964	5.572
1954	30.271	1965	20.800
1955	21.704	1966	34.474
1956	11.315	1967	26.204
1957	9.067	1968	12.894
1958	30.130	1969	7.732
1959	19.169	1970	20.889
1960	13.936	1971	17.448
1961	15.680	1972	24.098
1962	11.956	1973	36.604
Quarterly Rates of Change			
Year	Variance	Year	Variance
1952	3.544	1963	0.382
1953	0.545	1964	2.862
1954	3.903	1965	10.506
1955	5.293	1966	9.861
1956	1.088	1967	7.460
1957	4.132	1968	3.738
1958	6.808	1969	5.601
1959	12.738	1970	0.815
1960	5.765	1971	10.783
1961	0.993	1972	1.722
1962	4.156	1973	1.631

Source: Money figures are seasonally adjusted figures based upon data taken from various issues of the Federal Reserve Bulletin. The seasonal adjustment procedure utilized is described in Chapter III of the text. Variances were computed utilizing monthly and quarterly rates of change in the money supply over each annual period.

APPENDIX B

RESERVE REQUIREMENT CHANGES, 1952 THROUGH 1973

Effective Date	Reserve Requirement Changes
July 1, 1953	the reserve requirement of country banks against their net demand deposits was reduced from 14 percent to 13 percent.
July 9, 1953	the reserve requirements of central reserve city banks and reserve city banks against their net demand deposits were reduced from 24 percent to 22 percent and 20 percent to 19 percent respectively. This action and that taken on July 1 reduced required reserves approximately $1.56 billion.
June 16, 1954	the reserve requirements of country banks against their time deposits was reduced from 6 percent to 5 percent.
June 24, 1954	the reserve requirement of central reserve city banks against their net demand deposits was reduced from 22 percent to 21 percent. Additionally, the reserve requirements of central reserve city banks and reserve city banks against their time deposits were reduced from 6 percent to 5 percent.
July 29, 1954	the reserve requirements of central reserve city banks and reserve city banks against their net demand deposits were reduced from 21 percent to 20 percent and 19 percent to 18 percent respectively.
Aug. 1, 1954	the reserve requirements of country banks against their net demand deposits was reduced from 13 percent to 12 percent. The total effect of reserve requirement changes during June, July, and August of 1954 reduced required reserves approximately $1.555 billion.
Feb. 27, 1958	the reserve requirement of central reserve city banks and reserve city banks against net demand deposits were reduced from 20 percent to 19½ percent and 18 percent to 17½ percent respectively. This action reduced required reserves approximately $320 million.
Mar. 1, 1958	the reserve requirement of country banks against net demand deposits was reduced from 12 percent to 11½ percent. This action reduced required reserves approximately $180 million.
Mar. 20, 1958	the reserve requirements of central reserve city banks and reserve city banks against net demand deposits were

reduced from 19½ percent to 19 percent and 17½ percent to 17 percent respectively. This action reduced required reserves approximately $315 million.

Apr. 1, 1958 — the reserve requirement of country banks against their net demand deposits was reduced from 11½ percent to 11 percent. This action reduced required reserves approximately $175 million.

Apr. 17, 1958 — the reserve requirement of central reserve city banks against their net demand deposits was reduced from 19 percent to 18½ percent. This action reduced required reserves approximately $130 million.

Apr. 24, 1958 — the reserve requirements of central reserve city banks and reserve city banks against their net demand deposits were reduced from 18½ percent to 18 percent and 17 percent to 16½ percent respectively. This action reduced required reserves approximately $320 million.

Sep. 1, 1960 — the reserve requirement of central reserve city banks against their net demand deposits was reduced from 18 percent to 17½ percent. This action reduced required reserves approximately $120 million and RPD's $100 million.

Nov. 24, 1960 — the reserve requirement of country banks against their net demand deposits was increased from 11 percent to 12 percent. This action increased required reserves approximately $380 million and RPD's $360 million.

Dec. 1, 1960 — the reserve requirement of central reserve city banks against their net demand deposits was reduced from 17½ percent to 16½ percent. This action reduced required reserves approximately $250 million and RPD's $200 million.

Oct. 25, 1962 — the reserve requirement of reserve city banks against their time deposits was reduced from 5 percent to 4 percent. This action reduced required reserves and RPD's approximately $410 million.

Nov. 1, 1962 — the reserve requirement of country banks against their time deposits was reduced from 5 percent to 4 percent. This action reduced required reserves and RPD's approximately $360 million.

Jul. 14, 1966 — the reserve requirement of reserve city banks against time deposits (other than savings deposits) in excess of $5 million was increased from 4 percent to 5 percent. This action increased required reserves and RPD's approximately $350 million.

Jul. 21, 1966 the reserve requirement of country banks against time deposits (other than savings deposits) in excess of $5 million was increased from 4 percent to 5 percent. This action increased required reserves and RPD's approximately $70 million.

Sep. 8, 1966 the reserve requirement of reserve city banks against time deposits (other than savings deposits) in excess of $5 million was increased from 5 percent to 6 percent. This action increased required reserves and RPD's approximately $370 million.

Sep. 16, 1966 the reserve requirement of country banks against time deposits (other than savings deposits) in excess of $5 million was increased from 5 percent to 6 percent. This action increased required reserves and RPD's approximately $75 million.

Mar. 2, 1967 the reserve requirements of all member banks against savings deposits and the first $5 million of time deposits was reduced from 4 percent to 3½ percent. This action reduced required reserves and RPD's approximately $425 million.

Mar. 16, 1967 the reserve requirements of all member banks against saving deposits and the first $5 million of time deposits was reduced from 3½ percent to 3 percent. This action reduced required reserves and RPD's approximately $425 million.

Jan. 11, 1968 the reserve requirement of reserve city banks against net demand deposits in excess of $5 million was increased from 16½ percent to 17 percent. This action increased required reserves approximately $360 million and RPD's $310 million.

Jan. 18, 1968 the reserve requirement of country banks against net demand deposits in excess of $5 million was increased from 12 percent to 12½ percent. This action increased required reserves approximately $190 million and RPD's $170 million.

Apr. 17, 1968 the reserve requirement of all member banks against net demand deposits was increased 1/2 percentage point. This action increased required reserves approximately $660 million and RPD's $590 million.

Oct. 16, 1969 a 10 percent marginal reserve requirement was established on certain foreign borrowings, primarily Eurodollars, by member banks and on the sale of assets to their foreign branches. This action increased required reserves and RPD's approximately $400 million.

Oct. 1, 1970 the reserve requirement of all member banks against time deposits (other than savings deposits) in excess of $5 million was reduced from 6 percent to 5 percent. At the same time, a 5 percent reserve requirement was imposed against funds obtained by member banks through the issuance of commercial paper by their affiliates. This action reduced required reserves and RPD's approximately $500 million (net).

Jan. 7, 1971 the reserve percentage required to be maintained against certain foreign borrowings, primarily Eurodollars, by member banks and the sale of assets to their foreign branches was raised from 10 percent to 20 percent. This action had little effect on required reserves and RPD's.

Nov. 9, 1972 regulations D and J were revised to (1) adopt a system of reserve requirements against demand deposits of all member banks based on the amount of such deposits held by a member bank, and (2) require banks - member and nonmembers - to pay cash items presented by a Federal Reserve Bank on the day of presentation in funds available to the Reserve Bank on that day. These changes reduced required reserves approximately $2.5 billion effective Nov. 9 and $1.0 billion effective Nov. 16, and increased required reserves $300 million, effective Nov. 23. On the same dates RPD's were reduced $2.3 billion and $785 million and increased $235 million respectively.

Jun. 21, 1973 the Board amended its Regulation D to establish a marginal reserve requirement of 8 percent against certain time deposits and to subject to the 8 percent reserve requirement certain deposits exempt from the rate limitations of the Board's Regulation Q. In addition, reserves against certain foreign branch deposits were reduced from 10 percent to 8 percent. These changes had little effect on required reserves or RPD's.

Jul. 12, 1973 the reserve requirements were imposed against finance bills. This action increased required reserves and RPD's approximately $90 million.

Jul. 19, 1973 the reserve requirement against all net demand deposits, except the first $2 million, was increased 1/2 percentage point. This action increased required reserves approximately $760 million and RPD's approximately $670 million.

Oct. 4, 1973 the marginal reserve requirement against certain time deposits was increased from 8 percent to 11 percent. This action increased required reserves and RPD's approximately $465 million.

Dec. 27, 1973	the marginal reserve requirement against certain time deposits was reduced from 11 percent to 8 percent. This action reduced required reserves and RPD's approximately $360 million.

Source: Selected Issues, Federal Reserve Bulletin.
Selected Issues, Annual Report of the Board of Governors of the Federal Reserve System.

APPENDIX C

FURTHER COMMENTS ON LAGGED RESERVE REQUIREMENTS

The effect of the introduction of lagged reserve requirements on the behavior of the required reserve-deposit ratio can be demonstrated by modifying the money supply hypothesis as presented in equations 1 through 7, pp. 13-14. It is assumed, for simplicity sake, that individuals hold zero time deposits, the U. S. Treasury holds zero deposits at commercial banks, commercial banks hold zero vault cash and all banks are members of the Federal Reserve System. Furthermore, required reserves this week, week t, are a specified proportion, r', of deposits held two weeks earlier, week t-2. Thus the system of equation specifying the money supply hypothesis is:

1) $M_t = D_t + C_t$ (1)

2) $S_t = R_t + C_t$ (2)

3) $R_t = r'D_{t-2} + eD_t$ (3)

4) $C_t = kD_t$ (4)

Substituting equations 3 and 4 into 2 gives:

5) $S_t = r'D_{t-2} + eD_t + kD_t$ (5)

Multiplying r' by D_t/D_t and manipulating terms yields:

6) $S_t = wr\ D_t + eD_t + kD_t$ (6)

where $w = D_{t-2}/D_t$.

Substituting equation 6 into 1 and solving for M_t, it is found that

7) $M_t = \frac{1 + k}{wr' + e + k} S_t$ (7)

The required reserve ratio, r, is thus equal to wr' and is a function of two elements: one, the legal reserve requirement ratio, r' , and two,

the relationship between deposits held in week t and deposits held during week t-2, as expressed by w.[1]

Given the model presented in this appendix, the effects over time of an injection of surplus reserves into the banking system are simulated, comparing contemporaneous with lagged reserve requirements. Initial conditions for both simulations are:

$$r' = 0.10$$

$$e = 0.05$$

$$k = 0.25$$

$$w = 1$$

$$S_t = \$400,000$$

As such in both simulations, the money supply in week t, the initial period, is $1,250,000. It should be pointed out that given contemporaneous reserve requirements, w should have a value of 1 since the reserve requirement ratio is not dependent upon the relationship between deposits in weeks t and t-2.

The initial conditions are allowed to prevail through week t+1. At the beginning of week t+2, the Federal Reserve purchases $100,000 of securities from the non-bank public, whereby surplus reserves are injected indirectly into the banking system. The effects of this action are presented in Tables XVII and XVIII. Table XVII presents the results utilizing contemporaneous reserve requirements, whereas the results for lagged reserve requirements are presented in Table XVIII. In both simulations it is assumed the banking system achieves reserve equilibrium each week.[2]

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[1]A formulation similar to this is presented by Albert Burger, The Money Supply Process (Belmont, CA: Wadsworth Publishing Company, Inc., 1971), pp. 52-53.

With the injection of surplus reserves the banking system is initially out of equilibrium. Given contemporaneous reserve requirements, at least three channels exists through which reserve equilibrium can be reestablished. First, currency held by the non-bank public may increase as earning assets are expanded by commercial banks. As such, reserves flow out of the banking system reducing surplus reserves. Secondly, as deposits are created in the earning asset expansion process, required reserves increase absorbing additional surplus reserves. And thirdly, surplus reserves are further decreased as desired excess reserves increase. Desired excess reserves may increase for two reasons. One, as deposits expand commercial banks may hold additional excess reserve as a larger cushion against unexpected deposit withdrawals. And two, as the Federal Reserve purchases securities and banks find themselves holding surplus reserves, interest rates are bid downward. Given the inverse relationship between interest rates and the e-ratio, the e-ratio increases, hence the amount of excess reserves held increases. This latter effect is reflected in Table XVII as an increase in the e-ratio from 0.05 to 0.0525 in period t+2.

In the process of extinguishing surplus reserves demand deposits are increased to $1,242,236, currency increases to $310,559, and hence the money supply expands to $1,552,795. And, in the absence of further injections of reserves demand deposits, currency and the money supply all remain at their new higher levels.

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[2]The means of achieving reserve equilibrium are restricted in that banks are not allowed to borrow from the Federal Reserve, hence the source base is not affected by reserve adjustments.

TABLE XVII

SIMULATION WITH CONTEMPORANEOUS RESERVE REQUIREMENTS

Week/ Variable	Money Supply (M) $	Demand Deposits (D) $	Currency (C) $	Source Base (S) $	Required Reserves (R) $	w	Actual Reserve Requirement Ratio (r)	Excess Reserve Ratio (e)	Excess Reserves (eD_t) $
t	1,250,000	1,000,000	250,000	400,000	100,000	1	0.10	0.05	50,000
t+1	1,250,000	1,000,000	250,000	400,000	100,000	1	0.10	0.05	50,000
t+2	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
t+3	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
t+4	1,552,795	1,242,236	310,599	500,000	124,224	1	0.10	0.0525	65,217
t+5	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
t+6	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
t+7	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
t+8	1,552,795	1,242,236	210,559	500,000	124,224	1	0.10	0.0525	65,217
t+9	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
t+10	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217
$t+\infty$	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217

TABLE XVIII

SIMULATION WITH LAGGED RESERVE REQUIREMENTS

Week/ Variable	Money Supply (M) $	Demand Deposits (D) $	Currency (C) $	Source Base (S) $	Required Reserves (R) $	w	Actual Reserve Requirement Ratio (r)	Excess Reserve Ratio (e)	Excess Reserves (eD_t) $
t	1,250,000	1,000,000	250,000	400,000	100,000	1	0.10	0.05	50,000
t+1	1,250,000	1,000,000	250,000	400,000	100,000	1	0.10	0.05	50,000
t+2	1,639,344	1,311,475	327,869	500,000	100,000	0.7625	0.07625	0.055	72,131
t+3	1,639,344	1,311,475	327,869	500,000	100,000	0.7625	0.07625	0.055	72,131
t+4	1,524,184	1,219,347	304,837	500,000	131,476	1.0756	0.10756	0.0525	64,016
t+5	1,524,184	1,219,347	304,837	500,000	131,476	1.0756	0.10756	0.0525	64,016
t+6	1,562,253	1,249,803	312,451	500,000	121,935	0.9756	0.09756	0.0525	65,615
t+7	1,562,253	1,249,803	312,451	500,000	121,935	0.9756	0.09756	0.0525	65,615
t+8	1,549,668	1,239,735	309,934	500,000	124,980	1,0081	0.10081	0.0525	65,086
t+9	1,549,668	1,239,735	309,934	500,000	124,980	1.0081	0.10081	0.0525	65,086
t+10	1,553,829	1,243,063	310,766	500,000	123,974	0.9973	0.09973	0.0525	65,261
$t+\infty$	1,552,795	1,242,236	310,559	500,000	124,224	1	0.10	0.0525	65,217

With lagged reserve requirements, the adjustment process is different as shown in Table XVIII. Given the same increase in the source base during period t+2, the increase in the money supply is much greater than with contemporaneous reserve requirements. The reason for the difference in results is the fact that required reserves in period t+2 are equal to 10 percent of deposits in period t. They are fixed at $100,000, and remain constant during period t+2 no matter what the level of deposits might be. As such, surplus reserves cannot be decreased during t+2 through an increase in required reserves. Surplus reserves for the banking system are extinguished only insofar as interest rates decrease and deposits expand such that desired excess reserves and currency held by the non-bank public increase. In that interest rates are expected to fall by a greater amount than before, the e-ratio will rise by a greater amount; the rise is assumed to be from 0.05 to 0.055. Note also the behavior of the r-ratio. Even in the absence of legal reserve requirement changes, the r-ratio decreases.

In period t+4 required reserves increase as they are now computed on the basis of the higher level of deposits in period t+2. Assuming the banking system was in equilibrium at the end of period t+3, the banking system finds itself in a deficient reserve position. Each commercial bank attempts to reachieve equilibrium by selling earning assets to the non-bank public or by calling in loans. This results in an increase in interest rates, hence a decrease in the e-ratio to 0.0525; and it leads to decreases in deposits and currency held by the non-bank public. As interest rates increase and deposits decrease, the amount of desired excess reserves held by commercial banks shrinks freeing reserves which

can be utilized to satisfy reserve requirements. As currency held by the non-bank public decreases, reserves flow into the banking system reducing further the deficiency in reserves. Lost, however, is the process of closing a deficiency in a given settlement period through a reduction of required reserves as deposits decrease. Hence, deposits, currency held by the non-bank public, interest rates and desired excess reserves must all change by greater amounts to extinguish the deficiency. Again, note the change in the actual required reserve ratio, r.

In period t+6 required reserves fall from $131,476 to $121,935 as they are now computed as 10 percent of deposits in period t+4. This change in required reserves leaves the banking system in a surplus reserve position necessitating further adjustments. These adjustments will continue to be made over a series of reserve settlement periods until required reserves are equal to rD_t; this condition holds only if $D_t = D_{t-2}$. When this condition is satisfied, it should be noted, the money supply and its components will be exactly equal to the amounts obtained given contemporaneous reserve requirements. Compare period $t+\infty$ in Tables XVII and XVIII.

In summary, this simulation provides the following conclusions. One, with lagged reserve requirements demand deposits, currency held by the non-bank public, and hence the money supply must all change by greater amounts as commercial banks attempt to achieve reserve equilibrium within a given reserve settlement period. Two, whenever, deposits held in week t-2 are different from those held in week t, commercial banks find themselves in disequilibrium necessitating reserve adjustment which leads to further changes in the money supply. Three, as a result of the method of reserve computation with lagged reserve

requirements, the required reserve ratio will become more variable, more difficult to predict. This may decrease the Federal Reserves' ability to control the money supply. Fourth, the means of adjusting reserves through reserve requirement changes within a given reserve settlement period is permanently lost. This loss results in greater variability in the other reserve adjustment variables. Over a series of reserve adjustment periods, however, reserve requirement changes are a means of extinguishing reserve surpluses or deficiencies. It simply requires a longer period of time for this adjustment channel to become effective.

APPENDIX D

SEASONAL ADJUSTMENT FACTORS
1952-1973

TABLE XIX

SEASONAL ADJUSTMENT FACTORS 1952-1959

Period	Money Supply	Source Base	Currency in Circulation	Required Reserves	Excess Reserves	Vault Cash of Member Banks	Currency Held by Non-Bank Public	Demand Deposits	Time Deposits	Government Deposits
Jan.	102.49	100.98	100.30	101.87	106.56	105.27	99.95	103.15	99.40	64.66
Feb.	100.40	99.36	99.20	100.14	93.96	98.59	99.06	100.72	99.64	79.72
Mar.	99.55	99.25	99.00	99.83	99.72	95.01	99.11	99.64	100.02	93.89
Apr.	99.13	99.03	98.85	99.55	93.76	96.03	99.09	99.14	100.18	103.71
May.	98.74	98.99	99.01	99.19	93.46	94.76	99.25	98.60	100.22	107.75
Jun.	99.35	99.75	99.59	99.91	102.34	97.46	99.63	99.30	100.51	98.96
Jul.	98.80	99.90	100.02	99.57	104.90	98.71	100.15	98.45	100.57	123.70
Aug.	98.76	99.39	99.84	98.66	100.44	97.46	99.98	98.39	100.47	118.92
Sep.	99.46	99.77	100.21	99.00	102.21	101.41	100.26	99.26	100.33	102.90
Oct.	100.01	100.20	100.36	99.97	98.59	100.45	100.49	99.87	100.25	109.63
Nov.	100.83	100.86	101.09	100.08	98.88	101.74	101.03	100.77	99.50	104.38
Dec.	102.53	102.56	102.71	102.23	105.18	113.10	101.98	102.66	98.88	91.79

TABLE XX

SEASONAL ADJUSTMENT FACTORS 1958-1966

Period	Money Supply	Source Base	Currency in Circulation	Required Reserves	Excess Reserves	Vault Cash of Member Banks	Currency Held by Non-Bank Public	Demand Deposits	Time Deposits	Government Deposits
Jan.	102.60	100.43	100.28	101.75	107.26	106.86	99.66	103.35	99.57	74.35
Feb.	99.86	98.89	98.80	99.33	100.29	98.74	98.88	100.10	99.88	90.68
Mar.	99.14	98.81	98.82	98.97	89.30	96.47	98.98	99.17	100.24	93.33
Apr.	100.26	99.14	99.01	99.45	93.78	97.63	99.18	100.55	100.42	73.09
May.	98.40	99.19	99.05	99.27	93.56	96.73	99.23	98.14	100.50	122.74
Jun.	98.80	99.71	99.68	99.60	92.08	98.35	99.74	98.55	100.38	118.46
Jul.	99.02	100.41	100.35	100.09	99.72	98.96	100.44	98.63	100.58	121.50
Aug.	98.68	100.07	100.05	99.33	106.53	97.86	100.31	98.25	100.06	112.94
Sep.	99.44	100.09	100.07	99.83	100.07	99.84	100.19	99.26	100.19	105.10
Oct.	100.11	100.35	100.10	100.38	97.90	99.27	100.21	100.10	100.06	102.90
Nov.	101.00	100.84	101.02	100.05	106.09	100.64	101.03	101.00	99.24	94.16
Dec.	102.70	102.07	102.72	101.92	113.42	108.64	102.10	102.86	98.84	90.75

TABLE XXI

SEASONAL ADJUSTMENT FACTORS 1965-1973

Period	Money Supply	Source Base	Currency in Circulation	Required Reserves	Excess Reserves	Vault Cash of Member Banks	Currency Held by Non-Bank Public	Demand Deposits	Time Deposits	Government Deposits
Jan.	102.57	100.89	100.35	103.14	107.57	107.78	99.62	103.40	99.65	93.98
Feb.	98.93	99.24	98.79	100.25	99.41	99.98	98.85	98.95	99.91	120.93
Mar.	98.99	99.01	98.81	99.10	99.71	97.22	99.07	98.97	100.50	90.62
Apr.	100.53	99.46	99.13	99.89	73.76	97.19	99.30	100.87	100.48	93.88
May.	98.36	99.60	99.30	99.78	96.60	97.36	99.56	98.03	100.44	114.93
Jun.	99.54	99.64	99.98	98.75	93.49	98.32	100.02	99.38	100.02	101.85
Jul.	99.53	100.38	100.52	100.09	83.92	99.54	100.64	99.24	99.93	117.72
Aug.	98.62	99.89	100.12	99.18	107.85	98.97	100.26	98.19	100.26	96.56
Sep.	99.50	99.85	99.94	99.62	107.75	100.16	99.89	99.39	100.04	97.89
Oct.	100.03	100.12	99.87	100.49	101.07	99.10	100.00	100.04	100.04	95.41
Nov.	100.65	100.33	100.81	99.33	111.85	99.97	100.88	100.56	99.43	81.88
Dec.	102.75	101.58	102.38	100.48	117.01	104.40	101.94	102.97	99.31	94.36

APPENDIX E

DATA UTILIZED IN THE ANALYSIS (SEASONALLY ADJUSTED)

$m = \frac{1+k}{r+t+k}$

Year and Month		Source Base (Billions) (S)	Required Reserve Ratio (r)	Currency-Deposit Ratio (k)	Desired Excess Reserve Ratio (e)	Non-Member Bank Vault Cash Ratio (v)	Time Deposit-Deposit Ratio (t)	Government Deposit Ratio (g)
1952	1	48.630	0.13800	0.27041	0.01877	0.00436	0.39853	0.03510
	2	48.715	0.13749	0.27079	0.01775	0.00384	0.39814	0.04254
	3	49.012	0.13747	0.27043	0.01872	0.00384	0.39786	0.04250
	4	48.708	0.13694	0.27277	0.01744	0.00424	0.40264	0.04476
	5	48.817	0.13687	0.27104	0.01727	0.00413	0.40109	0.04082
	6	49.106	0.13683	0.27034	0.01727	0.00424	0.40044	0.04416
	7	49.613	0.13874	0.27086	0.01625	0.00415	0.40308	0.06242
	8	49.697	0.13816	0.27077	0.01676	0.00388	0.40318	0.05552
	9	49.972	0.13762	0.27028	0.01754	0.00395	0.40313	0.05071
	10	50.066	0.13748	0.27113	0.01687	0.00405	0.40568	0.04934
	11	50.216	0.13736	0.27185	0.01688	0.00383	0.40952	0.04976
	12	50.384	0.13610	0.27170	0.01704	0.00415	0.41226	0.05320
1953	1	50.384	0.13494	0.27430	0.01683	0.00408	0.41674	0.05725
	2	50.562	0.13451	0.27537	0.01696	0.00389	0.41717	0.05765
	3	50.547	0.13490	0.27464	0.01641	0.00395	0.41616	0.04655
	4	50.277	0.13420	0.27608	0.01642	0.00448	0.41956	0.03562
	5	50.274	0.13385	0.27641	0.01688	0.00439	0.41952	0.02583
	6	50.424	0.13376	0.27480	0.01782	0.00413	0.42143	0.02606
	7	49.868	0.12828	0.27548	0.01738	0.00393	0.42433	0.04172
	8	49.998	0.12798	0.27579	0.01654	0.00386	0.42647	0.05671
	9	49.995	0.12721	0.27622	0.01700	0.00398	0.43036	0.05402
	10	49.802	0.12632	0.27481	0.01755	0.00434	0.43442	0.03792
	11	49.844	0.12677	0.27435	0.01694	0.00441	0.43874	0.04647
	12	49.617	0.12535	0.27522	0.01632	0.00422	0.44168	0.04091
1954	1	49.971	0.12501	0.27332	0.01811	0.00409	0.44450	0.04576
	2	49.779	0.12469	0.27332	0.01669	0.00347	0.44662	0.04569
	3	49.746	0.12474	0.27166	0.01683	0.00394	0.44800	0.04186
	4	49.628	0.12438	0.27469	0.01779	0.00391	0.45613	0.03832
	5	49.809	0.12477	0.27031	0.01718	0.00406	0.45332	0.03544
	6	49.650	0.12314	0.26880	0.01760	0.00407	0.45606	0.03852
	7	49.181	0.11990	0.26686	0.01743	0.00406	0.45902	0.03300
	8	48.671	0.11537	0.26565	0.01755	0.00423	0.46215	0.03994
	9	48.506	0.11481	0.26536	0.01707	0.00393	0.46284	0.03760
	10	48.872	0.11528	0.26400	0.01672	0.00379	0.46215	0.05348
	11	49.072	0.11567	0.26214	0.01731	0.00387	0.46218	0.05679
	12	48.779	0.11436	0.26078	0.01645	0.00399	0.46272	0.05192
1955	1	48.746	0.11373	0.25945	0.01624	0.00416	0.46179	0.04391
	2	48.916	0.11360	0.25774	0.01628	0.00391	0.45785	0.04356
	3	48.791	0.11370	0.25941	0.01590	0.00380	0.45949	0.03811
	4	49.083	0.11436	0.25890	0.01607	0.00413	0.45870	0.04440
	5	49.103	0.11422	0.25826	0.01596	0.00384	0.45738	0.04255
	6	48.887	0.11363	0.25833	0.01568	0.00389	0.45813	0.03783
	7	49.157	0.11413	0.25762	0.01597	0.00406	0.45751	0.03464
	8	49.318	0.11470	0.25888	0.01588	0.00410	0.46035	0.03850
	9	49.244	0.11420	0.25867	0.01570	0.00410	0.46213	0.03536
	10	49.303	0.11382	0.25866	0.01556	0.00423	0.46373	0.03824
	11	49.269	0.11402	0.26023	0.01557	0.00415	0.46830	0.03855
	12	49.244	0.11314	0.25944	0.01585	0.00373	0.46730	0.03451
1956	1	49.275	0.11311	0.25896	0.01552	0.00389	0.46478	0.03156
	2	49.238	0.11275	0.25888	0.01587	0.00377	0.46439	0.03147
	3	49.552	0.11316	0.25906	0.01594	0.00376	0.46428	0.04048
	4	49.573	0.11318	0.25780	0.01581	0.00390	0.46306	0.03646
	5	49.558	0.11310	0.25887	0.01551	0.00424	0.46646	0.04390
	6	49.593	0.11285	0.25823	0.01602	0.00437	0.46774	0.03928
	7	49.637	0.11289	0.25937	0.01612	0.00420	0.47062	0.02915
	8	49.736	0.11361	0.25996	0.01599	0.00400	0.47487	0.03434
	9	49.842	0.11374	0.25927	0.01594	0.00407	0.47576	0.03956
	10	49.704	0.11278	0.25950	0.01573	0.00397	0.47781	0.03289
	11	49.958	0.11316	0.25964	0.01607	0.00434	0.47807	0.03717
	12	50.029	0.11242	0.26002	0.01617	0.00402	0.47861	0.03410
1957	1	49.846	0.11211	0.25964	0.01536	0.00425	0.48420	0.02846
	2	49.729	0.11144	0.25954	0.01578	0.00388	0.48923	0.02196
	3	49.826	0.11118	0.25924	0.01553	0.00408	0.49442	0.02942
	4	50.188	0.11150	0.25915	0.01547	0.00397	0.49618	0.03891
	5	49.977	0.11085	0.25949	0.01530	0.00408	0.50110	0.03500
	6	50.009	0.11051	0.26097	0.01518	0.00399	0.50637	0.03727
	7	50.295	0.11107	0.26042	0.01527	0.00413	0.50772	0.03638
	8	50.175	0.11094	0.25980	0.01548	0.00432	0.51066	0.02393

Year and Month	Source Base (Billions) (S)	Required Reserve Ratio (r)	Currency-Deposit Ratio (k)	Desired Excess Reserve Ratio (e)	Non-Member Bank Vault Cash Ratio (v)	Time Deposit-Deposit Ratio (t)	Government Deposit Ratio (g)
1957 9	50.214	0.11082	0.26106	0.01528	0.00414	0.51718	0.03134
10	50.049	0.11031	0.26159	0.01491	0.00414	0.52350	0.03546
11	49.864	0.11009	0.26267	0.01520	0.00395	0.52690	0.02667
12	50.070	0.10926	0.26352	0.01541	0.00415	0.53322	0.03546
1958 1	50.005	0.10952	0.26382	0.01534	0.00400	0.53683	0.03089
2	50.048	0.10857	0.26088	0.01553	0.00408	0.54825	0.02715
3	49.802	0.10520	0.26072	0.01572	0.00565	0.55920	0.04252
4	49.503	0.10216	0.26013	0.01555	0.00394	0.56657	0.04376
5	49.471	0.10023	0.25886	0.01569	0.00412	0.57024	0.04364
6	49.773	0.10064	0.25742	0.01523	0.00378	0.57323	0.05004
7	49.793	0.10045	0.25806	0.01523	0.00396	0.58151	0.04445
8	49.983	0.10056	0.25624	0.01500	0.00408	0.58192	0.04116
9	49.802	0.09982	0.25568	0.01496	0.00409	0.58289	0.03458
10	49.727	0.09937	0.25556	0.01485	0.00371	0.58191	0.03545
11	49.848	0.09949	0.25404	0.01473	0.00396	0.57935	0.03501
12	50.107	0.09894	0.25460	0.01438	0.00414	0.58137	0.03802
1959 1	50.064	0.09833	0.25313	0.01418	0.00344	0.58249	0.04067
2	50.177	0.09832	0.25231	0.01425	0.00350	0.57993	0.04438
3	50.142	0.09816	0.25224	0.01433	0.00350	0.57952	0.03465
4	50.432	0.09839	0.25066	0.01407	0.00385	0.57986	0.04538
5	50.530	0.09801	0.25131	0.01436	0.00364	0.58100	0.03921
6	50.400	0.09733	0.25202	0.01405	0.00400	0.58331	0.03199
7	50.632	0.09777	0.25013	0.01386	0.00410	0.57943	0.03446
8	50.744	0.09880	0.25084	0.01427	0.00411	0.56308	0.03797
9	50.647	0.09745	0.25171	0.01401	0.00380	0.58364	0.04334
10	50.443	0.09705	0.25146	0.01436	0.00414	0.58554	0.04012
11	50.399	0.09727	0.25178	0.01425	0.00396	0.58562	0.04125
12	50.236	0.09656	0.25262	0.01411	0.00390	0.58867	0.04692
1960 1	50.359	0.09662	0.25463	0.01447	0.00343	0.58908	0.04842
2	50.083	0.09644	0.25331	0.01367	0.00404	0.58396	0.03959
3	49.993	0.09598	0.25447	0.01329	0.00395	0.58659	0.04043
4	49.986	0.09586	0.25590	0.01312	0.00386	0.59235	0.04340
5	50.094	0.09588	0.25454	0.01301	0.00396	0.59167	0.04573
6	50.072	0.09562	0.25450	0.01311	0.00396	0.59763	0.04671
7	50.176	0.09537	0.25311	0.01291	0.00411	0.60018	0.04817
8	50.167	0.09478	0.25112	0.01244	0.00367	0.60472	0.04675
9	49.803	0.09396	0.25157	0.01083	0.00379	0.61120	0.04450
10	49.852	0.09380	0.25189	0.01056	0.00396	0.61896	0.04805
11	49.793	0.09433	0.25186	0.00924	0.00392	0.62570	0.05350
12	48.699	0.09412	0.25186	0.00345	0.00396	0.63284	0.04499
1961 1	48.770	0.09404	0.25119	0.00358	0.00435	0.63901	0.04793
2	48.916	0.09397	0.24895	0.00332	0.00429	0.64286	0.04556
3	48.839	0.09375	0.24831	0.00317	0.00431	0.64726	0.04328
4	48.808	0.09359	0.24868	0.00330	0.00421	0.65469	0.03292
5	48.826	0.09280	0.24597	0.00295	0.00441	0.65750	0.03256
6	48.935	0.09270	0.24659	0.00333	0.00420	0.66638	0.03233
7	48.932	0.09233	0.24762	0.00292	0.00430	0.67322	0.03014
8	49.236	0.09244	0.24720	0.00280	0.00427	0.68063	0.04136
9	49.485	0.09229	0.24747	0.00286	0.00438	0.68329	0.04187
10	49.772	0.09255	0.24762	0.00251	0.00435	0.68746	0.05250
11	50.018	0.09270	0.24722	0.00283	0.00426	0.69063	0.05180
12	50.174	0.09247	0.24796	0.00242	0.00407	0.69378	0.04526
1962 1	50.270	0.09193	0.24872	0.00280	0.00427	0.70548	0.04294
2	50.323	0.09122	0.24864	0.00238	0.00392	0.71670	0.04334
3	50.536	0.09069	0.24900	0.00249	0.00414	0.73095	0.04476
4	50.754	0.09033	0.24988	0.00254	0.00429	0.74121	0.04338
5	50.861	0.09036	0.24914	0.00250	0.00430	0.74543	0.04747
6	50.970	0.09009	0.25120	0.00246	0.00407	0.75796	0.05076
7	51.052	0.08986	0.25236	0.00244	0.00416	0.76685	0.04819
8	51.070	0.08938	0.25344	0.00244	0.00412	0.77898	0.05052
9	51.185	0.08933	0.25397	0.00207	0.00422	0.78620	0.05753
10	51.313	0.08865	0.25369	0.00223	0.00405	0.79397	0.05932
11	50.863	0.08536	0.25426	0.00251	0.00390	0.80259	0.05403
12	51.154	0.08510	0.25369	0.00224	0.00413	0.81221	0.05123
1963 1	51.263	0.08490	0.25324	0.00199	0.00419	0.81941	0.05342
2	51.526	0.08449	0.25454	0.00207	0.00399	0.82704	0.05187
3	51.754	0.08413	0.25590	0.00207	0.00399	0.83870	0.05304
4	51.836	0.08365	0.25614	0.00201	0.00409	0.84410	0.04724
5	52.062	0.08352	0.25550	0.00210	0.00412	0.84876	0.04731
6	52.244	0.08330	0.25769	0.00174	0.00406	0.85783	0.05182
7	52.528	0.08306	0.25744	0.00206	0.00385	0.85854	0.05220

Year and Month		Source Base (Billions) (S)	Required Reserve Ratio (r)	Currency-Deposit Ratio (k)	Desired Excess Reserve Ratio (e)	Non-Member Bank Vault Cash Ratio (v)	Time Deposit-Deposit Ratio (t)	Government Deposit Ratio (g)
1963	8	52.480	0.08219	0.25886	0.00184	0.00387	0.87453	0.04540
	9	52.787	0.08239	0.25943	0.00174	0.00388	0.87803	0.05101
	10	52.855	0.08190	0.25880	0.00174	0.00396	0.88413	0.04162
	11	53.263	0.08201	0.25907	0.00161	0.00407	0.89153	0.03667
	12	53.792	0.08188	0.26093	0.00195	0.00421	0.90388	0.04523
1964	1	53.842	0.08165	0.26067	0.00163	0.00413	0.90993	0.04421
	2	54.000	0.08126	0.26180	0.00160	0.00405	0.91876	0.04242
	3	54.408	0.08132	0.26383	0.00163	0.00380	0.92460	0.05150
	4	54.439	0.08094	0.26412	0.00164	0.00370	0.92813	0.04589
	5	54.642	0.08070	0.26637	0.00145	0.00351	0.93759	0.04424
	6	55.057	0.08074	0.26636	0.00169	0.00366	0.94373	0.05103
	7	55.120	0.08037	0.26432	0.00159	0.00382	0.93988	0.04474
	8	55.334	0.07988	0.26542	0.00154	0.00363	0.95051	0.04381
	9	55.763	0.08015	0.26362	0.00164	0.00397	0.94873	0.04819
	10	55.882	0.07969	0.26365	0.00164	0.00370	0.95549	0.04141
	11	56.276	0.07966	0.26485	0.00143	0.00372	0.96708	0.04764
	12	56.493	0.07920	0.26393	0.00138	0.00385	0.97524	0.04666
1965	1	56.645	0.07843	0.26497	0.00142	0.00378	0.98853	0.03830
	2	56.997	0.07813	0.26544	0.00166	0.00406	1.00464	0.04134
	3	57.237	0.07826	0.26582	0.00134	0.00400	1.01457	0.05506
	4	57.391	0.07835	0.26584	0.00161	0.00365	1.02010	0.05038
	5	57.467	0.07790	0.26777	0.00125	0.00389	1.03670	0.06149
	6	57.880	0.07829	0.26764	0.00136	0.00382	1.04419	0.06328
	7	58.074	0.07764	0.26798	0.00138	0.00372	1.04984	0.05726
	8	58.192	0.07665	0.26912	0.00144	0.00385	1.06412	0.05298
	9	58.476	0.07661	0.26851	0.00132	0.00369	1.06265	0.04077
	10	58.916	0.07615	0.26818	0.00122	0.00394	1.06951	0.03760
	11	59.263	0.07616	0.26889	0.00119	0.00397	1.08039	0.03464
	12	59.863	0.07668	0.26848	0.00137	0.00370	1.08197	0.03669
1966	1	60.004	0.07564	0.26839	0.00115	0.00399	1.08418	0.03308
	2	60.273	0.07549	0.26964	0.00128	0.00389	1.09003	0.03530
	3	60.467	0.07562	0.26891	0.00111	0.00397	1.09317	0.03569
	4	60.863	0.07573	0.26790	0.00145	0.00381	1.09609	0.02596
	5	60.986	0.07491	0.27124	0.00131	0.00385	1.11837	0.04353
	6	61.171	0.07529	0.27094	0.00117	0.00371	1.11796	0.04017
	7	61.798	0.07577	0.27514	0.00147	0.00381	1.14012	0.04894
	8	61.655	0.07533	0.27629	0.00106	0.00401	1.15188	0.03569
	9	62.278	0.07659	0.27526	0.00128	0.00379	1.14222	0.03078
	10	62.381	0.07667	0.27741	0.00102	0.00372	1.14444	0.03528
	11	62.610	0.07689	0.27849	0.00120	0.00402	1.14756	0.03070
	12	63.000	0.07730	0.27857	0.00114	0.00382	1.15100	0.02670
1967	1	63.160	0.07583	0.28142	0.00114	0.00384	1.17501	0.03177
	2	63.684	0.07587	0.27964	0.00117	0.00416	1.18544	0.03044
	3	63.708	0.07450	0.27830	0.00140	0.00393	1.18929	0.03872
	4	63.520	0.07397	0.28007	0.00134	0.00388	1.21111	0.03684
	5	63.600	0.07270	0.27825	0.00121	0.00409	1.21485	0.04038
	6	64.186	0.07352	0.27761	0.00141	0.00372	1.22589	0.02782
	7	64.482	0.07287	0.27596	0.00133	0.00378	1.23031	0.03396
	8	64.682	0.07243	0.27447	0.00110	0.00376	1.23303	0.03094
	9	65.267	0.07278	0.27470	0.00101	0.00383	1.23739	0.03530
	10	65.719	0.07271	0.27427	0.00085	0.00364	1.23715	0.04528
	11	66.208	0.07305	0.27408	0.00107	0.00349	1.24549	0.04419
	12	66.699	0.07389	0.27506	0.00088	0.00350	1.24792	0.03606
1968	1	66.981	0.07311	0.27529	0.00105	0.00374	1.24964	0.03602
	2	67.630	0.07390	0.27499	0.00118	0.00382	1.25503	0.04016
	3	68.167	0.07425	0.27678	0.00104	0.00369	1.25963	0.04982
	4	68.191	0.07421	0.27692	0.00107	0.00373	1.25618	0.03072
	5	68.325	0.07308	0.27569	0.00126	0.00372	1.24862	0.03759
	6	69.085	0.07425	0.27597	0.00108	0.00366	1.24778	0.03630
	7	69.336	0.07355	0.27478	0.00102	0.00372	1.25021	0.03221
	8	69.924	0.07316	0.27546	0.00098	0.00363	1.26260	0.03836
	9	70.146	0.07221	0.27614	0.00099	0.00379	1.27311	0.03968
	10	70.688	0.07258	0.27500	0.00117	0.00371	1.28259	0.04242
	11	71.425	0.07289	0.27456	0.00079	0.00344	1.28673	0.03491
	12	71.956	0.07229	0.27402	0.00106	0.00390	1.29020	0.03341
1969	1	72.130	0.07326	0.27348	0.00055	0.00335	1.27520	0.03266
	2	72.420	0.07320	0.27392	0.00062	0.00346	1.26515	0.03560
	3	72.399	0.07274	0.27456	0.00059	0.00349	1.25853	0.03297
	4	72.676	0.07304	0.27330	0.00056	0.00380	1.25177	0.03498
	5	73.612	0.07459	0.27510	0.00084	0.00337	1.24869	0.04960
	6	73.726	0.07407	0.27655	0.00100	0.00376	1.24540	0.03645

Year and Month		Source Base (Billions) (S)	Required Reserve Ratio (r)	Currency-Deposit Ratio (k)	Desired Excess Reserve Ratio (e)	Non-Member Bank Vault Cash Ratio (v)	Time Deposit-Deposit Ratio (t)	Government Deposit Ratio (g)
1969	7	73.286	0.07347	0.27650	0.00038	0.00379	1.21981	0.02929
	8	73.839	0.07460	0.27964	0.00078	0.00356	1.20726	0.02750
	9	73.787	0.07409	0.27996	0.00060	0.00385	1.20269	0.03342
	10	74.253	0.07494	0.28073	0.00039	0.00395	1.19631	0.02710
	11	75.257	0.07612	0.28220	0.00062	0.00364	1.19340	0.03897
	12	75.470	0.07608	0.28249	0.00060	0.00437	1.19451	0.03644
1970	1	75.629	0.07660	0.28097	0.00042	0.00376	1.17412	0.03101
	2	75.801	0.07620	0.28380	0.00076	0.00400	1.18064	0.03588
	3	75.903	0.07511	0.28324	0.00031	0.00392	1.18137	0.04615
	4	76.604	0.07563	0.28210	0.00043	0.00403	1.19233	0.03394
	5	76.903	0.07463	0.28520	0.00050	0.00382	1.20192	0.03343
	6	77.106	0.07386	0.28602	0.00053	0.00399	1.21307	0.03828
	7	77.574	0.07324	0.28588	0.00044	0.00378	1.23988	0.03441
	8	78.205	0.07292	0.28444	0.00034	0.00379	1.25908	0.04342
	9	78.768	0.07243	0.28278	0.00064	0.00408	1.27761	0.04131
	10	78.562	0.07087	0.28357	0.00063	0.00371	1.29748	0.03799
	11	79.019	0.07082	0.28366	0.00026	0.00371	1.31086	0.04049
	12	79.679	0.07038	0.28421	0.00057	0.00372	1.33093	0.04483
1971	1	80.414	0.07058	0.28471	0.00062	0.00376	1.35530	0.04180
	2	81.080	0.07026	0.28459	0.00048	0.00378	1.37404	0.04027
	3	81.531	0.06966	0.28371	0.00047	0.00376	1.39100	0.03446
	4	81.973	0.06915	0.28447	0.00044	0.00358	1.39444	0.03363
	5	82.737	0.06911	0.28284	0.00074	0.00350	1.39572	0.03882
	6	83.061	0.06882	0.28246	0.00032	0.00380	1.40677	0.02991
	7	83.760	0.06842	0.28338	0.00044	0.00368	1.40551	0.03267
	8	84.096	0.06821	0.28380	0.00041	0.00370	1.41244	0.03974
	9	84.504	0.06820	0.28546	0.00042	0.00369	1.43122	0.04322
	10	84.547	0.06743	0.28646	0.00045	0.00357	1.45145	0.03106
	11	85.158	0.06789	0.28612	0.00052	0.00387	1.46581	0.02676
	12	85.364	0.06714	0.28684	0.00030	0.00373	1.48483	0.03996
1972	1	86.387	0.06793	0.28771	0.00034	0.00388	1.50440	0.04299
	2	86.714	0.06751	0.28757	0.00027	0.00351	1.50587	0.03307
	3	87.559	0.06714	0.28674	0.00049	0.00366	1.50112	0.04664
	4	88.338	0.06769	0.28618	0.00038	0.00374	1.50397	0.04357
	5	88.885	0.06760	0.28734	0.00022	0.00384	1.52504	0.04849
	6	89.197	0.06721	0.28766	0.00045	0.00383	1.54090	0.03583
	7	89.689	0.06669	0.28507	0.00036	0.00388	1.53184	0.03229
	8	90.279	0.06666	0.28431	0.00047	0.00390	1.54539	0.02840
	9	90.272	0.06558	0.28539	0.00030	0.00362	1.55982	0.03160
	10	91.363	0.06573	0.28546	0.00048	0.00394	1.56762	0.03599
	11	89.877	0.06167	0.28632	0.00055	0.00390	1.57699	0.03920
	12	89.476	0.05947	0.28515	0.00036	0.00362	1.57626	0.03937
1973	1	90.687	0.06006	0.28508	0.00060	0.00386	1.59006	0.04310
	2	90.685	0.05910	0.28658	0.00039	0.00350	1.61388	0.04083
	3	91.829	0.05892	0.28946	0.00053	0.00350	1.65339	0.05733
	4	92.850	0.05894	0.29231	0.00037	0.00357	1.67281	0.04402
	5	93.313	0.05860	0.29015	0.00011	0.00374	1.67910	0.03725
	6	93.722	0.05813	0.28917	0.00011	0.00368	1.67807	0.03394
	7	95.176	0.05914	0.28763	0.00083	0.00376	1.67914	0.02664
	8	95.876	0.05968	0.28960	0.00040	0.00372	1.72171	0.02055
	9	96.245	0.05952	0.29342	0.00040	0.00364	1.75154	0.02640
	10	97.249	0.06034	0.29375	0.00039	0.00379	1.75158	0.03059
	11	97.864	0.06052	0.29263	0.00028	0.00351	1.73308	0.02521
	12	98.443	0.05956	0.29267	0.00038	0.00364	1.73544	0.03177

APPENDIX F

COMPARISON OF t-STATISTICS COMPUTED IN TESTING DIFFERENCES IN MEAN PREDICTED CONTRIBUTIONS

TABLE XXII

COMPARISON OF t-STATISTICS COMPUTED IN TESTING DIFFERENCES IN MEAN PREDICTED CONTRIBUTIONS

	Absolute Value of t-Statistics[a]			
	Monthly Data		Quarterly Data	
Variables	Period B Compared with Period D	Period C Compared with Period D	Period B Compared with Period D	Period C Compared with Period D
r_1	2.15*	2.09*	0.57	0.88
r_2	1.98*	0.82	0.04	0.00
r_3	1.79	1.56	2.45*	2.00
r_4	0.49	2.00	0.24	0.06
r_5	0.19	0.63	1.34	1.12
r_6	0.81	1.94	1.10	0.60
r_7	1.95	1.27	0.03	0.34

[a]Where the variances of the samples were not significantly different, the value of t was computed as:

$$t = (\bar{X}_1 - \bar{X}_2)/\sqrt{s^2\left(\frac{n_1 + n_2}{n_1 n_2}\right)}$$

where

$$s = \frac{(n_1-1)s_1 + (n_2-1)s_2}{(n_1-1)+(n_2-1)}$$

and degrees of freedom of:

$$df = n_1 + n_2 - 2$$

Where the variances of the samples were significantly different, the value of t was estimated as:

$$t' = (\bar{X}_1 - \bar{X}_2)/\sqrt{(s_1^2/n_1 + s_2^2/n_2)}$$

and degrees of freedom of:

$$df = \frac{[(s_1^2/n_1) + (s_2^2/n_2)]^2}{[(s_1^2/n_1)^2/(n_1-1) + (s_2^2/n_2)^2/(n_2-1)]}$$

*Means significantly different at 5% level.

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