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An Empirical Investigation into the Interest Elasticities of the Demand for Money

Thomas Hunter Ratliff
University of Central Florida

AN EMPIRICAL INVESTIGATION INTO THE INTEREST ELASTICITIES OF THE DEMAND FOR MONEY

BY

THOMAS HUNTER RATLIFF
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CHAPTER I

INTRODUCTION

Studies on the demand for money are quite numerous and extensive. However, most of these studies have been conducted during a period of relative price stability. During the past five years the United States economy has experienced relative price instability in the form of a comparatively high rate of inflation. This inflation may alter the conclusions of much of the empirical work previously completed. It is believed that price level movements have major implications for the demand for money, and it is the purpose of this paper to investigate the effects of inflation on the interest elasticities of the demand for money. It is hypothesized that inflation does affect both the demand for money and the interest elasticities.

In order to determine these effects, firstly, the theoretical aspects will be reviewed in order to understand clearly the development of economic thought on this subject. The place of money will be discussed within the framework of economic science and the evolution of the two current schools of thought on the demand for money will be traced. Secondly, a review of the literature will be undertaken to ascertain the current status of empirical work by both Keynesians and monetarists on the demand for money. Thirdly, the problem is defined with respect to theoretical and empirical findings and the hypotheses are formally presented. Fourthly, the data is

examined in order to define the variables and specify the assumptions. Fifthly, the empirical results are presented. Finally, conclusions are drawn and implications of those conclusions are analyzed.

CHAPTER II

REVIEW OF THE THEORY OF THE DEMAND FOR MONEY

The origins of the demand for money can be found in the very nature and significance of economics. In order to derive the benefits from trade most efficiently, there is a need - hence a demand for money. The study of the evolution of catallactics implies the necessity of a standard of value, a store of value, and a medium of exchange.

The medium of exchange function leads us directly into the quantity theory of money as put forth by Irving Fisher.[1] The quantity theory of money is based upon an identity, the equation of exchange. The equation of exchange as used by Professor Fisher takes the form:

$$M_S V_T = PT$$

where M_S is the quantity of money, V is the velocity, P is the price level, and T is the volume of transactions. Therefore, the amount of money times its rate of turnover is equal to the level of transactions times the average price.

The Classical Economists proved deductively that the full employment level of output was the equilibrium level. Since the level of output is at full employment, the level of transactions may

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[1]Irving Fisher, The Purchasing Power of Money (New York: MacMillan and Company, 1911), p. 163.

be considered as given. The value of the money supply is independent of the other variables and may also be assumed to be given. Fisher's concern was with the transactions velocity of circulation. It was treated as an independent variable and assumed to be constant. Velocity was treated as an independent variable in that it was not directly influenced by the other variables. Thus, the variable P was determined by the interaction of the other three. The quantity theory is a loose relationship, but by assuming velocity and the level of transactions as constant, the price level is directly and proportionally related to the money supply. Fisher went to great detail in analyzing the factors that affect the magnitude of the money variable, hence the determinants of the demand for money. Institutional arrangements, the effects of communications, production processes, etc. influenced the demand for money. At any given point in time these variables may be taken as given and hence considered ceteris paribus. The crucial finding was that the amount of money in an economic system should be large enough to support the total level of transactions. Fisher concluded that the demand for money is a constant proportion of the level of transactions.

The Cambridge economists (Pigou, Marshall, et.al.) analyzed the issue in terms of microeconomic analysis.[2] The emphasis lies in the theory of consumer behavior and may be stated as: given the fact

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[2]David E. W. Laidler, The Demand for Money: Theories and Evidence (Scranton: International Textbook Company, 1970), p. 49.

that a consumer needs cash for the purpose of facilitating some level of transactions, how much does he wish to hold?

The amount of money an individual wants to hold is determined by his level of wealth. His money holdings can not exceed his total wealth. Even if an individual did desire to hold all of his wealth in the form of money, it is doubtful that he could do so.

Therefore, there are absolute constraints; holding no cash balances and holding all of his wealth in the form of cash. What proportion of his wealth that an individual would wish to hold in the form of money is determined by the opportunity costs. Money is only one form of wealth, but it does not offer interest earning income. Stocks and bonds offer a return on assets in the form of interest; and, in addition, there is the possibility of a capital gain. Two other factors, in the demand for money, the Cambridge economists recognized were the loss of convenience and risk.

A rational individual evaluates the loss of convenience, the risk, the income foregone, and the necessary amount for transactions before he makes his choice. The Cambridge approach said little about the functional forms of the relationships. Pigou claimed that for the individual the level of wealth, the volume of transactions, and the level of income are in stable proportion to each other.[3] The demand for money would then be proportional to the level of income. Thus, the equation for the demand for money becomes:

$$Md = kPY$$

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[3] Ibid.

where k (Marshallian k) represents that proportion which is $\frac{1}{v}$. The Cambridge and the Fisher approaches are very similar except that Fisher emphasizes the level of transactions whereas the Cambridge economists emphasize income. Keynes is a logical outgrowth of the Cambridge school of thought. Keynes' analysis of how a consumer selects the proportion of his wealth to be held in the form of money (called liquidity preference) is stated in terms of motives.[4]

The transactions purpose creates the need for money to function as a medium of exchange in day to day transactions. The purpose of the transaction demand is to synchronize receipts of income and expenditures and is proportional to the level of income in both the Fisher and the Cambridge sense. Keynes himself was not willing to regard the transactions demand as technically fixed because he realized the trade-off between convenience and the return on alternative assets. The precautionary motive arises from the need to hold money for unforseen contingencies. It arises from the fact that an individual might not be able to convert other assets into money quickly without loss; therefore he wishes to hold money. The precautionary motive is a function of the level of income. It is also a trade-off between the amount of risk an individual is willing to bear and the return on

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[4]John Maynard Keynes, The General Theory of Employment, Interest, and Money (New York: Harcourt, Brace, & World, Inc., 1936), p. 166.

that same money as an earning asset. Keynes did not stress the role of the rate of interest in the transaction and precautionary motives, and in his demand function it is overlooked. The real significance of the rate of interest lies with the speculative motive.

It is the speculative motive that attracts the most attention since it determines by way of the rate of interest what proportion of a consumer's total wealth the consumer will choose to hold in terms of money. (The speculative motive explains the holding of money balances for use at some future date.) In the analysis of this motive, bonds are used as the substitute asset (opportunity cost) although any other asset would be just as appropriate. A bond is an asset which pays a certain income to its holder per time period. A rise (fall) in the interest results in decreases (increases) in the price of bonds. Individuals holding bonds when interest rates are rising incur capital losses. When the rate of interest is expected to fall, the demand for money is relatively low since a bondholder expects the price of his bond to increase. He will make a capital gain. When the interest rate is expected to rise the bondholder is likely to experience a capital loss. If the interest rate was expected to rise very rapidly, a wealth holder might wish to hold all of his assets in the form of money. If the rate was extremely low and the expected increase very large, then the conditions are set for the demand for money to become perfectly elastic, hence, the liquidity trap. These expectations depend on what could be regarded

at anyone time as a 'normal rate'.[5] If the rates were below the normal rate, they would be expected to rise. If they were above this normal rate, they would be expected to fall.

The Keynesian demand function for money is:[6]

$$M = M_1 + M_2 = L_1(Y) + L_2(r)$$

where M_1 = transactions and precautionary motive

M_2 = speculative motive

Y = income

r = interest rate

The Keynesian model has been considerably modified by Baumol and Tobin into what has been called the "modified - Keynesian" variant.[7] Both Tobin and Baumol were cognizant of Keynes' recognition of the influence of the interest rate in the transactions and precautionary motives. Baumol analyzed the behavior of an individual and the influence of the period of time between paychecks on the transactions demand for money.[8] He assumed that the individual spreads out his expenditures evenly and spends all of his income. Therefore, the individual holds some assets all of the time except when the last increment of income is spent before the next paycheck.

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[5] Ibid., p. 53.

[6] Ibid., p. 199.

[7] Thomas F. Dernburg and Duncan M. McDougall, Macroeconomics, The Measurement, Analysis, and Control of Aggregate Economic Activity (New York: McGraw-Hill Book Company, 1972), p. 175.

[8] W. J. Baumol, "The Transactions Demand for Cash: An Inventory Theoretic Approach," Quarterly Journal of Economics 38 (1956): 545-556.

Baumol analyzed how an individual holds these assets. He recognizes that there is a transaction or brokerage fee each time a bond is cashed. Therefore, the consumer tries to maximize his income from the assets while minimizing the costs of the brokerage fee. The individual will carry out this process until the marginal revenue from the increment of interest is equal to the marginal cost of the brokerage fee.

Tobin's analysis was along similar lines and draws similar conclusions.[9] Tobin's unique contribution included an analysis of the transactions and speculative balances which relies primarily on attitudes toward risk rather than on expectations of future bond prices.[10] His argument was recognition that although an individual may not expect bond prices to change, he can not be certain that they will not change. The degree of uncertainty depends on the asset in question. The return to cash is zero, but the risk of a capital loss is low. The return on a grade C bond may be very high, but so is the risk. He also found that people are risk averse. The individual plans his portfolio so that the disutility of additional uncertainty is balanced against the utility of additional return at the margin.[11] Tobin recognized the importance of the level of wealth in the

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[9]J. Tobin, "The Interest Elasticity of the Transactions Demand for Cash," Review of Economics and Statistics 38 (1956): 241-247.

[10]James Tobin, "Liquidity Preference as Behavior Towards Risk," Review of Economic Studies 25 (1955): 65-86.

[11]Norman F. Keiser, Macroeconomics (New York: Random House, 1971), p. 254.

determination of the demand for money.[12] He hypothesized that the quantity of money demanded is an increasing function of the level of wealth. The Tobin model is as follows:[13]

$$M = L(i, Y, K)$$

where M = demand for money

i = interest rate

Y = income

K = capital stock or level of wealth

The introduction of wealth logically leads to Friedman's analysis.[14] Friedman assumed that people receive utility from money balances held and was interested in determining how much money people want to hold. According to Friedman, there are five basic assets or forms of wealth. They are money, stocks, bonds, human capital and nonhuman capital. These assets all yield returns which when aggregated lead to the concept involved in the permanent income hypothesis. The rate of return on the other assets or opportunity costs, determine how much of their assets people want to hold in the form of money. (The term people instead of individual is intentional since the Friedman demand function for money is an aggregative model.) The important determinant is the level or stock of wealth. If an

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[12]James Tobin, "A Dynamic Aggregative Model," Journal of Political Economy 63 (1955): 103-115.

[13]Dernburg and McDougall, Macroeconomics, The Measurement, Analysis, and Control of Aggregate Economic Activity, p. 175.

[14]Milton Friedman, "The Quantity Theory of Money - A Restatement," in Studies in the Quantity Theory of Money, ed. by Milton Friedman (Chicago: The University of Chicago Press, 1956), pp. 6-35.

individual were to sell all of his assets including his labor, the resulting dollar value would be his level of wealth. The level of wealth for an individual is his budget constraint as it was in the Cambridge formulation. The choice is between "a readily available source of purchasing power" and the interest and potential capital gain or loss of the less liquid assets. Friedman's demand for money function takes the form:[15]

$$Md = f(W, r - \frac{1}{r}\frac{dr}{dt}, \frac{1}{p}\frac{dP}{dt}, h)\, p$$

where Md = demand for money

W = wealth

r = return

h = the ratio of human to nonhuman wealth

p = price level

The preceding theories trace the logical evolution of economic thought on the demand for money. Various demand functions for money have been presented with alternative relationships among money, interest, and some form of income. The alternative theories converge and that the differences tend to be esoteric.

The development of economic theory on the demand for money was significantly influenced by empirical research. Although this research is an integral part of the evolution of the theory, it seems appropriate for reasons of continuity to review it separately. The

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[15] Ibid.

next section of this paper is devoted to the empirical findings, and now our attention is turned to it.

CHAPTER III

REVIEW OF THE EMPIRICAL EVIDENCE

In the preceeding section a brief exposition of the major theoretical hypotheses on the demand for money was presented. Testing the hypotheses yields the necessary condition for theory to be valid. Although empirical testing can only fail to disprove a hypothesis, or disprove such a hypothesis, it is an essential part of scientific inquiry. The empirical evidence on the demand for money is exhaustive. The purpose of this chapter is to review and summarize the major findings of that research.

There are a number of problems that arise in all of the empirical tests. The first and most important problem concerns the appropriate definition of the relevant variables. This problem also implies that different variables may result in testing different relationships, therefore extreme care is exercised in each test to define closely the relationship being tested. The specific definition of the relationship utilized is often a crucial factor when interpreting the results of the test. It is also extremely difficult to isolate exact relationships between variables and treat other factors as constant. Recognizing these potential problems in analyzing the result we now turn to the tests.

Following the Keynesian revolution much of the research was directed to the relationship between the demand for money and the

interest rate. The first true statistical liquidity function was computed by A. J. Brown.[16] It took the indirect form of establishing a positive correlation between interest rates and velocity.

In the United States, Tobin's early work was more influential than Brown's.[17] Tobin distinguished between active and idle balances reasoning that the former were for transactions purposes and the latter influenced by the rate of interest. In this first study he assumed that the demand for active balances is proportional to income and that when the ratio of money to income was at its lowest value, idle balances were zero. The lowest observed ratio estimated the parameter m in the equation:

$$\frac{Md}{P} = mY + \lambda(r)$$

The money market was assumed to be in equilibrium so idle balances could be measured by:

$$\frac{Ms}{P} - mY$$

He then plotted idle balances against interest rates and found a hyperbola as Keynesian theory would predict.

W. J. Baumol questioned the relationship of active balances being proportionately related to the level of income and developed

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[16]A. J. Brown, "Interest, Prices, and the Demand for Idle Money," in Oxford Studies of the Price Mechanism, ed. by P. W. S. Andrews and Thomas Wilson (Oxford: Oxford University Press, 1951), pp. 32-41.

[17]James Tobin, "Liquidity Preference and Monetary Policy," Review of Economics and Statistics 29 (May 1947): 32-41.

the theoretical hypothesis that the transaction demand was also influenced by the rate of interest.[18] Tobin, recognizing the implication of Baumol's work, retested the model incorporating a modification to include that possibility.[19] The significant finding was a negative relationship between the demand for money and the interest rate.

Bronfenbrenner and Mayor in their 1960 work chose to follow Tobin's distinction between active and idle balances.[20] The goals of Bronfenbrenner and Mayer were to define the liquidity function, determine its interest elasticity, and investigate the possibility of a liquidity trap.

They defined the demand function as:

$$\frac{Md}{P} = bY \cdot r^{\beta}$$

They assumed the money market to be in equilibrium and were able to measure the interest elasticity of the demand for money via the equation:

$$\frac{Ms}{PY} = b \cdot r^{\beta}$$

They fitted this to successive years relating the change in the logarithm of the $\frac{Ms}{PY}$ variable to the change on the logarithm of

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[18]Baumol, "The Transactions Demand for Cash: An Inventory Theoretic Approach," Quarterly Journal of Economics, 549.

[19]Tobin, "The Interest Elasticity of the Transactions Demand for Cash," Review of Economics and Statistics, 241-247.

[20]Martin Bronfenbrenner and Thomas Mayer, "Liquidity Functions in the American Economy," Econometrica 28 (October 1960): 810-834.

the interest rate (β). The elasticity turned out to be relatively inelastic with a coefficient of .37. More significantly, they found no tendency for the interest elasticities to be higher at low rates of interest. For the liquidity trap to occur (absolute liquidity preference means an elasticity equal to infinity), the elasticity must increase at lower rates. They concluded that there was no empirical basis to substantiate the theory of the liquidity trap.

Contemporary with these earlier studies is the contribution of Lawrence R. Klein in the development of macroeconomic models. Klein's conclusion with respect to the liquidity function cannot be adaquately analyzed out of the context of his major work. For our purposes the important contribution of Klein's work is that he identified active balances with demand deposits and idle balances with time deposits and was the first to do so.[21] His independent variables were corporate bond yields, current and lagged one year. He, too, found a negative relationship with the rate of interest.

All of these tests assume that the demand for money is proportional to the level of income. Friedman's theory of the demand for money would suggest that wealth is the more appropriate variable. The return on the forms of wealth is permanent income, measured as a weighted average of present and past levels of income. In testing the relationship between the demand for money on the one hand and

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[21]Lawrence R. Klein, "Economic Fluctuations in the United States, 1921-1941," (Cowles Commission Monograph No. 11, New York: John Wiley and Sons, 1950), 21.

permanent income and the interest rate on the other, the results were not significant with respect to the interest rate.[22] Friedman had modified his data to abstract from the business cycle in order to determine what he proposed to be a long run stable demand for money. In his abstraction, he assumed away the basic problem other investigators were trying to determine. The results obtained with the permanent income variable proved to be superior to those utilizing a level of income. The permanent income developed by Friedman is the transmission mechanism between the level of wealth and the demand for money. Friedman was not the first to employ the importance of wealth in the demand function, that honor belongs to Tobin.[23]

As specified earlier, the Tobin model took the form:

$$M = L(i, Y, k)$$

The k term represents the productive wealth of the economy. It was an aggregation of the value of assets in the United States economy. It does not include human wealth as defined by Friedman. It would appear that this function would be redundant since income is the return on wealth and wealth is the present value of income.

In order to determine which variable is more appropriate, Meltzer, Brunner and Meltzer, and Laidler, conducted identical tests using identical data and identical statistical techniques except

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[22]Milton Friedman, "The Demand for Money - Some Theoretical and Empirical Results," Journal of Political Economy 67 (June 1959): 327-351.

[23]Tobin, "A Dynamic Aggregative Model," Journal of Political Economy, pp. 103-115.

using current income in one and permanent income or wealth in the other. They all found the permanent income or wealth to be superior to current income.

There is one study dated in 1963 which concludes that income is the superior variable.[24] Heller's investigation, however, has been severely criticized for the manner in which the wealth variable was calculated.[25] If the manner of calculation of wealth was indeed in error, the conclusion perhaps may be invalid.

Meltzer's works represent the synthesis of all of these findings into the formulation that is the basis for almost all subsequent works. Recognizing the importance of elasticities, Meltzer's function took the form:

$$\frac{Md}{P} = b \cdot X^{\beta 0} \cdot r^{\beta 1}$$

where the exponents β are the elasticities.[26] Meltzer's investigation is the most rigorous that we found. The X variable was tested to represent the level of income, the level of nonhuman wealth, and the level of permanent income. He also used M_1, M_2, and what was yet to be defined as M_3 to represent money. He used the yield on 20 year bonds as the interest rate. Meltzer's findings clearly established

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[24] H. R. Heller, "The Demand for Money - The Evidence from the Short Run Data," Quarterly Journal of Economics 79 (June 1968): 394-412.

[25] Laidler, The Demand for Money: Theories and Evidence, p. 103.

[26] Allan Meltzer, "The Demand for Money: The Evidence from the Time Series," Journal of Political Economy 71 (June 1963): 219-246.

the relationship between the demand for money, however defined, and the interest rates. He computed the interest elasticity for the long term rate to be about -0.7. He also found that the inclusion of wealth (measured as the value of assets, hence nonhuman) provided a more stable function than income. He estimated the wealth elasticity to be just over +1.0.

Meltzer used a long term interest rate. Laidler presented a more complete analysis using both a long and a short term rate.[27] He, too, found that the long term rate elasticity was about -0.7 and the elasticity for the short term to be -0.15. Teigan, using a level of income rather than a form of wealth and a short term rate, also estimated the short term interest elasticity to be about -0.15.[28]

There are many other variables that may influence the demand for money such as the price level, the expected rate of change in prices, the risk incurred in holding bonds, and the distribution of income. We feel that the effects of inflation have had significant effects on both the price level variable and the expected rate of change in prices. There has been little if any empirical research done on this possibility. The reason that it has been neglected is that until recently the price level was relatively stable. To test for the effects of inflation on the demand for money when those effects

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[27]David Laidler, "The Rate of Interest and the Demand for Money - Some Empirical Evidence," Journal of Political Economy 74 (December 1966): 545-555.

[28]R. Teigan, "Demand and Supply Functions for Money in the United States," Econometrica 32 (October 1964): 477-509.

were not present would have yielded no evidence. This researcher has conducted an empirical investigation incorporating many of the important concepts of others in order to determine the effects of inflation on the interest elasticities. The hypothesis, methodology, and results of the tests conducted will be presented in the next chapter.

CHAPTER IV

STATEMENT OF THE PROBLEM AND HYPOTHESES

There are reasons to believe that the rate of inflation has a significant effect on the demand for money. The purpose of this investigation is to determine the extent of that effect. A priori relationships have been postulated by economic theorists with a view to build models that would explain the demand for money. Such models have been widely tested empirically and the results have been incorporated in the formulation of models of the demand for money. Some of these models were presented in chapter III.

The studies of hyperinflations by Cagan, Lerner, and others would indicate that the rate of inflation along with more generally accepted variables, may be an important determinant of the demand for money.[29] If the rate of inflation is indeed an important explanatory variable it should be reflected by changing interest elasticities. Meltzer has shown that the demand for money is proportional to the price level. In other words the demand for money in real terms is relatively constant over time.

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[29]Phillip Cagan, "The Monetary Dynamics of Hyperinflation," in Studies in the Quantity Theory of Money, ed. by Milton Friedman (Chicago: The University of Chicago Press, 1969); Eugene Lerner, "Inflation in the Confederacy 1861-65," in Studies in the Quantity Theory of Money, ed. by Milton Friedman (Chicago: The University of Chicago Press, 1969).

All of the empirical tests used in this context have deflated money into real terms for purposes of analysis. If the problem is assumed away the significance of an important variable may be missed. Both Friedman and Selden have emphasized the influence of the rate of change in prices but were unable to detect significant effects. It may be that the data they used reflected a period of time when the price level was relatively stable. Therefore, the data could not be expected to reveal effects of the rate of inflation on the demand for money. Data of the past four years, however, reflect a relatively high rate of inflation. Tests based on observations on the selected variables over the past few years might then be expected to reveal the importance of the rate of inflation as a determinant of the demand for money.

The empirical studies as outlined in the third section of this paper showed that the longer term rate of interest yielded better results than did the shorter term variable. All of these tests used data from the period 1892-1960. In an inflationary environment, however, people are less willing to hold money for long periods of time because they may suffer a capital loss. They would become more responsive to a short term rate of interest than to a longer term one. Because of uncertainty with respect to the rate of inflation, the planning period for their choice would have become considerably shorter. This would be reflected in the interest elasticities. The interest elasticity of the demand for money is defined as the relative responsiveness of the quantity of money demanded to changes in the interest rate.

It is hypothesized here that the shorter term rate of interest becomes the more important explanatory variable as the rate of inflation increases. People do not wish to enter into long term commitments during inflationary periods as a result of the uncertain environment created by the rate of inflation. They would prefer to hold their assets in a relatively more liquid form. This would imply an increased responsiveness of the quantity of money that is demanded to a change in the interest rate, that is, an increasing elasticity with respect to the short term rate. Individuals would prefer to hold their liquid assets in shorter term investments which could either be renewed or converted into nonliquid assets that would be suitable as hedges against inflation.

The hypothesis that the rate of inflation is significant can be tested by constructing identical demand functions for different periods. The first regression utilizing various forms of money, income, and interest rates, fitted to 1967-1970 observations should reflect that the longer term rate of interest is a superior explanatory variable to the short term rate. This would agree with previous empirical work. During this period the price level was relatively constant. The price level has not been relatively constant during the 1971-1974 period, and the affects of inflation should be reflected in the data. The second regression utilizing identical forms of money, income, and interest rates as before but based on observations from an inflationary period, should indicate that the short term rate variable is a better explanatory variable than the

long term rate. If the hypothesis is not disproved this change should also be reflected in the interest elasticities. As the rate of inflation increases we hypothesize that as the shorter term rate of interest provides a better explanatory variable and simultaneously the longer term rate becomes a poorer explanatory variable.

We seek the answers to a number of questions:

1. Which interest rates are important in the non-inflationary periods and which ones in inflationary periods?

2. Are the demand functions indeed similar, as Meltzer has suggested? Does the rate of inflation significantly affect the liquidity function?

3. What are the interest elasticities in both periods as compared with traditional results?

4. Does the interest elasticity increase as the rate of inflation increases?

4. Are the observable effects consistent with the hypothetical ones?

CHAPTER V

THE DATA AND OTHER PRELIMINARY PROBLEMS

The purpose of this section is to discuss the problems encountered in the collection of data, the definition of variables, and the specification of hypotheses.

The first problem involves the basic methodology. All of the tests used consist of fitting regression equations to data. The selection of data revealed a problem of identification. Although the investigation is about the demand for money, it is essential to use data which assume equilibrium in the money market. Only on the basis of this assumption may the quantity of money as defined by the Federal Reserve Board be used to measure the demand for money.

Economic theory provides a general concept of variables to be utilized. There is, however, a wide spectrum of definitions for money and of ways of measuring the quantity of money. Yearly Federal Reserve Bulletins furnish complete data. Unfortunately the methods of compiling this information have changed several times in the past ten years. The data would often reflect these changes by increases in the money variable by as much as 30 billion dollars from month to month. In order to overcome this difficulty it was decided to use the revised tables of the money stock as presented in the 1973 Federal

Reserve Bulletin.[30] This revision meant that minor problems needed to be resolved: how the money stock is calculated - whether computed from Friday bank closings or Monday check clearing. The result of the revision was to standardize the data which are presented in tabular form for a 15 year period. Since the methodology has remained constant from that time, it was possible to update the data with more current editions of the Bulletins as noted in the bibliography.

Unadjusted data were employed because the more revisions are made to data, the greater the probability that real effects may be distorted or masked. The data for the money stock are listed in the Federal Reserve Bulletins under the heading of M_1 and M_2.

> M_1 was defined to include (1) demand deposits at commercial banks other than those due domestic commercial banks and the U.S. Government, less cash items in the process of collection and Federal Reserve float; (2) foreign demand balances at Federal Reserve Banks; (3) currency outside the Treasury, Federal Reserve Banks, and vaults of all commercial banks.[31]
>
> M_2 includes - in addition to currency and demand deposits - savings deposits, time deposits open account, and time certificates of deposit (CD's) other than negotiable time CD's issued in denominations of $100,000 or more by large weekly reporting commercial banks. It excludes time deposits of the U.S. Government and of domestic commercial banks.[32]

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[30]U.S., Federal Reserve System: Federal Reserve Bulletin, by Board of Governors of the Federal Reserve System, No. 2, Vol. 59 (Washington D.C.: Division of Administrative Services, February, 1973), pp. 61-80.

[31]Ibid., p. 71.

[32]Ibid.

Because the observations on the quantity of money were on a monthly basis, an income proxy which was also observed on a monthly basis was needed. Such are personal income accounts which also closely approximate the trend of the GNP. Consequently personal income was selected as the income variable. Since virtually all of the empirical tests concluded that some form of wealth variable was preferable, the personal income variable was transformed into permanent income according to Friedman's formula.[33] To be precise:

$$Ypt = bY_t + b(1 - b)Y_{t-1} + b(1 - b)^2Y_{t-2}...b(1 - b)^NY_{t-N}$$

and b was defined according to Friedman's results as .33. Permanent income formulations have a smoothing effect on income data. Transforming the income data into permanent income yielded the expected result. Since personal income is by definition income to persons, and contains such factors as transfer payments, which could be logically based on some manipulation of the wealth formula, the transformation may have been unnecessary. The income data were transformed into permanent personal income so as not to leave anything to chance.

The interest rate structure is quite complex with no fewer than 24 different rates given in the Federal Reserve Bulletin. Basically they are divided into groups of long and short term although the dividing line is somewhat hazy.

As proxies for interest rate variables the Market Yield on 3-month Treasury Bills as quoted on bank discount bases and Aaa

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[33]Friedman, A Theory of the Consumption Function, p. 230.

corporate bonds were selected for the short term rate and the long term rate respectively. The figures quoted are monthly averages. The data on these interest rates were readily available in the Federal Reserve Bulletin.

Difficulties did arise when investigating the stability of the demand function over time. The rate of inflation was influencing interest rates, and adjusting for inflationary effects became complex. It was tempting to try simply subtracting the rate of inflation from interest rates, but this yielded negative interest rates at times. It is a very interesting situation that deserves further attention, but due to constraints of time it must be left for some future study. As an accepted deflator the consumer price index was employed in spite of its limitations. Money and income were deflated by the formula:

$$\frac{\text{nominal variable}}{\text{price index}}$$

For interest rates the formula below was used:

$$\text{real } i = i \frac{100}{(\text{price index})}$$

This technique removed the upward trend of interest rates over time, which seemed to be a consequence of inflation.

The data were divided into two groups. The first group included the period 1967-1970 when the consumer price index rose 20 percent. There were 53 monthly observations in this group. The second group included the period 1971-1974 during which the price index rose 42% representing relative price instability. There were 48 observations in the second group.

Each of these periods is about 4 years in duration. An arbitrary decision was made concerning definite changes in trends of interest rates. Each period includes rising and then declining rates. The latter period definitely does not reflect price stability and thus yields good data which should reflect the effects of price changes.

It was recognized that there were other explanatory variables involved. These were held in "ceteris paribus". In the course of the investigation, however, the data had to be adjusted for some of the factors that had been previously held constant in order to improve the results. Those results are the subject of the next chapter.

CHAPTER VI

PRESENTATION OF THE RESEARCH

In this section the results of the empirical investigation are presented. Several issues concerning the determination of the more important relationships, the structure of the functions, the stability of the functions, and finally the question of the interest elasticities are presented.

The first issue is the determination of the important relationships among the possible combinations of variables. Initially the dependent variable was regressed on two independent variables using raw data. The results may be found in equations (1) through (8) in Table 1. The tests of significance for the two independent variables are shown in Table 2. Although these models suffered from specification errors causing the estimates of the parameters to be inaccurate, it was possible to conclude that the important relationships in both periods were: (1) the relationship between the quantity of money defined as currency plus demand deposits, M_1, and the yield on 3-month Treasury Bills; and (2) the relationship between the quantity of money defined as currency plus demand deposits plus time and savings deposits in commercial banks, M_2, and the yield on corporate bonds classified as Aaa by Standard and Poors. Equation (3) would indicate that the longer term rate of interest is the more

TABLE 1

ESTIMATES OF LIQUIDITY PREFERENCE FUNCTIONS FOR THE U.S.
1967-1970

Equation	Standard Error of Regression Coefficient in Parentheses	Coefficient of Determination	Standard Error
(1)	$M_1 = 53.611 + .245Y - 1.557L$ (1.996) (1.911)	.95311	2.045
(2)	$M_1 = 57.928 + .221Y + .137S$ (1.996) (1.504)	.95210	2.046
(3)	$M_2 = 173.365 + .031Y + 26.990L$ (3.427) (4.016)	.84075	4.385
(4)	$M_2 = 88.167 + .448Y + .093S$	.90776	4.403
	1971-1974		
(5)	$M_1 = 88.822 + .001Y + 21.528L$ (.663) (1.914)	.52089	2.671
(6)	$M_1 = 97.179 + .174Y + .829S$ (2.627) (2.356)	.96945	2.671
(7)	$M_2 = 143.715 + .438Y + .004L$ (7.333) (.2237)	.88073	7.814
(8)	$M_2 = 40.213 + .558Y - .521S$ (7.345) (6.748)	.91424	8.073

*N = 53, monthly data for 1967-1970.

N = 48, monthly data for 1971-1974.

M_1 = Currency + demand deposits, unadjusted.

M_2 = M_1 + time deposits in commercial banks.

L = Yields on Aaa corporate bonds (Long term).

S = Market Rate on 3 month Treasury Bills (Short term).

Y = Permanent Personal Income.

TABLE 2

TESTS OF SIGNIFICANCE FOR Y, L, & S

Equation	Calculated F Y	L	S	Critical F(.05)
(1)	85.525	.8144		4.001
(2)	429.6589		.0423	4.001
(3)	.6126	72.1514		4.001
(4)	217.5282		.0020	4.001
(5)	.6865	43.120		4.001
(6)	281.6133		2.1230	4.001
(7)	331.9717	.0243		4.001
(8)	113.0734		.0329	4.001

important rate in the 1967-1970 period. Equation (6) would indicate that the short term rate is the more important rate in the 1971-1974 time period. The results obtained with Equation (5) indicate that the long term rate of interest is a significant determinant of M_1, althouth this formulation explains only 52.1% of the variability of M_1. Examination of the signs of the residuals and the grouping of residuals of the same sign indicated autocorrelation. However, the initial tests did provide insight into the important relationships and that was their primary purpose.

In order to investigate the structure of the function the variables were deflated via the price index. Equations (9) through (12) were deflated into 1959 dollars. Equations (13) through (16)

were deflated into 1967 dollars. The earlier test was then repeated using the deflated data. The results are presented in Table 3. Equations (1) through (8) of Table 1 correspond with equations (9) through (16) of Table 3. The tests of significance are presented for the income and interest variables in Table 4. These tests, which are more consistent with other investigations, reinforce the earlier findings. Although the coefficients of determination as a group were poorer, the specification error as revealed by the presence of autocorrelation did not appear to be as severe. The longer term rate of interest provides a better fit than the short term rate in the 1967-1970 time period. This is in accordance with the other empirical evidence as noted in Chapter III. Although as before there is a very strong relationship between M_2 and the long term rate (equation (15)); there is a marked improvement in the performance of the short term rate of interest as a determinant of M_1 (equation (14)) over its performance in the earlier period. There was an indication of this improvement in Table 1, but it is more noticable in Table 2. There are also considerable improvements in both sets of F ratios for the interest variables. (The F ratios were a most convenient test of significance of the early research that were provided in the computer program.) This finding would support the hypothesis that the short term rate of interest is becoming a more important determinant as the rate of inflation has increased. It is also interesting to note that the interest variable in equations (9-16) has a negative sign as theory would suggest. The F value exceeded the critical F value and is significant for equation (14).

The growing importance of the short term rate of interest should be reflected in the behavior of the interest elasticities. Because of poor fits obtained with M_1 and longer term rate of interest, and with M_2 and the shorter term rate of interest, it was decided to discontinue this line of investigation.

The next issue concerned the stability of the function and the interest elasticities simultaneously. The common logarithms of the deflated data were regressed in order to measure the rate of change in the dependent variable. The results of the tests are equations (17-20) shown in Table 5. Equations (17) and (18) represent the 1967-1970 noninflationary period. Equations (19) and (20) represent the 1971 - 1974 inflationary period. The tests of significance are presented in Table 6. The hypothesis H_0: $\beta = 0$ is tested against the hypothesis H_1: $\beta \geq 0$.

The observations for all three variables were influenced by an upward trend over time. The stability of the functions was difficult to assess and for the time being must be considered to be undetermined. The magnitude of the coefficients of the interest elasticities increased greatly as indicated in Table 7. Since the elasticity with respect to the short term rate had increased so dramatically and in view of the a priori knowledge that the latter period of time was a period of relatively severe recession, it was tempting to assume that this would be indicative of a liquidity trap. This hypothesis has been repeatedly disproved, however, and closer investigation revealed probable cause for doubt of the validity of

TABLE 3

ESTIMATES OF LIQUIDITY PREFERENCE FUNCTIONS FOR THE U.S. 1967-1970 USING DEFLATED DATA*

Equation	Standard Error of Regression Coefficients in Parentheses	Coefficient of Determination	Standard Error
(9)	$M_1 = 94.765 + .155Y - 2.756L$ (.301) (.214)	.41667	.4932
(10)	$M_1 = 226.955 - .139Y - .755S$ (22.704) (24.113)	.01666	30.490
(11)	$M_2 = 60.716 + .580Y - 10.754L$ (1.098) (.791)	.74836	1.333
(12)	$M_2 = 108.809 + .387Y - 1.654S$ (1.094) (.345)	.68504	1.333
	1971-1974		
(13)	$M_1 = 150.570 + .068Y - .585L$ (.196) (.077)	.09209	.684
(14)	$M_1 = 366.256 - .083Y - 20.394S$ (.182) (.408)	.43927	.684
(15)	$M_2 = 284.854 + .390Y - 25.223L$ (2.016) (1.863)	.92100	2.167
(16)	$M_2 = -4.102 + .617Y - 1.985S$ (2.016) (1.404)	.87345	2.167

*N = 53, monthly data for 1967-1970.

N = 48, monthly data for 1971-1974.

M_1 = Currency + demand deposits, unadjusted.

M_2 = M_1 + time deposits in commercial banks.

L = Yields an Aaa corporate bonds (Long term).

S = Market Rate on 3 month Treasury Bills (Short term).

Y = Permanent Personal Income.

TABLE 4

TESTS OF SIGNIFICANCE FOR Y, L, & S

Equation	Calculated F Y	L	S	Critical F(.05)
(9)	16.9010	2.9274		4.001
(10)	.0003		.0000	4.001
(11)	78.7562	13.8521		4.001
(12)	98.0620		1.6984	4.001
(13)	3.9004	.4814		4.001
(14)	6.5907		29.5321	4.001
(15)	103.8052	31.8472		4.001
(16)	161.3355		2.9747	4.001

the much higher elasticity. The .78 coefficient as determined in equation (20) probably is not accurate when due consideration is given to the regression results as a whole: the coefficient of determination = .01; the residuals appeared to be highly autocorrelated indicating the possibility of a specification error. Techniques for correcting for autocorrelation are available.[34] The data were corrected for autocorrelation, but regressing the modified data did not do away with the presence of autocorrelation. When autocorrelation is so severe, it suggests that an important factor may have been

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[34]Teh-wei Hu, Econometrics, An Introductory Approach (Baltimore: University Park Press, 1973), pp. 80-82.

TABLE 5

ESTIMATES OF LIQUIDITY PREFERENCE FUNCTIONS FOR THE U.S.
LOGARITHMS OF DEFLATED DATA 1967-1974

Equation	Standard Error of Regression Coefficients in Parentheses	Coefficient of Determination	Standard Error
(17) $\log M_2 =$	.008 + .960 log Y (.004) - .133 log L (.004)	.85972	.005
(18) $\log M_1 =$	1.609 + .185 log Y (.002) + .224 log S (.003)	.55337	.004
(19) $\log M_2 =$	.967 + .511 log Y (.005) + .284 log L (.004)	.78956	.006
(20) $\log M_1 =$	10.539 - 2.967 log Y (.008) + .783 log S (.002)	.01255	.049

TABLE 6

TESTS OF SIGNIFICANCE FOR Y, L, & S

Equation	Calculated F Y	L	S	Critical F(.05)
(17)	35.7695	1.5633		4.001
(18)	11.8214		27.5583	4.001
(19)	2.4767	1.2576		4.001
(20)	65.7666		5.3104	4.001

TABLE 7

INTEREST ELASTICITIES OF DEFLATED DATA

Years	Short Term Coefficient	Long Term Coefficient
1967-1970	.22	.13
1971-1974	.78	.28

overlooked. When reviewing the basic model it becomes clear that the model is dealing with comparative statics while the data are reflecting a very important dynamic trend, growth.

In order to correct for this, some very crucial assumptions were made: (1) the economy grows at a rate of about 4% per annum, (2) the money supply being somewhat proportionate to the level of output, in accordance with theoretical transactions demand, also grows at a rate of 4% per year, (3) it should be possible to correct for growth without distorting the effects of the interest variables. This correction was made in a relatively simple manner. A 4% present value table was used and the present value of the money and income variables were calculated. The correction should not affect the data with respect to masking an easy or tight monetary policy trend. Close study of the adjusted data revealed an inverse relationship to the interest variable as theory suggests. The adjusted data were then converted into common logarithms and new regressions were run to estimate equations (17-20). The modified results equations (21) through (24), may be found in Table 8. Equations (21) and (22) represent the 1967-1970 period. Equations (23) and (24) represent the 1971-1974 period. The similarity between the two sets of functions are indicative of the stability of the demand for money. The difference in the magnitudes of the intercepts is expected because different series of price index numbers were used. This difference could also be due to procedure employed for adjusting the data for growth: equations (21) and (22) were adjusted in terms of 1967 as the base year, whereas

TABLE 8

ESTIMATES OF LIQUIDITY PREFERENCE FUNCTIONS FOR THE U.S. EXPRESSED AS LOGARITHMS AND CORRECTED FOR ANNUAL GROWTH IN MONEY SUPPLY

Equation	Standard Error of Regression Coefficients in Parentheses	Coefficient of Determination	Standard Error
(21) log M_2 =	$-.050 + \underset{(.024)}{1.004} \log Y - \underset{(.023)}{.233} \log L$	.99652	.024
(22) log M_1 =	$-.742 + \underset{(.023)}{1.081} \log Y - \underset{(.022)}{.450} \log S$	.99411	.003
(23) log M_2 =	$-.078 + \underset{(.022)}{1.016} \log Y - \underset{(.019)}{.219} \log L$	.9979	.022
(24) log M_1 =	$-.991 + \underset{(.023)}{1.152} \log Y + \underset{(.021)}{.546} \log S$	.9986	.023

TABLE 9

TESTS OF SIGNIFICANCE FOR Y, L, & S

Equation	Calculated F Y	L	S	Critical F(.05)
(21)	782.5181	4.7269		4.001
(22)	519.6325		.3254	4.001
(23)	3345.99	6.8097		4.001
(24)	2727.7		7.8963	4.001

TABLE 10

INTEREST ELASTICITIES

Years	Short Term Coefficient	Long Term Coefficient
1967-1970	-.45	-.23
1971-1974	.54	-.21

equations (23) and (24) were adjusted in terms of 1971 as a base. The income and interest elasticities behave in a remarkably similar fashion. As a result it may be that the demand for money is a stable function of income and of a rate of interest.

The tests of significance are shown in Table 9 and the interest elasticities in Table 10. The coefficients of determination are .99. This may be because the relationship between the money variable and the permanent income variable was so strong to begin with and this adjustment for growth brought them into nearly perfect alignment. The F ratios were significant for all of the interest rates except for the short term in the non-inflationary period.

It may be noted in passing that the elasticities for the wealth (permanent income) variable are just over 1.0. This finding is consistent with the evidence obtained in other studies.

The interest elasticities for the adjusted data may be found in Table 10. The results of these tests would indicate that the short term interest rates have increased from .45 to .54. More significantly the sign has changed from a negative to a positive. We can only hypothesize as to reasons why this occurred: (1) it is possible that the logarithmic formulation could have had this effect, (2) businesses could be trying to rebuild money stocks in the face of rising interest rates, (3) individuals could be simply demanding more money because of uncertainty. The long term elasticity decreased from .23 to .21. The findings of both 1967-1970 elasticities are within the range

established by other researchers. The increase to .54 definitely was not within those ranges.

Of interest is the increasing importance of the rate of interest as an explanatory variable as shown by the results in equation (24). This would suggest as hypothesized that the short term rate is becoming a better explanatory variable as a determinant of the demand for money than the long term rate. Wealth holders do not wish to tie up money in long term investments if inflation may cause them to suffer a loss. There is a definite liquidity preference although not in the accepted Keynesian sense.

Finally, both interest variables along with income were tested together. These variables were fitted with both M_1 and M_2 money variables for both time periods. The results of these tests may be found in Table 11. Good fits were obtained with the M_2 variable. The relatively poor fit in equation (28) could be due to an adverse influence of the long term rate. Equation (24) revealed a very close fit and the only difference is the addition of the longer term rate into the function. Equations (25) and (26) are for 1967-1970 period. Equations (27) and (28) are for the 1971-1974 period. The purpose of this last set of regressions was to incorporate both interest variables in the same liquidity function. It can be said that the introduction of both variables into the function does not improve the fit. It was found earlier that certain combinations (Table 1) resulted in very poor fits. No doubt a poor explanatory variable is incorporated in each of these functions. Such

TABLE 11

ESTIMATES OF LIQUIDITY FUNCTIONS FOR THE U.S.
USING LOGARITHMS OF DEFLATED DATA 1967-1974
WITH BOTH INTEREST VARIABLES

Equation	Standard Error of Regression Coefficients in Parentheses	Coefficient of Determination	Standard Error
(25) $\log M_1$	$= -.8053 + \underset{(.05483)}{1.09107} \log Y + \underset{(.16566)}{.06199} \log L + \underset{(.09234)}{.06195} \log S$	.99426	(.0103)
(26) $\log M_2$	$= -.8451 + \underset{(.09421)}{1.1628} \log Y + \underset{(.28483)}{.24704} \log L + \underset{(.15877)}{.00609} \log S$	.8425	(.0177)
(27) $\log M_1$	$= -.85181 + \underset{(.89082)}{.71010} \log Y + \underset{(2.12679)}{1.47474} \log L + \underset{(.70536)}{.021106} \log S$	.2128	(1.1852)
(28) $\log M_2$	$= -.33611 + \underset{(.03016)}{1.06828} \log Y - \underset{(.07140)}{1.0811} \log L + \underset{(.0239)}{.02469} \log S$	.9972	(.0062)

is the long term rate in the functions using M_1 as the proxy for the money variable, and the short term rate if M_2 is used. It is important to note that in equation (28) the short term rate is a very good explanatory variable. This result is similar to the results found in the earlier tests.

A last word concerning specification errors in the regressions of Tables 8 and 10 needs to be made. These regressions did not reveal autocorrelation or heteroskedasticity. The residuals of the logarithms when converted back into numbers were of very small magnitudes.

Finally, errors of measurement, such as a misread number converted into a logarithm: or a number inaccurately entered into the computer undoubtedly occurred. Such errors are unlikely to have been important enough to alter the outcome of these tests.

CHAPTER VII

CONCLUSIONS

The results of this investigation seem to indicate that the rate of inflation affects the demand for money. This is achieved via the interest rate variable. The interest rate variable is influenced by the rate of inflation in two ways. The first has to do with the relevant time period during which people decide for how long to invest their funds. The findings of this study would indicate that during inflationary periods the short term interest rate as represented by the yield on 3-month Treasury Bills is in fact a better explanatory variable than is the longer term rate as represented by the average yield on Aaa corporate bonds. People wish to maintain their assets in a form that is quickly convertible into hedges against inflation. This is reflected as a form of liquidity preference. They wish to remain more liquid in inflationary periods which are accompanied by uncertainty in order to protect the real value of their assets. If the rate of inflation increases while they are holding longer term assets at a given rate they may suffer a capital loss. There is a definite preference for shorter term assets. This is an important consideration for future research in the monetary area because even if inflation is assumed away with some type of deflator the effects on the interest elasticity are still present. The second

effect has to do with the interest elasticities. This study leads to the conclusion that the interest elasticity for the short term rate variable increases during an inflationary period. Declining interest elasticity of the longer term rate, implying the decline of that variable as an important determinant of the demand for money, which had been hypothesized was indeterminent.

The demand for money function appears to be stable over time, even in an inflationary period. This agrees with the findings of previous studies reported in Chapter III. It should be noted again that the other studies had not specifically investigated the effects of inflation on the demand for money.

The findings of this investigation pose interesting questions for future research such as: when selecting appropriate variables in future liquidity functions, which is more likely to perform as a better explanatory variable, a long or a short term rate; are there limits to the rate of inflation which determine the more appropriate interest rates; are the changes in the elasticities with respect to the rate of inflation predictable?

These questions remain to be answered. Future monetary research will need to treat the rate of inflation as an important variable, rather than as a minor irritant for which a simple correction will suffice.

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