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Further search for the missing money

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Further search for the missing money

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DEDICATION

To my parents
and my wife, Rana

CHAPTER I. INTRODUCTION

Basic Problem

The demand function for money is one of the building blocks of macroeconomic models. This function is also a critical relationship in conducting monetary policy. The conventional form of this function worked very well in the past. However, since late 1974 this function has failed to predict the public's demand for the money stock within a reasonable range of error. More specifically, since 1974 the conventional equation has overpredicted the actual quantity of money demanded. For example, Goldfeld's [8] version of the conventional equation, estimated over the period of 1952:2-1973:4, was used to predict money demand for 1976:2 (10 quarters out of the sample period). This resulted in a dynamic prediction error of nearly $30 billion in current prices.

At first it was believed, by Pierce [17] and others, that the problem was a temporary one caused by recession and there was hope that the equation would come on the track again in an upswing. But later data showed a prolonged problem of systematic overprediction of money stock by the conventional equation. There was another development occurring along with this overprediction in the 1970s. This was a marked increase in the growth of nonreservable liabilities of commercial banks. This latter development gave a clue to tracing the "missing" money. Extensive work has been done to explain the shortcoming of the conventional equation. These studies have been able to explain only a part of the shortfall, the problem has not been solved totally yet. The problem is still open for further investigation and this dissertation is a step in that direction.

Purpose of the Study

The purpose of this study is to find an aggregate and/or to respecify the demand equation for money in order to fill the gap between the actual money stock and the one predicted by the conventional equation. Overnight repurchase agreements (RPs)[1] play an important role in redefining the monetary aggregates. And a more drastic departure from the conventional form is to introduce a time variable into the conventional equation. A combination of redefined aggregates and respecified equations will be tried to find the one with least percentage errors of prediction.

Chapter II contains a review of the literature. The new aggregates are discussed in Chapter III. Chapter IV discusses the statistical methods applied in the study. The empirical results are reported in Chapter V, and an explanation of the remaining errors of prediction appears in Chapter VI. Conclusion of the study is stated in Chapter VII.

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[1]For a definition of RPs, see Chapter III.

CHAPTER II. REVIEW OF THE LITERATURE

Addressing the Problem

In his inclusive work, "The Demand for Money Revisited," Stephen Goldfeld [9] examined different specifications of the money demand equation. Following the transaction approach, the simplest form was the equation in which real stock of money balances was a function of real Gross National Product (GNP), the interest rate on savings and time deposits at commercial banks and on commercial paper, and a lagged dependent variable. This specification of the money demand equation was estimated in logarithmic form, over the period of 1952:2-1972:4. The general feature of this specification was that it had sensible parameter estimates, and also it was sufficiently stable to use for extrapolation purposes. This work was a further step in supporting the stability of the money demand equation and its logical consequences. But observations in the second half of 1974 and the beginning of 1975 caused some doubts about the usefulness of the conventional equation for extrapolation (prediction) purposes. Since the second half of 1974, the equation began to overestimate the actual holding of real cash balances. James Pierce [17] in examining the behavior of interest rates in the period of recovery, briefly pointed out the difficulties that had occurred concerning the money demand equation. He thought that the problem would be resolved by subsequent revision of the data on GNP and the money stock. But further evidence indicated a prolonged problem and caused some doubts about the usefulness of conventional specification. This problem was addressed in

Goldfeld's 1976 article entitled, "The Case of the Missing Money" [8]. He tried to improve the specification of the demand function for old M-1 in order to explain the shortfall in money demand, but as he put it, "the paper is rather a failure."

For more understanding of the problem and possible causes of it, a closer look should be taken at the equation estimated by Goldfeld in his latter work [8] and its prediction performance. Following is the conventional equation estimated by Goldfeld, which is a little different from the equation described above. In his second article, Goldfeld [8] used the per capita version of the equation, along with the assumption of nominal adjustment of money stock (as opposed to real adjustment). He also used the Treasury bill rate (TBR), instead of the commercial paper rate (CPR), as a proxy for the market interest rate, along with the rate of interest on time deposits (RTD). The form of the equation is as follows:

$$L(m_t) = C_1 + C_2 L(y_t) + C_3 L(TBR)_t + C_4 L(RTD)_t + C_5 L(m_{t-1,t}) + E_t, \quad (2.1)$$

where

m_t = real per capita money balances,

y_t = real per capita GNP,

TBR = Treasury bill rate,

RTD = interest rate on time deposits,

$m_{t-1,t}$ = per capita nominal money balances in period t-1 deflated by current price level; that is $\frac{m_{t-1}}{P_t/P_{t-1}} = \frac{M_{t-1}}{P_t}$, where M_{t-1} is the nominal money stock at t-1,

E_t = error term, and L(x) is the natural logarithm of the variable x.

This equation was estimated by Goldfeld [8] over the period of 1952:2-1973:4. The parameter estimates and prediction error are as follows.[1]

$C_2 = 0.112$,

$C_3 = -0.010$.

$C_4 = -0.035$,

$C_5 = 0.822$

$\rho = 0.54$,

RMSE = \$11.3 billion,

error for 1976:2 = \$-19.8 billion.

When this equation was dynamically simulated for ten out-of-sample quarters (starting in 1974:1) it resulted in a root mean square error (RMSE) of \$11.3 billion (in terms of 1972 dollars), 4.8 percent of the average of actual balance over the simulation period. The equation also overpredicted real balances for 1976:2 by \$19.8 billion, 8.7 percent of the actual value of real balances. The RMSE and 1976:2 prediction error (overprediction) of the demand deposit version[2] of the equation were \$13.3 and \$22.6 billion, respectively, in absolute terms, and 7.6 and 13.3 percent in percentage terms. These results show the significance of the problem.

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[1] The root mean square is calculated as square root of the mean of squared prediction errors within a specific period. ρ is the estimated coefficient from a regression of E_t on E_{t-1}.

[2] For the demand deposit version, currency in the hands of nonbank public is subtracted from the old M-1 aggregate.

In this dissertation, equations fitted with aggregate money stock and income data resulted in better predictive performance than equations fitted with per capita data. Using aggregate data together with the assumption of nominal adjustment for old M-1, resulted in a \$18.44 billion error for 1976:2, which is 7.98 percent of the actual level.

What is the reason (or reasons) behind this poor prediction performance? To answer this question we must look at the theoretical basis of the conventional equation of the demand for money and see how it differs from the econometric form of the equation.

The conventional equation of the demand for money is based upon the inventory theoretic approach. This approach views the demand for money balances as for transaction purposes, and gives the simplest expression of the transaction demand for money as:

$$M = \sqrt{\frac{bT}{2r}} \, . \qquad (2.2)$$

Equation 2.2 relates the quantity of money balances (M) to a measure of the volume of transactions (T), interest rate on a short-term asset (r), and a brokerage fee (b) as the transaction cost of converting the riskless asset to money. Dividing both sides of equation 2.2 results in equation 2.3:

$$M/P = \sqrt{\frac{(b/P)(T/P)}{2r}} \, . \qquad (2.3)$$

Empirical implementation of equation 2.3 requires the choice of some observed variables as counterparts to its theoretical constructs. In the conventional equation real GNP was used for T/P, interest rates on time deposits and commercial paper were used as measures of r, and brokerage costs (b/p) were assumed to be constant. Since the adjustment of actual to desired real money balances may not be completed in one quarter, equation 2.1 contains a lagged dependent variable among its regressors to represent a partial adjustment of money balances to desired levels. In this equation the monetary aggregate was assumed to be old M-1.[1] The attacks on the conventional equation are centered on these measurements. Further, its validity has come under attack because of institutional and technological changes.

Appropriate Transaction Variable

The appropriateness of GNP as a measure of transactions has been questioned for the following reasons: (1) GNP measures the final output of the economy and does not include the transactions of intermediate goods, commodities produced previously, and financial assets. But, certainly, some money balances are held for carrying these transactions. This would not be a serious problem if the ratio of intermediate transactions to final transactions remained constant through time. But this ratio could change. For instance, the ratio will change with changes in the composition of output and changes in the degree of integration of

[1]Old M-1 consists of the currency in the hands of nonbank public and the demand deposits at all commercial banks other than those due to domestic commercial banks and the U.S. government, less cash items in the process of collection and Federal Reserve float, plus foreign demand balances at Federal Reserve Banks.

firms. (2) The Gross National Product contains some imputed values, like owner occupied housing services, which are actually not exchanged for money. A possible substitute for GNP, which is proposed by many economists, is bank debits. Bank debits measure the value of checks written against privately held demand deposits at commercial banks. It is not obvious that this measure of transactions would serve better than GNP. Although the debits may not have the above problems, there are other problems associated with them. As will be discussed in more detail later, increasingly sophisticated cash management practices tend to decrease the money balances necessary to carry out any given level of transactions. This economizing on money balances is brought about, in part, by an increase in the volume of debits. In his empirical work employing bank debits, Goldfeld excluded the debits at New York banks because most of the financial transactions take place in New York.[1] But it is not clear why these debits should be excluded if some money balances are held against financial transactions.[2] This measure of transaction was tried by Goldfeld [8] and Lieberman [13]. Goldfeld replaced GNP by bank debits in equation 5.2 (Table 5) and obtained a perverse effect; i.e. it resulted in a greater RMSE and prediction error for 1976:2. When bank debits were used in marginal form it improved the results by about 25 percent. Lieberman used a different measure of debit as a substitute for GNP in his

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[1]As Lieberman [13] points out, it is not clear why the debits at the Chicago and San Francisco banks should not be excluded too.

[2]Lieberman [13], footnote 8, p. 308.

basic equation and improved the prediction results.[1] In short, the debits variable used in marginal form (i.e. change in debits from one period to another) either along with GNP or as the only transaction variable, was able to improve the prediction results to some extent. As Goldfeld pointed out, forecasting and policy analysis is concerned with GNP or its components and debits will be useful only if there is a stable relationship between GNP and debits. Since the time series of debits is volatile in the short run and does not work particularly well in a quarterly model, Enzler, Johnson, and Paulus [7] introduced another measure of transactions. They regressed debits on various expenditure categories of GNP and used the results to construct a transaction variable as a weighted sum of GNP expenditure components. In constructing this new measure, residential construction received a weight of 1.5, exports received 0.5, government purchases of labor services received zero, and all other GNP expenditure categories receive 1.0. Enzler and his associates substituted this variable for GNP and by doing so they were able to obtain a slightly improved sample-period fit and a substantial reduction in out-of-sample error. Substitution of this variable for GNP, by Goldfeld, improved the prediction results only slightly.

As was mentioned above, GNP is a measure of transactions in final goods. The demand for money balances to carry out the financial transactions is believed to be correlated with the level of wealth or change in its level. Net worth, used along with GNP, reduced the prediction errors

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[1]Footnote number 14 in Lieberman [13] explains the measurement of the debit variable used by him. Also, Lieberman used annual data.

slightly, in Goldfeld's work. Entering both level and percentage changes of household net worth as independent variables in the basic equation, by Enzler and associates, resulted in a better sample fit and eliminated the serial correlation of the residuals. However, this new equation gave worse out-of-sample prediction errors than the basic equation.

The discussion in this section shows that redefining the transaction variable improves the prediction errors generally, but does not solve the problem.

Brokerage Cost

Another problem is associated with the assumption of constant brokerage cost in the econometric version of the equation. This assumption could have been close to reality if there was an absence of institutional changes and innovations in money market instruments. But, it is certainly not justifiable if those factors are at work.[1] Brokerage cost consists of all the costs necessary for converting an interest bearing asset to "money" and vice versa. It includes the cost of "trips to the bank," explicit brokerage charges, penalties for premature withdrawal of funds, etc. Institutional changes and financial innovations along with ever increasing use of the computer in banking affect the brokerage cost by both eliminating trips to the bank and providing free brokerage services. For instance, the development of a money market mutual fund that invests shareholders' funds in a pool of short-term money market instruments

[1]According to Enzler and his co-authors, "even in the absence of innovation or changes in market structure, brokerage costs might change." See [7], p. 271.

provides the public with a very liquid interest bearing asset. The shareholder can redeem his (or her) share very quickly and with no charge by simply writing a check or making a wire transfer against the commercial bank associated with the fund.[1] Another example is authorization of transfer of funds from savings to demand deposits by telephone. This institutional change eliminates the cost of a trip to the bank, and the explicit service charge is usually zero.[2] These developments have possibly caused a reduction of funds in demand deposits. Some other developments having similar effects are overdraft credit lines, permitting banks to offer third-party transferable savings deposits, and bank-managed accounts. With the latter devise, at the end of each day the bank automatically invests deposit funds, over and above an agreed-upon minimum, in an overnight money market instrument, like RPs.

It is believed that the motivation behind many of the financial innovations and developments of the 1970s was high interest rates. As interest rates rise, the opportunity cost of holding money increases and the public tries to economize on cash holdings. This attitude stimulates financial innovations. Once the public learns how to manage the cash holding, they are not likely to forget or abandon it even if interest rates happen to go down. That is to say, the function may not be completely "reversible." Another proposed correction in the money demand equation was adding an independent variable to the equation consisting of

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[1]For more detail about MMMFs, see Chapter III.

[2]Some banks set a limit on the number of free-of-charge transfers and the number varies with the volume of funds in the savings account. There is a small service charge for extra transfers.

the value of previous peak interest rates. Since economizing on cash balances is stimulated by the volume of transactions, it was also proposed to consider the previous peak value of GNP as an independent variable in the demand equation. By substituting the previous peak value of GNP for its level, in the basic equation, Enzler and associates improved the out-of-sample prediction performance of the equation. A similar practice by Goldfeld[1] improved the out-of-sample predictions and reduced the RMSE. Adding a variable consisting of the previous peak value of the commercial paper rate to the basic equation, by Enzler and associates, reduced the out-of-sample errors very significantly, but they were still high. This specification had the best prediction results in Enzler and his associates' work. A similar practice by Goldfeld improved the out-of-sample prediction results and reduced the RMSE, also. Altering the transaction variable and adding both previous peak values of GNP and the commercial paper rate to the independent variables of the basic equation, collectively, reduced both RMSE and 1976:2's prediction error drastically in Goldfeld's work. This specification (equation 6.6 in Goldfeld [8]) had the best out-of-sample prediction performance.[2]

The Interest Rate

Variable "r" in equation 2.3 represents "the interest rate." In principle, all the short-term and long-term interest rates should be

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[1]Goldfeld added GNP/peak GNP to his basic equation.

[2]This specification is probably the worst according to the sample period prediction results.

represented in the econometric version of the equation. But, since all short-term interest rates are highly correlated with one another, only one short-term interest rate, such as the Treasury bill rate or commercial paper rate, is usually used as a proxy for short-term interest rates. The long-term interest rates are related to the short-term rates through "term structure of interest rate." They do not have to be explicitly represented in the demand equation. The interest rate paid on time deposits and savings deposits should be represented explicitly because they are regulated by the Federal Reserve authorities.

At the outset of unusual behavior of the money demand equation, Pierce expressed doubt about the Treasury bill rate as a good proxy for "the interest rate."[1] He constructed an equation that had the commercial paper rate as a dependent variable and the Treasury bill rate as an independent variable and adjusted TBR by applying coefficients estimated for this equation. By using the adjusted TBR he was able to reduce the prediction errors substantially in the third and fourth quarters of 1974.

According to Enzler and his associates, TBR is an acceptable proxy for "the interest rate." They tried other interest rates and combinations of the rates with small reward. According to Goldfeld, "simulation performance of equations using alternatively the commercial paper rate and

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[1]Pierce noted that in about 1974 TBR had followed a pattern different than the other rates. He mentioned three possible reasons for this phenomena. One was that the TBR is not subject to state and local income taxes. Second, the demand for TB by suddenly rich Arabs became very large, and the third was that the economic shock of that time caused the portfolio managers to attach unusually large risk premiums to private debt. For further explanation, see Pierce [17].

Treasury bill rate were virtually identical." Goldfeld tried to relax the assumption of constant elasticity of demand with respect to interest rates by adding the square of the logarithm of interest rates to the basic equation, but this variable turned out to be insignificant.

Measurement of Money

A rather important critique is that the money itself perhaps is measured incorrectly. What is presented on the left-hand side of the conventional equation, equation 1.1, is the old M-1 definition of money. But other assets and monetary instruments may be a close substitute for old M-1. Possible substitutes for old M-1 in recent years are overnight "Repurchase Agreements" (RPs), NOW Accounts, and checkable deposits at thrift institutions.

Tinsley, Garrett, Bonnie, and Friar [27] tried to partition the demand for immediately available funds (IF), defined as sum of RPs and Federal Funds (FF), into two parts: the demand on income account, TY(IF) and the demand on portfolio account, TP(IF). By combining TY(IF) with old M-1 they were able to explain about 80 percent of the cumulative shortfall in predictions of money balances. This approach was criticized by Porter and Mauskopf [18]. They consider RPs a portfolio asset and say, "the strong growth in RP's in 1976, while demand deposit growth was weak, may be explained by a shift out of deposits into RP's associated with the ongoing reduction in real-term uncertainty." This statement implies that RPs are not interest bearing transaction balances but, rather, they are a profitable overnight asset. Following this approach, money does not need to be redefined and it is enough to say that there has been a definite shift in the relationship between transaction demand for money and GNP and interest rate. This shift occurred because of an intensive use of a cash management techniques.

Following the same framework as Goldfeld's conventional equation, this study has tried to define the monetary aggregate to explain the shortfall in prediction of money demand.

CHAPTER III. REDEFINING THE MONETARY AGGREGATES

A Historical Background

The past decade has been a period of rapid innovation in the United States' financial system. These innovations along with some regulatory changes have fundamentally altered the character of the public's financial assets. A selected list of these developments appears in Table 3.1. These developments have increased the similarity among certain kinds of deposits and, at the same time, they have caused the disappearance of resemblances among other kinds of deposits. Further, the deposit liabilities of commercial banks and those of thrift institutions have become more similar than they were in the past.

Authorization of negotiable order of withdrawal (NOW) accounts and credit union share drafts has enabled the thrift institutions and some commercial banks to introduce new deposits with almost the same transaction services as demand deposits. NOW balances at commercial banks grew from $13 million in June 1974 to about $2 billion in June 1978. During this same period, NOW accounts at thrift institutions rose from $178 million to about $1.2 billion, resulting in a total increase in NOW accounts to $3.2 billion. Share draft balances at credit unions and demand deposits at thrift institutions rose to about $1.5 billion by June 1978. Other development that have increased the similarity between certain kinds of deposits are preauthorization of transfer of funds from savings accounts to demand deposits, preauthorization of bill payments, telephone transferring systems, and, more recently, automatic transfer

Table 3.1. Selected developments affecting the nature of the monetary aggregates[a]

Development	Date first introduced	Deposit liability	New monetary aggregate containing deposit liability
Preauthorized transfer	9/70	Savings balances at S&Ls and commercial banks	M-2
NOW accounts	6/72	Savings balances at MSBs, S&Ls and commercial banks	M-1B
2 1/2-year, 4-year, 6-year and 8-year time deposits	1/70, 7/73 12/74, 6/78 respectively	Time deposits at MSBs, S&Ls, and commercial banks	M-2, M-3
Substantial penalty on early withdrawal of time deposits	7/73	Time deposits at commercial banks, S&Ls, and MSBs	M-2, M-3
Point-of-sale terminals (POS) permitting remote withdrawals of deposits from savings	1/74	Savings balances at S&Ls	M-2
Credit union share drafts	10/74	Regular share accounts at federal credit unions	M-1B
Savings accounts from domestic governments and businesses	11/74, 11/75	Savings balances at commercial banks	M-2
Telephone transfers	4/75	Savings balances at commercial banks	M-2
Demand deposits at thrifts	5/76	Deposits of MSBs and S&Ls	M-1B
6-month money market certificates	6/78	Time deposits at S&Ls, MSBs and commercial banks	M-2
Automatic transfer services (ATS)	11/78	Savings balances at commercial banks and thrifts having transactions balances	M-1B

[a]Taken from "A Proposal for Redefining the Monetary Aggregates," Federal Reserve Bulletin. January 1979, p. 15.

services (ATS). These developments have increased the liquidity of savings deposits at both commercial banks and thrift institutions. Telephone transfers and ATSs facilitate the transfer of funds from savings to demand deposits significantly.

However, the preauthorization of transfer of funds simply permits direct payments from customers' savings accounts. If a check is written against the checking account, without sufficient funds in it, the bank would transfer funds from the savings to the checking account to cover the difference. Allowing state and local governments and businesses to have savings accounts has made it more important to recognize the transaction related feature of savings accounts, given the regulatory and technological changes mentioned above. Funds in the savings accounts of domestic governments grew from $0.336 billion in the year after their introduction (1974), to about $6.3 billion by June 1977; and funds of businesses grew to about $10.1 billion by that date (see Table 3.2).

Imposing a substantial penalty on early withdrawal of time deposits, effective July 1973, has brought about the disappearance of a similarity between savings deposits and small-denomination time deposits. This development made small time deposits less liquid, while savings deposits were becoming more liquid. This dissimilarity demands more attention, considering the fact that the funds in small-denomination time deposits with maturities over four years at commercial banks grew from about $21 billion in 1974 to about $74.4 in 1978. At thrift institutions they grew from $40.6 billion to $196.8 billion during the same four-year period.

Table 3.2. Selected deposit balances at commercial banks and thrift institutions (millions of dollars, not seasonally adjusted)[a]

Type of deposit balance	June 1974	June 1975	June 1976	June 1977	June 1978
NOW accounts					
At commercial banks	13	211	804	1,501	2,080
At thrift institutions	178	369	611	875	1,181
Share draft balances at credit unions	--	3	61	234	576
Demand deposits at thrift institutions	--	166	314	594	864
Savings at commercial banks					
By domestic governments	--	336	3,440	6,282	4,878
By businesses	--	--	6,013	10,123	10,757
Small denomination time deposits with maturities over four years					
At commercial banks[b]	21,027	35,956	49,890	66,151	74,396
At thrift institutions[c]	40,600	82,100	117,500	158,400	196,800

[a]Taken from "A Proposal for Redefining the Monetary Aggregates," Federal Reserve Bulletin. January 1979, p. 15.

[b]Measured as of July of each year.

[c]Estimated as of March of each year for savings and loans and April of each year for mutual savings banks.

The above developments have resulted in more similarity in the deposits in commercial banks and in thrift institutions. These two institutions were regarded as distinct, at least in the definitions of old M-1 and old M-2.

Along with the above developments, commercial banks have relied more on nondeposit liabilities; particularly security repurchase agreements (RPs). Overnight RPs grew from $0.1 billion, in 1966:1, to only $4.0 billion in 1973:1. But, they grew very rapidly to $21.0 billion by 1978:4 and to $28.2 billion by the last quarter of 1980. Money market mutual funds, another instrument that competitors for public money heavily rely on, grew from $0.1 billion, in 1973:4, to $9.5 billion in 1978:4, and, very interestingly, it grew to $76.7 billion by the last quarter of 1980.

Besides the above developments, the public (particularly businesses) has intensified its use of cash management activities since the mid-1970s. Simpson states: "In extensive interviews with [Federal Reserve] board staff, cash managers and commercial bankers indicated that their reliance on cash management intensified around the mid-1970s. Much of the funds 'released' from demand deposits was used to acquire highly liquid interest-earning investments, such as repurchase agreements, commercial paper, and Treasury bills" [24, p. 15]. Intensive cash management has become possible largely because of recent technological innovations, that have made possible the use of techniques such as wire transfers, information-retrieval systems, cash-concentration accounts, and lock boxes.[1] Cash management techniques have enabled the public to use fewer transaction balances for a given volume of transactions, by holding less money in their checking accounts and actively using savings deposits and other assets to carry out the transactions.

A quantitative estimate of the effect of the above factors on growth of old M-1 is given by Paulus and Axilrod [16].[2] They completed their report in the last quarter of 1976. In their study they projected, more or less in an ad hoc manner, the effect of the above factors on money growth for one year, i.e. for the period of 1976:3 to 1977:3 (Table 3.3). By looking at Table 3.2 we can realize how much the direction of the projected effects of quantitative factors coincide with the direction of actual growth of those factors. For instance, they projected that NOW accounts would have more negative effect on money growth for the period of 1976-77 than the previous period; and the data for NOW accounts show that their volume had increased for that period.

Table 3.3 shows that permitting businesses and state and local governments to have savings accounts could have displaced three percent of demand deposits in the period of 1975:3-1976:3 and 1.5 percent of them in 1976:3 to 1977:3. As we will see in the next section, since, even, the new aggregates like M-1A and M-1B do not have these savings as their

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[1]The impact of cash management techniques on demand for money is discussed in detail by Richard Porter and Eileen Mauskopf [18]. Also, see Chapter VI for more on this issue.

[2]The article does not mention the method of estimation explicitly. Apparently, the estimates are based on the study of the bank accounts.

Table 3.3. Demand deposit substitutes and other factors constraining M_1 growth ($ billion)[a]

	Outstanding amounts (quarterly average)		Change over 1-year QIII 75–QIII 76 period	Estimated effect on M_1	
	1975 QIII	1976 QIII		QIII 1975–QIII 1976	Projected QIII 1976–QIII 1977
Substitutes for commercial bank demand deposits:					
Business savings accounts	0.0	6.6	6.6	-2.5	-1.2
NOW accounts	.7	1.6	.9	-.7	-1.2
State and local government savings accounts	.5	3.1	2.6	-.5	-.3
Demand deposits at MSBs[b]	.2	.4	.2	-.2	-.4
Check credit (overdrafts at banks)	2.7	2.9	.2	neg.[c]	neg.
Credit union share drafts	neg.	.1	.1	neg.	neg.
Money market mutual funds	3.7	3.7	0.0	neg.	neg.
Subtotal	7.8	18.4	10.6	-3.9	-3.2
Other factors reducing M_1:					
Compensating balances				-1.0	.2
Telephone transfers				-.2	-.3
Preauthorized transfers at banks and S&Ls				-.1	-.2
Other[d]				-.2	-.3
Total				-5.4	-3.8

[a]Taken from Paulus and Axilrod [16].

[b]Excludes demand deposit escrow accounts held at MSBs in connection with servicing of mortgages.

[c]neg. = negligible.

[d]Includes such items as zero balance accounts and payable through drafts, which enable corporations to maintain low, or no, demand deposits while making current payments. Also includes customer-bank communication terminals in stores that enable individuals to pay for purchases by electronic debiting of interest-bearing accounts.

components, one might end up with having the above problem in working with the new aggregates too.

New Monetary Aggregates

The developments that we discussed in section one of this chapter and their coincidence with a poor performance of old M-1 created some doubt about the appropriateness of the old aggregates. After several years of research by people in and out of the Federal Reserve System, the Board of Governors of the Federal Reserve redefined the monetary aggregates.

Four newly-defined monetary aggregates have replaced the old M-1 through M-5 measurement of money and a broader measure of liquid assets has been adopted. The new aggregates are presented in Table 3.4.

Although the table is self-explanatory, a brief comment on its contents might be helpful. Before going through the explanation of the new monetary aggregates and their components, it should be noted that the underlying organizing principle in redefining the new aggregates is to combine similar kinds of monetary assets at each level of aggregation [22].

The two measures of narrow definition of money are M-1A and M-1B. M-1A is obtained by subtracting the sum of the demand deposits of foreign commercial banks and official institutions from old M-1. Since the deposits held by foreign commercial banks and official institutions are believed to be clearing balances for financial transactions between the parties operating in the Eurodollar and foreign exchange market, many economists believe that this new aggregate is correlated more nearly with

Table 3.4. New and old monetary aggregate definitions [3]

The new monetary aggregates	Amount in billions of dollars, November 1979	The old monetary aggregates	Amount in billions of dollars, November 1979
M-1A Currency	106.6	M-1 Currency	106.6
Demand deposits[a]	265.5	Demand deposits[b]	276.0
M-1B M-1A			
NOW and ATS account balances, credit union share draft balances, demand deposits at mutual savings banks	115.7		
M-2 M-1B	387.9	M-2 M-1	382.6
Overnight RPs issued by commercial banks[c]	20.3	Savings deposits at commercial banks	210.6
Overnight Eurodollar deposits at Caribbean branches of U.S. banks held by U.S. nonbank residents	3.2	Time deposits at commercial banks[d]	352.1
Money market mutual fund shares	40.4		
Savings deposits at all depositary institutions	420.0		
Small time deposits at all depository institutions[e]	640.8		
M-2 consolidation component[f]	-2.7		
M-3 M-2	1510.0	M-3 M-2	945.3
Large time deposits at all depositary institutions[g]	219.5	Savings and time deposits at thrift institutions	664.2
Term RPs issued by commercial banks	21.5		
Term RPs issued by savings and loan associations	8.2		1609.5

M-4	M-2	945.3
	Large negotiable time deposits at all depositary institutions	95.9
		1041.2
M-5	M-3	1609.5
	Large negotiable deposits at all depositary institutions	95.9
		1705.4

L	M-3	1759.1
	Other Eurodollars of U.S. nonbank residents	34.5
	Bankers acceptances	27.6
	Commercial paper	97.1
	Savings bonds	80.0
	Liquid Treasury obligations[h]	125.4
		2123.8

[a]Equals demand deposits at all commercial banks other than those due to domestic commercial banks and the U.S. government, less cash items in the process of collection and Federal Reserve float, less demand deposits due to foreign commercial banks and official institutions.

[b]Equals demand deposits at all commercial banks other than those due to domestic commercial banks and the U.S. government, less cash items in the process of collection and Federal Reserve float, plus foreign demand balances at Federal Reserve banks.

[c]Estimated as 51 percent of all commercial bank RPs with the nonbank public and net of RPs held by money market mutual funds.

[d]Time certificates of deposit other than negotiable time certificates issued in denominations of $100,000 or more.

[e]Time deposits issued in denominations of less than $100,000.

[f]Consists of demand deposits included in M-1B that are held by thrift institutions and are estimated to be used for servicing their savings and small time deposits included in the new M-2 measure.

[g]Negotiable and nonnegotiable time certificates of deposit issued in denominations of $100,000 or more.

[h]Consists of Treasury bills with an original maturity of one year or less plus Treasury notes and bonds which mature within 18 months.

the GNP. M-1B is equal to M-1A plus the sum of interest bearing checkable deposits at all depository institutions. These deposits consist of NOW accounts, automatic transfer from savings (ATS) accounts, credit union share draft balances, and demand deposits at thrift institutions. As late as 1975, the new interest bearing checkable deposits accounted for less than 0.5 percent of M-1B, but their share increased to 2.3 percent by 1978, and to 6.4 percent by December 1980 with a total of $16.2 billion. Until 1979, the sum of the components added to M-1B was not large enough to offset the sum of the components subtracted from old M-1. So, the volume of M-1B did not exceed the volume of old M-1 until 1979. The empirical results of these aggregates are reported in Chapter V.

New M-2 is M-1B plus the volume of so called "near money." Near money consists of overnight RPs issued by commercial banks, overnight Eurodollar deposits at Caribbean branches of the U.S. banks held by the U.S. nonbank residents, money market mutual fund shares, savings deposits and small time deposits at all depository institutions, and the M-2 consolidation component.

This aggregate contains controversial components. Here is where RPs appear in a monetary aggregate for the first time. Some people have attempted to include the transaction related part of RPs in narrow measure of money. As mentioned in Chapter II, Tinsley, Garrett, Bonnie, and Friar [27] developed a model to partition the demand for immediately available funds, consisting of RPs and federal funds, to demand on portfolio and income accounts; and suggested that the demand on income accounts be regarded as a component of the narrow money.

The statistical method used for this partitioning is an arbitrary one. The assumption of overnight RPs representing the exchange related part of total RPs is also arbitrary [3, p. 52] and should be as valid as Tinsley-Garrett-Bonnie-Friar's method. Another component of new M-2 is money market mutual fund shares. This is the first time this component appears in a monetary aggregate. One reason for excluding these funds from narrow measure of money is "the lack of timely, reliable data verified by Federal Reserve reporting procedures" [10, p. 84]. Another reason is that their turnover rate, in the past few years, was about the same as that of savings deposits, and about one-fiftieth of the demand deposits' rate of turnover, see Table 3.5.[1]

As for savings deposits, it has been argued that the liquidity of these accounts at thrift institutions is not equal to their liquidity at commercial banks. It has been suggested attaching a higher weight to the funds at commercial banks [2]. Simpson [24] has proposed the inclusion of savings deposits at commercial banks in a wider measure of M-1, and treating the savings deposits at thrift institutions as part of M-2.

Consolidation accounts, with negative sign, measure the deposits held by thrift institutions at commercial banks for facilitating the customers' withdrawals from savings and time deposits and deposits owned by mutual funds for redemption of shares.

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[1]Porter, Simpson, and Mauskopf [19] included MMMFs, along with RPs, in narrow monetary aggregate, and they were able to reduce the percentage cumulative prediction error by that.

Table 3.5. Turnover rates at commercial banks and money market funds[a,b]

	July '77	Oct. '77	Jan. '78	April '78	July '78	Oct. '78	Jan. '79	April '79
Demand deposits	128.1	134.6	131.5	138.0	139.4	144.1	151.2	156.8
Savings deposits								
All customers	1.6	1.7	1.8	1.9	2.0	2.1	2.7	3.2
Business customers	4.0	4.5	4.7	4.7	5.1	5.8	6.8	7.0
Others	1.5	1.5	1.7	1.8	1.8	1.9	2.5	3.0
Money market fund shares	3.1	3.3	3.6	3.7	3.5	3.7	3.8	3.1

[a]Turnover rates for demand deposits are seasonally adjusted. Turnover rates for savings deposits and MMMF shares are not seasonally adjusted.

[b]Taken from Federal Reserve Bulletin; "Donoghue's Money Fund Report" of Holliston, Mass.

New M-3 is constructed by adding large denomination time deposits (with denominations of $100,000 or more) at all depository institutions, and term RPs issued by commercial banks and savings and loan associations to M-2. This aggregate is broader than the restricted transaction balances, which is the underlying character of M-1A and M-1B, and it is broader than the measure of both money and near money balances, M-2.

An even broader measure of liquid assets, among the new monetary aggregates, is indicated by "L." L is constructed by adding term Eurodollars held by U.S. nonbank residents, bankers acceptances, commercial paper, savings bonds, and liquid Treasury obligations to M-3. Liquid Treasury obligations consist of Treasury bills with an original maturity of one year or less, and Treasury notes and bonds which mature within 18 months from the issue date. Since variation in the quantity of components such as Treasury securities and commercial paper, reflects the overall portfolio and financing decisions of private nonbank corporations, the Treasury, banks, thrift institutions, and the Federal Reserve, L is interpreted as a measure of total short-term credit or liquidity in the economy, rather than being a broader measure of the stock of money, like M-2 and M-3. Since we are more concerned with a narrow measure of money, only the prediction results for M-1A and M-1B, among these new aggregates, are reported in Chapter V.

In the next two sections of this chapter, we look more closely at RPs and money market mutual funds. RPs and MMMFs are combined with M-1B to give other new aggregates (M-1C, M-1D, and M-1E) that are not official monetary aggregates. Since it has been argued that savings deposits have become more liquid, and with the available techniques they could be used for transaction purposes, I subtracted small time deposits at all depository institutions from new M-2 and called the new aggregate M-1F. This aggregate is simply equal to M-1D plus overnight Eurodollars and savings deposits in all depository institutions. Finally, I have subtracted savings deposits from M-1F, and I have called the new aggregate M-1G. M-1G is equal to M-1D plus overnight Eurodollars. I tried this aggregate to see whether including overnight RPs, money market mutual funds, and overnight Eurodollars would explain the lost funds from demand deposits. The empirical results for all these aggregates are reported in Chapter V.

Repurchase Agreements (RPs)

A repurchase agreement (RP) is an agreement between a lender of funds and a borrower. The borrower sells U.S. Treasury or federal agency securities to the lender,[1] and agrees to buy them back at a certain time and at a certain price. What this transaction means to the lender is that he has lent funds secured by U.S. Treasury or federal agency securities. The borrower either buys back the securities at a slightly higher price than the sale price, or he buys them back at the same price and agrees to pay an interest fee. This sort of transaction is done by both security dealers and banks, and it is one of the lowest cost ways of borrowing money. Before repurchase agreements came into existence, commercial banks

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[1] These securities, in fact, serve as collateral for the loaned funds. The collateral could be other assets too, but only the RPs backed by U.S. Treasury and federal agency securities are exempt from reserve requirements.

had (and still have) access to similarly low cost funds, called "federal funds." Through the interbank market, member banks with excess reserves, i.e. the reserves in excess of the amount required, lend funds in the federal funds market to banks that are short of required reserves. This lending and borrowing is done on the books of the Federal Reserve Banks. The lending bank sends a wire to the Federal Reserve Bank and orders the transfer of funds from its reserve account to the borrower's account. Commercial banks can trade these federal funds, which are exempt from reserve requirements and interest rate ceilings, with institutions defined as "banks." The 1969 amendment to regulations D and Q exempted RPs from interest rate ceilings and reserve requirements and enabled banks to have access to the funds of other parties at relatively low rates--slightly lower than the federal funds rate. The market for RPs expanded rapidly during the 1970s. The increase in only overnight RPs, i.e. the RPs with a duration of one day, was $26 billion for this decade. The RPs grew most rapidly in the second half of the 1970s. The volume of overnight RPs rose from $2.5 billion in December 1969 to $7.5 billion in December 1975 and then to $28.5 billion by December 1980.

Economists believe that three factors are responsible for this growth. First, as mentioned earlier, the amendment to regulations D and Q, that made it clear that RPs issued by banks against Treasury bills and federal agency securities, were exempt from reserve requirements.

A second factor contributing to the rapid growth of RPs in the second half of the 1970s was the Treasury's 1974 decision to shift the bulk of its deposits from Treasury Tax and Loan Accounts at commercial banks to accounts at the Federal Reserve banks. This shift freed billions of dollars worth of Treasury bills and federal agency securities that banks had been holding as collateral against Treasury deposits. These bills and securities could then be used as collateral in the RPs market [26].

A third factor contributing to the extensive activity in the RPs market was the generally high level of interest rates experienced since the mid-1960s, particularly the sharp rise to peak levels in 1973 and 1974 and then again in 1979 and 1980.

Since the commercial banks pay no explicit interest rate on demand deposits, high market interest rates mean a high opportunity cost to the owners of demand deposits. That is, the cost of maintaining checking accounts increases as market interest rates rise. By the mid-1970s, high market rates had encouraged the corporate finance managers to rely more on cash management by applying new financial management techniques to reduce their holdings of demand deposits (upon which no interest is paid).

The large money-center banks are the net borrowers of these funds; the interbank RPs market tends to channel funds from smaller banks to these large banks. Nonbank security dealers are the main competitors for the large banks in the RPs market. Security dealers issuance of RPs against U.S. Treasury and agency securities has expanded greatly since mid-1976; and most of this growth has been in the shorter maturities, 15 days or less.

Most of the activities in the RPs market take place in the morning. Both large banks and security dealers establish their RP financing needs, based largely on the volume of existing collateral, early in the morning and then proceed to raise RP funds. Usually, the collateral becomes exhausted by noon, the market begins to soften, and interest paid on RPs declines to a less favorable level (for the lenders). Although some banks offer their customers automatic RPs, by investing the excess of a customer's demand deposit over the negotiated level in RPs, the volume of this sort of funding, Simpson says [23], is believed to be small. In general, RP customers decide on their purchase early in the morning, well in advance of the time of closing the balance for the day. The arrangements between large corporate depositors and commercial banks on the one hand and availability of the new cash management techniques on the other hand, have made it possible for the customers to decide on the purchase of RPs in the morning.

Since banks are prohibited by law from paying explicit interest on demand deposits, for attracting such funds the banks pay implicit interest rates to the owners of demand deposits.

Banks offer a package of financial services in return for holding a specific amount in demand deposits known as "compensating balances." The volume of compensating balances is largely a function of market interest rates and reserve requirement rates. Typically, the arrangements with holders of large deposits specify compensating balances as an average of end-of-day collected balances over a period, usually a month or a year. By this arrangement the corporates have flexibility in their demand deposit balances for the end of each day. If they come short of the average required, they can offset that by holding more than the average the next day.

Large firms having access to computer and more sophisticated financial management techniques can predict their balance for the end of the day with high accuracy. The averaging provision allows the depositor to invest early in the day any funds that are projected to be in excess of targeted compensating balances at the end of the day with no risk. According to one view,[1] firms could manage their cash more efficiently by applying and more actively using the new financial management techniques. By doing so they could hold smaller amounts of demand deposits for a given volume of transactions and rather easily meet their average required compensating balances, despite normal day-to-day fluctuations in their cash flows. RP markets provide a highly liquid, safe, and relatively profitable short-term asset, even overnight, to acquire for the saved funds.

This discussion suggests that RPs are an attractive alternative to holding deposits, as are Treasury bills and commercial paper. RPs differ from Treasury bills and from many other market instruments in that they can be negotiated with overnight maturities and are not subject to capital gains or losses. The low transaction cost of RPs gives the minimum holding period of a nearly zero time span that makes, still, the overnight possession of the asset profitable.

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[1]This view is expressed by Simpson [23], along with some other people.

There is an alternative interpretation of RPs. Some evidence suggests that RPs are used more as a substitute for demand deposits. Two special surveys of very large banks, taken April 24, 1974 and December 7, 1977, indicate first that at least one-half of RP funds attracted by banks from businesses and state and local governments had overnight maturities or were under continuing contracts, and about 10 to 20 percent of RPs with these customers had maturities of two to seven days. With such a large holding of RPs of short maturity range, the depositors can readily and conveniently use RP funds to cover unexpected cash needs.

Second, in recent years, week-to-week changes in demand deposit growth appear to be inversely correlated with the week-to-week changes in RPs arranged with large banks. Reductions in demand deposits have been associated with increases in RPs at the large banks and increases in demand deposits have been associated with declines in RPs.

So, there are two competing points of view regarding the RPs and the public's demand for demand deposits. The first view emphasizes the role of cash management practices in reducing the demand for transaction balances, i.e. demand deposits, and freeing some funds for investing in interest-bearing assets. According to this view, the application of cash management techniques enables the firms to reduce the near-term variability of cash flows, and hence to improve the accuracy of their near-term projections of cash flows. As a result, a large portion of the transaction balances held for meeting unexpected cash needs could be freed and invested in interest-bearing assets. RPs have been an attractive candidate for these funds because of their short maturities and relatively low transaction costs. The second view regards the large portion of funds placed in overnight RPs as transaction balances. This is a way for large depositors to obtain an explicit interest on their transaction balances, and it helps the commercial banks to lower their reserve requirements since no reserve is required on RP liabilities against Treasury bills and federal agency securities.

However we interpret RPs, one thing is common in these alternative interpretations and that is that at least some part of the shortfall in demand for narrow money is mirrored in the growth of RPs, particularly the overnight RPs. In this dissertation, we are not much concerned with an explanation of the motives for holding RPs. Accepting either alternative, we should be able to reduce the prediction errors (in percentage terms) by adding to narrow money the funds used in purchasing the transaction related RPs. For this purpose, we assume that the overnight RPs placed by the public with the commercial banks serve as an approximation of the transaction related part of RPs and we add overnight RPs to M-1B and present the new aggregate by M-1C.

Money Market Mutual Funds (MMMFs)

One of the more remarkable changes in the United States' financial system in recent years has been the rapid growth of money market mutual funds. These funds are open-end investment companies that invest only in short-term money market instruments. Through these devices investors pool funds to invest in a diversified portfolio of securities.[1] The investor who puts money into a fund receives shares and becomes a part owner of the fund. MMMFs came to market in 1972 but the volume of the assets in these funds were negligible until 1973. From 1975 to 1978 the volume of assets remained between $3 and $4 billion. Since 1978 they have grown very rapidly--from $4.2 billion in January 1978 to $75.8 billion in December 1980.

Mutual funds were designed to meet the needs of small investors, for whom direct investing in money market instruments is either impossible or awkward. Usually, money market securities are issued in rather large denominations and investors with limited funds cannot reduce risk by diversifying. With same instruments, the yield on small denomination securities is lower than the yield on those of large denomination. Investing in these funds is a good opportunity for small investors. One explanation for the rapid growth of MMMFs is that these funds are primarily a means for providing access to money market yields.

As we see in Figure 3.1, from 1975 to 1978 the yields paid by MMMFs fluctuated through a 300 basis point range and twice fell for months below the maximum rate payable on bank savings accounts. Figure 3.2 shows that the quantity of money market funds remained about the same during this period. Since October 1977 the funds' yield has been well above the maximum rate payable on banks' savings deposits. During this period, the volume of assets in these funds has grown rapidly and tended to close the

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[1]This section is mainly adapted from Timothy Q. Cook and Jeremy G. Duffield [5], and Marcia Stigum [26].

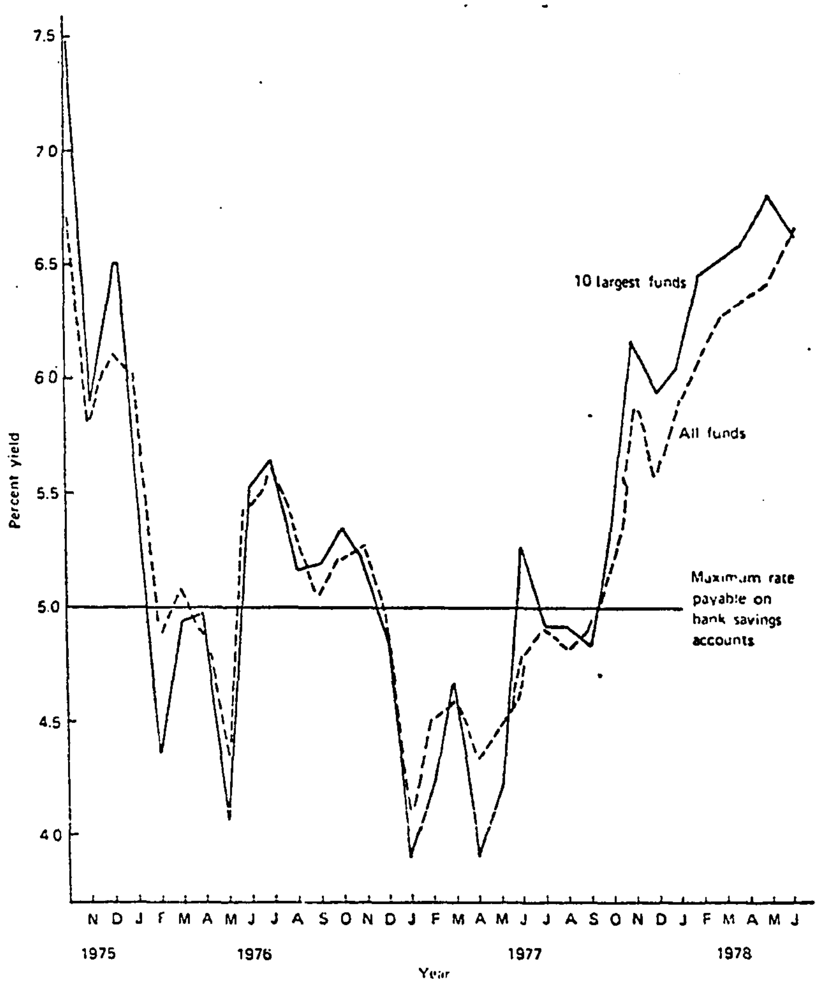

Figure 3.1. Yields paid by money market funds (monthly average) (Source: "Donoghue's Money Fund Report," as cited by Stigum [26])

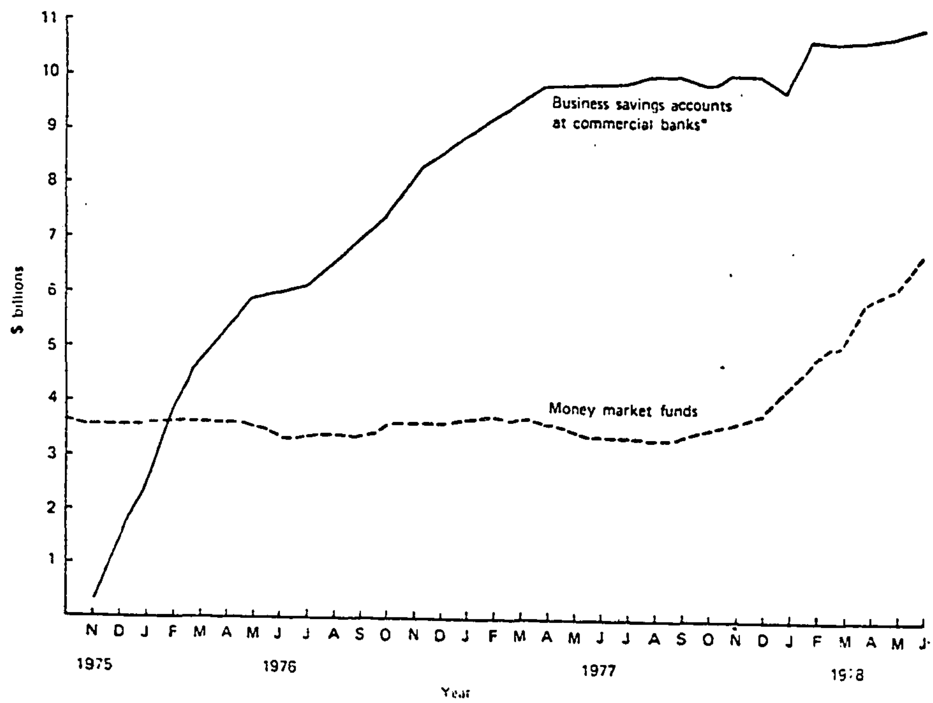

Figure 3.2. Money invested in money market funds and business savings accounts at commercial banks (Source: "Donoghue's Money Fund Report," as cited by Stigum [26]) (*the business savings for months other than those which are end-of-quarter call dates are estimated by the Federal Reserve Board)

gap between the volume of business savings accounts at commercial banks and money market funds.

The general operating characteristics of MMMFs are fairly standard, although there are some variations among different funds. Investors can purchase and redeem MMMF shares without paying a sales charge. The interest is calculated daily on outstanding shares and it is credited to the investor's account periodically--usually at the end of the month. Expenses of funds are deducted daily from gross income. The minimum initial investment generally varies from $500 to $5,000, although a very small number of funds have no minimum requirement and some funds, basically designed for institutional investors, require a minimum of $50,000 or more. The yield paid to the shareholder of a MMMF depends primarily on the yields of the securities held by the fund but it also depends on the expenses of the fund and its accounting policies. Withdrawals can be made in three ways: by written request, telephone request, or by the investor drawing a check. Most money market funds have set up an arrangement with a commercial bank under which the investor is provided with checks and can make withdrawals and execute payments simply by drawing a check against that bank. Generally, there is a minimum amount that each check can be written for, usually $500.

The investors in MMMFs are individuals, bank trust departments, and corporations (listed in order of their importance in the market). This order supports the idea that the investors with no, or limited, access to money market securities are more active in this market. There is no reason to believe that these funds are used for transaction purposes. In fact, there is evidence that the turnover rates of these funds resemble more the turnover rates of savings deposits.[1] But, since MMMF shares are highly liquid assets, they could have absorbed some part of the funds released by extensive use of cash management techniques by the smaller corporations that cannot meet the minimum requirement for entering the RP market. These funds may have grown mainly at the expense of savings deposits. Total savings deposits in commercial banks and thrift institutions have grown more slowly from the beginning of 1978 and finally this growth started to decline from July 1978, while the beginning of the take-off time for MMMFs[2] was early 1978.

In this study, the volume of MMMFs has been added to M-1B aggregate of money to see whether that will help to reduce the percentage error of prediction, by picking up some of the funds released from demand deposits. This new aggregate is indicated by M-1E and both RPs and MMMFs have been added to M-1B to examine the effect of both funds on the predictions of the demand for money and this new aggregate is indicated by M-1D.[3]

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[1]This point is discussed earlier in this chapter.

[2]As we will see in the empirical results, including MMMFs in monetary aggregates generally results in under estimation of actual value.

[3]Definition of these aggregates and other new aggregates proposed in this dissertation are presented in Table 1 of the appendix for convenience.

CHAPTER IV. STATISTICAL METHOD

Serial Correlation

One of the crucial assumptions in the ordinary least square method of estimation is that the covariance of the disturbance terms is zero; that is, if U is the vector of disturbance terms,

$$E(UU') = \sigma^2 I$$

in which the off-diagonal terms give

$$E(u_t u_{t+s}) = 0 \text{ for all } t \text{ and } s \neq 0.$$

This assumption for the time series data implies serial independence of the disturbance terms.

But, in the case of simple models it may not be very plausible to assume serially independent disturbance terms. In general, if we leave out some variables, which have pervasive serial correlation, that will raise the likelihood of autocorrelated disturbance terms. This possibility arises because the disturbance term contains the effect of the variables left out, which in turn have pervasive serial correlation. Another reason for having autocorrelated disturbance terms is measurement error in the "explained" variable.

To illustrate the problem we shall consider the following relation with two variables [11].

$$Y_t = \alpha + \beta x_t + u_t. \tag{4.1}$$

We assume that the disturbance term U_t follows a first-order autoregressive scheme:

$$u_t = \rho u_{t-1} + \varepsilon_t \tag{4.2}$$

where $|\rho| < 1$ and ε_t satisfies the following assumptions:

$$E(\varepsilon_t) = 0,$$

$$E(\varepsilon_t \varepsilon_{t+s}) = \sigma_\varepsilon^2 \text{ for } s = 0,$$

$$= 0 \text{ for } s \neq 0 \qquad (4.3)$$

for all t.

Expanding equation 4.2 yields:

$$u_t = \sum_{r=0}^{\infty} \rho^r \varepsilon_{t-r}, \qquad (4.4)$$

So,

$$E(u_t) = 0 \qquad (4.5)$$

and

$$E(u_t u_{t-s}) = \rho^s \sigma_u^2. \qquad (4.6)$$

The relation (4.6) could be written as:

$$\frac{E(u_t u_{t-s})}{\sigma_u^2} = \rho^s. \qquad (4.7)$$

Writing the covariance matrix based on equation (4.7) gives:

$$E(uu') = V = \sigma_u^2 \begin{bmatrix} 1 & \rho & \rho^2 & \cdots & \rho^{n-1} \\ \rho & 1 & \rho & \cdots & \rho^{n-2} \\ \vdots & & & & \\ \rho^{n-1} & \rho^{n-2} & & \cdots & 1 \end{bmatrix} = \sigma_u^2 \Omega. \qquad (4.8)$$

So, the autocorrelated disturbances break down the standard assumption of $E(UU') = \sigma^2 I$.

If the ordinary least-squares formulae are used in estimating the coefficients of a model that has autocorrelated disturbances, it will have three major consequences. One: although it gives unbiased estimates for β, their variance may be higher than what could be achieved with other estimating methods. Two: the t and F tests are no longer valid because of likely underestimation of the variance of regression coefficients. Three: the fitted equation will give inefficient predictions, i.e. predictions with unnecessarily large variances. If the independent variable follows an autoregressive scheme, that will accentuate the bias.

If there is an autocorrelation problem, the generalized least-squares estimator is the best linear unbiased estimator if V in equation (4.8) is known. If we know that the disturbance follows a first-order scheme and if the value of the parameter ρ is known, the direct application of generalized least-squares will result in the estimator:

$$b = (x' \Omega^{-1} x)^{-1} x' \Omega^{-1} y. \qquad (4.9)$$

For a first-order autocorrelation scheme, the parameters could alternatively be estimated by application of OLS to transformed data. This method is called a simple two-stage procedure and the transformation matrix, T, should be such that the relation

$$Ty = Tx\beta + Tu$$

gives a scalar dispersion matrix, that is

$$E(Tuu'T') = \sigma^2 I.$$

In short, the T-matrix used for transforming (N-1) observations is defined as

$$T = \begin{bmatrix} -\rho & 1 & 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & -\rho & 1 & 0 & \cdots & 0 & 0 & 0 \\ \vdots & & & & & & & \\ 0 & 0 & 0 & 0 & \cdots & -\rho & 1 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & -\rho & 1 \end{bmatrix}.$$

Application of simple least-squares to Ty and Tx for estimating the parameters of equation (4.1) will generally result in estimates close to the ones given by (4.9).

ρ-Unknown

Combine equation (4.1) and (4.2) and obtain:

$$(y_t - \rho y_{t-1}) = \alpha(1 - \rho) + \beta(x_t - \rho x_{t-1}) + \varepsilon_t \qquad (4.10)$$

and denote the estimates of α, β, and ρ by a, b, and r. Then, the sum of the squared residuals from (4.10) is given by:

$$\sum_{t=k}^{n} e_t^2 = \sum_{t=1}^{n} [(y_t - ry_{t-1}) - a(1-r) - b(x_t - rx_{t-1})]^2 \qquad (4.11)$$

One method of approximating the values of a, b, and r that minimizes the sum of squares in (4.11) is the Cochrane-Orcutt interative procedure. Starting with an arbitrary value for r, say r_1, this procedure minimizes the sum of squares with respect to a and b, and obtains values a_1 and b_1. Then it keeps a and b fixed at the a_1 and b_1 level, and minimizes the sum of squares with respect to r, to obtain a new value of r, r_2, and then it keeps this fixed and repeats the above procedure until it comes up with successive estimates that differ by arbitrarily small amounts.

Lagged Dependent Variable

The assumption of partial adjustment will give rise to a lagged dependent variable in the model. The reason for partial adjustment could be the cost of change; e.g. in this study the cost of change in the cash position of individuals or business firms in response to a change in the explanatory variables.

Let the optimal y value associated with x_t be denoted by y^*. So, we have

$$y^* = \alpha + \beta x_t. \qquad (4.12)$$

The adjustment process can be shown with the following equation:

$$y_t - y_{t-1} = \gamma(y_t^* - y_{t-1}) + u_t \qquad 0 < \gamma \leq 1. \qquad (4.13)$$

Equation (4.13) asserts that in the current period the agent will probably move only part of the way from its starting position (y_{t-1}) to the optimum position (y_t^*). The value of γ indicates the speed of adjustment; the bigger it is the greater is the adjustment made in the current period.

Combining equations (4.12) and (4.13) gives:

$$y_t = \alpha\gamma + \beta\gamma x_t + (1 - \gamma)\, y_{t-1} + u_t. \qquad (4.14)$$

Now, if we assume that u_t's are normally and independently distributed, with mean and variance equal to zero and σ_u^2, respectively, the only problem in estimating equation (4.14) is the presence of a lagged dependent variable among the regressors. Yet, in this case the least-squares method will yield consistent and asymptotically efficient estimators.

If we assume that the disturbance term in equation of form (4.14) is serially correlated, specified as

$$u_t = \rho\, u_{t-1} + \varepsilon_t \qquad (4.15)$$

with $|\rho| < 1$ and the $\varepsilon \sim NID(0, \sigma_\varepsilon^2)$.

The OLS gives inconsistent estimators. The bias will be more significant for large values of ρ and small values of the coefficient of lagged dependent variable.[1]

For estimating the model that has both lagged dependent variable and autocorrelated disturbance term, there are other methods. If ρ is known, the straight forward procedure will be to compute the OLS estimators.

If ρ is unknown, as it is in this study, one possible method of estimating the coefficients is an interative procedure [20], using a nonlinear estimation procedure. Let us rewrite equation (4.14) as,

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 y_{t-1} + u_t. \tag{4.16}$$

Combining equation (4.14) and (4.15) gives,

$$y_t = (1-\rho)\beta_0 + \beta_1 x_t - \rho\beta_1 x_{t-1} + (\rho + \beta_2)y_{t-1} - \rho\beta_2 y_{t-2} + \varepsilon_t. \tag{4.17}$$

---

[1]For proof, see Johnston [11]. He sets up the very simple model and shows the significance of the error. Let us say,

$$y_t = \beta y_{t-1} + v_t,$$
$$v_t = \rho v_{t-1} + \lambda_t;$$
$$|\beta| < 1, |\rho| < 1.$$

If we calculate $\hat{\beta}$, it will come out as

$$\hat{\beta} = (\beta + \rho) - \beta\rho \frac{\Sigma y_{t-1} y_{t-2}}{\Sigma y_{t-1}^2} + \frac{\Sigma\Sigma_t y_{t-1}}{\Sigma y_{t-1}^2}$$

taking probability limits

$$\text{Plim } \hat{\beta} = (\beta + \rho) - \beta\rho \text{ Plim } \hat{\beta}$$

$$\text{Plim } \hat{\beta} - \beta = \frac{(1-\beta^2)}{1 + \beta\rho}.$$

Different combinations of ρ and β will result in different errors. The bias can be very large, especially for combination of low values of β and large values of ρ.

Now, the attempt to estimate all four parameters, β_0, β_1, β_2, and ρ by direct minimization of the sum of square errors in (4.17) leads to nonlinear estimating equations. The Gauss method starts with an initial value for this set of parameters (β^0) and tries to find another set of parameters ($\beta^0 + \Delta$) to minimize the error sum-of-squares (ESS); where $\Delta = (x'x)^{-1} x'y$ and $x = \frac{\partial y}{\partial \beta} \mid \beta^0$. If ESS($\beta^0 + \Delta$) > ESS($\beta^0$) the procedure used will compute ESS($\beta^0 + 1/2\Delta$), ESS($\beta^0 + 1/4\Delta$), ..., until a smaller ESS is found.

Estimating Method

In estimating most of the equations in this study, although there is a lagged dependent variable among the regressors, it has been assumed as though there is no lagged dependent variable in the equation. For estimating these equations, the "AUTOREG" procedure of the SAS program is used. This procedure approximates least squares estimates in a manner similar to the Cochran-Orcutt method. This method first estimates the model

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 y_{t-1}, \tag{4.18}$$

using ordinary least squares method. It computes the autocorrelations up to lag n (which is one for all the equations in this study) of the residuals from the OLS regression. The Yule-Walker equations are solved to obtain estimates of autoregressive parameters (ρ in our model) and a preliminary estimate of σ^2. With knowing σ_2 and $\hat{\rho}$ it transforms all the original data of the variables. Using the transformed data, β (coefficients of equation (4.18)) is reestimated by an ordinary least squares regression. This method is equivalent to a generalized least squares estimate with appropriate weights.

Although, as mentioned before, this method is not an appropriate method when there is a lagged dependent variable in the model, but since it is easy to work with, and the parameter estimates are not believed to be very different from those one obtained by nonlinear methods, this method is used for estimating the parameters of most of the equations in this study--except for old M-1, M-1B, and M-1C that nonlinear method is also tried and the results are reported in the next chapter. As we will see in the next chapter, this method gives the parameter estimates of correct sign. The test for significance of the coefficients is pointless, because we already know that they are baised one way or the other. But, in this study we are not really concerned with coefficient estimates. The main goal of this study is to find an equation that gives best out-of-sample prediction values of dependent variables. However, the coefficients that turn out to be significant in these equations are generally found significant in others' work who have used different estimation methods.

CHAPTER V. EMPIRICAL RESULTS

We begin with a discussion of the empirical results obtained with the use of old M-1 to show, once again, the significance of the problem. Another purpose for starting with the old M-1 is that this aggregate has been a generally accepted definition of narrow money in the past. For old M-1, different specifications of the conventional model are examined in order to acquire some idea about the proper specification of the demand function for the aggregates proposed in this dissertation.

Old M-1

For old M-1, basically the conventional model is used, only differently specified from one case to another. Table 5.1 shows the regression results for different specifications of the model. In all the equations, the dependent variable is the real stock of money. In the case of equation 5.1.A, it is regressed on the real gross national product (GNP), the Treasury bill rate (TBR), the maximum interest rate payable on savings accounts by commercial banks (SR), and the lagged value of old M-1 (LM). All the variables are in logarithmic form. For example, GNP is used as a shorthand for the logarithm of gross national product. All the equations in this study are estimated for the period of 1959:2-1973:4. In equation 5.1.A, all the coefficients are of the right sign. The coefficients that turn out to be significant generally have been found significant in other studies, using different estimation methods. In equation 5.1.A, the coefficients of GNP, TBR, and LM are significantly different than zero.

Table 5.1. The regression results of old M-1, (1959:2-1973:4)[a]

Equation	Intercept	GNP	TBR	CPR	SR	LM	GNP long-run	ρ	R^2
5.1.A	0.339	0.106	-0.015		-0.023	0.813	0.569	0.396	0.984
	(1.143)	(3.167)*	(3.213)*		(1.298)	(9.265)*			
5.1.B	0.414	0.102	-0.014		-0.018	0.803	0.519	0.407	0.984
	(1.320)	(2.985)*	(3.117)*		(1.029)	(8.661)*			
5.1.C	0.567	0.120	-0.014		-0.017	0.752	0.484	0.490	
5.1.D	0.419	0.098	-0.018		-0.022	0.801	0.491	0.385	0.970
	(1.210)	(2.988)*	(3.376)*		(1.062)	(8.165)*			
5.1.E	0.244	0.103		-0.018	-0.024	0.836	0.630	0.341	0.987
	(0.895)	(3.262)*		(3.999)*	(1.449)	(10.266)*			
5.1.F	-0.557	0.253	-0.013		-0.183	0.487	0.493	0.227	0.632
	(3.215)*	(4.137)*	(1.115)		(4.278)*	(4.606)*			
5.1.G	0.114	0.097	-0.0118		-0.016	0.865	0.710	0.401	0.987
	(0.373)	(3.124)*	(2.850)*		(1.004)	(9.812)*			

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the tabled value of the t-statistic at five percent level.

The long-run elasticity of demand for money is about 0.57, which is close to what the theory suggests. R^2 is reported as an indication of the goodness of fit and it indicates a good fit for equation 5.1.A.

But, what concerns us more here is the prediction performance of the equation. For this matter, we should be more concerned with the dynamic prediction than with the static prediction. Static prediction is obtained by substituting into the equation the actual value of the lagged dependent variable, along with the actual values of independent variables. In the case of dynamic prediction, the predicted value of the lagged dependent variable is substituted into the equation. After predicting the independent variable for period t, it is used in predicting the independent variable for period t+1. Then, the predicted value for period t+1 is used to calculate the predicted value of the real money stock for period t+2, and so on.

In this study, only dynamic prediction results are reported. For analyzing the prediction performance, we look at the percentage errors shown in the last column of the tables showing the prediction results.[1] Table 5.1.A shows the prediction results of equation 5.1.A. It is apparent from Table 5.1.A that equation 5.1.A systematically overpredicts the quantity of money demanded. An interesting point is that the percentage error is systematically rising as it moves further from the starting point. This upward trend in percentage error indicates a serious problem. The errors are not randomly distributed, as they are expected to be for a

[1]The percentage error is calculated as the difference between predicted value and actual value, divided by actual value and multiplied by 100.

TABLE 5.1.A. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	245.147483	246.143466	-.995982382	-.406278853
2	241.734496	245.381392	-3.64689592	-1.50863695
3	237.66212	244.605415	-6.9432954	-2.92149856
4	233.189167	243.911594	-10.722427	-4.59816687
5	227.770832	243.780312	-16.0094798	-7.02876645
6	228.423189	244.419093	-15.9959044	-7.00274978
7	228.411768	245.008537	-16.5967686	-7.2661618
8	226.372076	246.05457	-19.6824933	-8.69475318
9	225.800079	247.99932	-22.1992419	-9.83137031
10	227.807278	249.684032	-21.8767541	-9.60318491
11	227.770832	251.26622	-23.4953883	-10.3153631
12	228.279327	253.149586	-24.8702588	-10.894661
13	227.381677	255.32631	-27.944633	-12.2897471
14	227.884746	257.264866	-29.3801201	-12.8925348
15	230.596631	258.836319	-28.2396884	-12.2463578
16	231.944936	259.829134	-27.8841977	-12.0219041
17	231.419018	260.632347	-29.2133287	-12.6235644
18	232.462751	261.765892	-29.3031411	-12.6055211
19	232.909508	262.460119	-29.5506111	-12.6875933
20	230.469838	262.738201	-32.268363	-14.0011219
21	224.628966	262.749015	-38.1200485	-16.9702284
22	224.162223	262.589504	-38.4272811	-17.1426213
23	224.939168	262.568309	-37.6291418	-16.7285859
24	223.238342	261.894305	-38.6559624	-17.316005

RMSE = 25.9648559

good prediction. The Root Mean Square Error (RMSE) for 24 out-of-sample quarters is \$25.96 billion (in terms of 1972 prices).[1]

Equation 5.1.B differs from equation 5.1.A only in the data used in the estimation of the equation. New data are used in estimation of equation 5.1.B. These new data consist of the recently revised data for GNP and implicit price deflator of GNP. The revised data are referred to here as "new data." The coefficients of equation 5.1.B are not much different from those of equation 5.1.A. The percentage errors of prediction of equation 5.1.B, shown in Table 5.1.B, follow the same pattern as the percentage errors of equation 5.1.A; but, they are generally about one percentage point less than the latter one. The RMSE of equation 5.1.B is about \$24.64 billion, which is \$1.32 billion less than that of equation 5.1.A.

Equation 5.1.C is estimated by a nonlinear method of estimation, explained earlier. The coefficients of this equation do not seem to be much different from those of equation 5.1.B, except for LM. The prediction results of equation 5.1.C, shown in Table 5.1.C, turned out to be only slightly different from the prediction results of equation 5.1.B.[2] The reduction in the RMSE is only \$0.09 billion. As mentioned before, this similarity in the prediction results does not encourage one to use the nonlinear method of estimation, given that it is more expensive and

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[1]All values are stated in terms of the 1972 dollar, unless specified differently.

[2]The predictions are obtained the same as in equation 2 only with coefficients estimated by the nonlinear method.

TABLE 5.1.B. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.654852	247.198361	-.543509219	-.22035213
2	243.890657	246.862266	-2.9716085	-1.21841834
3	240.237977	246.429978	-6.19200175	-2.57744502
4	236.056221	246.185729	-10.1295079	-4.29114212
5	230.536684	246.238197	-15.7015132	-6.81085236
6	231.604228	246.882841	-15.278613	-6.59686274
7	231.571805	247.394409	-15.8226044	-6.832699
8	228.832432	248.42247	-19.5900371	-8.56086565
9	228.4072	250.296809	-21.8896094	-9.58358992
10	231.002839	251.82933	-20.8264906	-9.01568601
11	230.739646	253.216294	-22.4766481	-9.74112968
12	230.871205	254.926292	-24.055087	-10.4192669
13	230.094478	256.967863	-26.8733851	-11.6792829
14	231.086014	258.799715	-27.7137003	-11.9928073
15	233.677042	260.246058	-26.5690161	-11.3699728
16	234.623006	261.092502	-26.4694959	-11.2817137
17	234.803736	261.846241	-27.0425049	-11.5170675
18	235.88868	262.960459	-27.0717789	-11.4765062
19	236.032616	263.659875	-27.6272596	-11.7048483
20	232.981721	263.927514	-30.9457927	-13.2824981
21	227.554552	264.115412	-36.5608602	-16.0668551
22	227.834616	264.141914	-36.3072975	-15.9358126
23	229.008701	264.329441	-35.3207399	-15.4233179
24	227.38395	263.751067	-36.3671168	-15.9937044

RMSE = 24.6372136

TABLE 5.1.C. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.C.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.654852	247.259423	-.604571004	-.245108093
2	243.890657	246.9774	-3.08674265	-1.26562562
3	240.237977	246.57587	-6.33789308	-2.63817285
4	236.056221	246.322393	-10.2661719	-4.34903677
5	230.536684	246.291822	-15.7551376	-6.83411303
6	231.604228	246.925872	-15.3216445	-6.61544248
7	231.571805	247.490196	-15.9183913	-6.8740628
8	228.832432	248.573951	-19.7415186	-8.62706321
9	228.4072	250.536693	-22.1294926	-9.68861429
10	231.002839	252.068744	-21.0659049	-9.11932728
11	230.739646	253.402398	-22.6627526	-9.8217853
12	230.871205	255.044441	-24.1732359	-10.4704421
13	230.094478	257.050591	-26.9561127	-11.7152367
14	231.086014	258.808225	-27.7222101	-11.9964898
15	233.677042	260.175898	-26.4988566	-11.3399487
16	234.623006	260.904967	-26.2819609	-11.2017834
17	234.803736	261.561423	-26.7576866	-11.395767
18	235.88868	262.662193	-26.7735128	-11.3500626
19	236.032616	263.336778	-27.3041624	-11.5679616
20	232.981721	263.607656	-30.6259352	-13.1452094
21	227.554552	263.827333	-36.272781	-15.9402573
22	227.834616	263.847744	-36.0131272	-15.8066969
23	229.008701	264.075172	-35.0664709	-15.3122876
24	227.38395	263.521015	-36.1370649	-15.892531

RMSE = 24.550575

time consuming than the linear method and does not appear to result in a superior predictive equation.

Equation 5.1.D differs from equation 5.1.B only in specifying the monetary aggregate. In equation 5.1.D, currency is excluded from old M-1 to leave only demand deposits as the independent variable. The estimated coefficients of equation 5.1.B and 5.1.D are similar, and their long-run income elasticities are close to 0.5. The out-of-sample prediction results of equation 5.1.D, shown in Table 5.1.D, are worse than those of equation 5.1.B.

In equation 5.1.E the commercial paper rate (CPR) is substituted for TBR. Equation 5.1.E is comparable to equation 5.1.A, because the old data set is used in estimating the coefficients of both equations. The prediction results of equation 5.1.E are represented in Table 5.1.E. The percentage errors of this equation are systematically increasing too. For every quarter, the percentage error from equation 5.1.E is greater than the one from equation 5.1.A.

In equation 5.1.F, the GNP and money balances are specified in per capita form, rather than in aggregate form. For obtaining the per capita value of GNP and money balances, their values are divided by the population.[1] The lagged dependent variable is assumed to be the lagged value of per capita real money balances, rather than the ratio of the lagged value of real money balances over the current population. This respecification of the variables did not help. Except for four quarters, equation 5.1.F has larger percentage errors (shown in Table 5.1.F) than equation

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[1]Population data is for uninstitutional populations of age 16 and older.

TABLE 5.1.D. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.D.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	190.054334	190.770377	-.716042317	-.376756636
2	187.241645	190.282217	-3.0405724	-1.62387614
3	183.897769	189.770631	-5.87286135	-3.19354681
4	179.863819	189.529202	-9.66538374	-5.37372319
5	174.452064	189.686868	-15.2348042	-8.7329458
6	175.17229	190.321411	-15.1491209	-8.64812635
7	174.787334	190.70437	-15.9170364	-9.10651595
8	171.896061	191.549462	-19.6534006	-11.4333048
9	170.669681	193.106815	-22.4371332	-13.1465255
10	172.185089	194.342249	-22.1571595	-12.868222
11	171.415426	195.447425	-24.0319995	-14.0197415
12	171.280061	196.848162	-25.5681007	-14.9276574
13	170.155036	198.477595	-28.322559	-16.6451488
14	170.90195	199.890813	-28.9888627	-16.9622773
15	172.788793	200.904237	-28.1154434	-16.2715665
16	173.115673	201.390116	-28.2744426	-16.3326879
17	172.704148	201.804317	-29.1001699	-16.8497227
18	173.988638	202.495825	-28.5071867	-16.3845105
19	173.821689	202.806928	-28.9852383	-16.6752713
20	170.591191	202.700985	-32.1097936	-18.8226563
21	165.022198	202.535663	-37.5134648	-22.7323749
22	165.167482	202.310826	-37.1433442	-22.4882911
23	165.864303	202.230984	-36.3666811	-21.9255624
24	164.148253	201.470206	-37.3219535	-22.7367352

RMSE = 25.6010732

TABLE 5.1.E. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.E.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	245.147483	246.225797	-1.07831355	-.439863195
2	241.734496	244.843942	-3.10944572	-1.28630616
3	237.66212	243.133144	-5.47102408	-2.30201771
4	233.189167	242.253567	-9.06439999	-3.88714454
5	227.770832	242.527824	-14.7569919	-6.47887695
6	228.423189	243.62355	-15.2003606	-6.65447352
7	228.411768	244.66225	-16.2504818	-7.11455542
8	226.372076	246.069356	-19.6972798	-8.70128512
9	225.800079	248.455486	-22.6554075	-10.0333922
10	227.807278	250.485189	-22.6779107	-9.95486663
11	227.770832	252.425632	-24.6547997	-10.8243885
12	228.279327	254.743789	-26.4644615	-11.5930171
13	227.381677	257.426947	-30.0452701	-13.2135845
14	227.884746	259.615694	-31.7309485	-13.9241213
15	230.596631	261.442014	-30.8453833	-13.3763374
16	231.944936	262.545556	-30.6006196	-13.1930536
17	231.419018	263.456102	-32.0370836	-13.8437557
18	232.462751	264.495771	-32.0330203	-13.7798508
19	232.909508	265.067628	-32.1581198	-13.8071305
20	230.469838	264.973328	-34.5034902	-14.9709353
21	224.628966	264.882663	-40.2536974	-17.9200831
22	224.162223	264.759681	-40.5974578	-18.1107491
23	224.939168	264.495663	-39.5564953	-17.5854191
24	223.238342	263.457207	-40.2188649	-18.0161098

RMSE = 27.4506439

TABLE 5.1.F. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.F.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	.163539619	.16454653	-1.00691091E-03	-.615698459
2	.160622241	.163519802	-2.89756125E-03	-1.80396017
3	.157284345	.162615783	-5.33143855E-03	-3.38968164
4	.153615892	.161441969	-7.82607667E-03	-5.0945749
5	.149449012	.160585499	-.0111364873	-7.45169681
6	.149299638	.160876107	-.0115764693	-7.75384954
7	.148510443	.16149343	-.0129829866	-8.74213713
8	.146519024	.162099688	-.015580664	-10.6338846
9	.145584297	.163441148	-.0178568507	-12.2656434
10	.146314041	.164239977	-.017925936	-12.2516854
11	.145627979	.164761205	-.0191332259	-13.1384272
12	.14539516	.165416893	-.0200217326	-13.7705633
13	.144279917	.16650243	-.0222225129	-15.4023605
14	.144049253	.16727495	-.0232256966	-16.1234412
15	.145119172	.167913125	-.0227939536	-15.7070588
16	.145424242	.168048523	-.0226242813	-15.5574345
17	.144539855	.168079939	-.0235400839	-16.2862236
18	.144655533	.168740911	-.0240853785	-16.6501606
19	.144308776	.168983982	-.0246752066	-17.0988954
20	.142259845	.169154576	-.026894731	-18.9053566

RMSE = .0458668813

5.1.A. The results are compared to those of equation 5.1.A, because the old data set is used in estimation of the coefficients of equation 5.1.F. As the reader might have noticed, the simulation of equation 5.1.F was done only for 20 out-of-sample quarters--the reason was limited data on the population. Finally, equation 5.1.F has R^2 of 0.63, which indicates a poor sample fit for this specification.

In the regressions discussed thus far, the assumption was that the public adjusts its cash position toward its desired stock of real balances. In equation 5.1.G, it is assumed that the public adjusts its cash position toward its desired stock of nominal money balances. This respecification of the model results in the equation referred to as the nominal adjustment version of the demand equation. In this case, the value of the lagged dependent variable is no longer the past value of real money balances; rather, it is the value of lagged nominal balances divided by the current price level. Equation 5.1.G, in comparison to equation 5.1.B, has lower income elasticity of demand and higher interest elasticities. The long-run income elasticity is higher for equation 5.1.G, and so is the coefficient of the lagged dependent variable; the speed of adjustment is lower in the case of nominal adjustment than in the case of real adjustment. As far as the prediction results are concerned, equation 5.1.G shows a better performance, shown in Table 5.1.G. As is apparent from comparing Tables 5.1.B and 5.1.G, the reduction in the percentage errors in the nominal adjustment case is greater before 1976:1. After that date, the difference is hardly noticeable. For instance, for 1979 the average reduction in percentage error is only about 0.21 of a

TABLE 5.1.G. DYNAMIC SIM. OF OLD M-1 BASED ON EQUATION 5.1.G.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.654852	246.702422	-.0475703343	-.0192861944
2	243.890657	244.567598	-.676940317	-.277558937
3	240.237977	242.345378	-2.10740183	-.877214277
4	236.056221	239.914872	-3.8586508	-1.63463212
5	230.536684	238.53937	-8.00268645	-3.47132886
6	231.604228	240.533397	-8.92916968	-3.85535695
7	231.571805	241.25934	-9.68753518	-4.18338285
8	228.832432	242.345153	-13.5127203	-5.90507217
9	228.4072	246.114843	-17.7076431	-7.75266414
10	231.002839	249.443255	-18.4404157	-7.98276584
11	230.739646	251.859015	-21.1193693	-9.15290012
12	230.871205	253.679488	-22.8082828	-9.87922369
13	230.094478	256.258673	-26.1641945	-11.3710658
14	231.086014	258.133764	-27.04775	-11.7046244
15	233.677042	260.54243	-26.8653888	-11.4968029
16	234.623006	261.924947	-27.3019408	-11.6365148
17	234.803736	263.485311	-28.6815749	-12.2151271
18	235.88868	262.786177	-26.8974966	-11.4026229
19	236.032616	263.558313	-27.525697	-11.6618193
20	232.981721	262.960248	-29.9785265	-12.8673298
21	227.554552	263.150388	-35.595836	-15.6427704
22	227.834616	263.515407	-35.6807904	-15.6608293
23	229.008701	264.013229	-35.004528	-15.2852393
24	227.38395	263.687497	-36.3035466	-15.9657472

RMSE = 23.4778999

percentage point, and for the last quarter of 1979 it is only about 0.03 of a percentage point. The RMSE of equation 5.1.G is $23.48 billion which is $1.16 billion lower than that of equation 5.1.B.

The above results suggest that the Treasury bill rate is a better proxy for the market rate of interest than the commercial paper rate. The per capita and demand deposit versions of the conventional equation proved to be inferior to the other specifications. In general, the equations fitted with new data performed better than the equations fitted with the old data. However, for comparison, only the results for real adjustment versions of the conventional equation have been reported, see Tables 5.1.A and 5.1.B. With the new data, the nominal adjustment version of the equation resulted in a little better prediction results than the real adjustment version.

M-1A and M-1B

Next, we look at two new monetary aggregates--M-1A and M-1B. Since the new GNP and price data had better prediction results, for the rest of the aggregates only the results with the new data are reported (except in some instances where reporting the results with the old data was necessary for comparison).

For M-1A, two different equations are estimated--the real adjustment and nominal adjustment versions of the conventional equation. The estimation results for these two equations are reported in Table 5.2. Equation 5.2.A is for the assumption of the real adjustment mechanism while equation 5.2.B is for the nominal adjustment. The signs of the coefficients of the variables of both equations are consistent with the theory. Both

Table 5.2. The regression results of M-1A, (1959:2-1973:4)[a]

Equation	Intercept	GNP	TBR	SR	LM	GNP long-run	ρ	R^2
5.2.A	0.468	0.104	-0.015	-0.017	0.789	0.496	0.402	0.982
	(1.342)	(2.846)*	(3.163)*	(0.930)	(7.681)*			
5.2.B	0.228	0.106	-0.012	-0.017	0.833	0.632	0.359	0.985
	(0.665)	(3.112)*	(2.808)*	(0.980)	(8.460)*			

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the tabled value of the t-statistic at five percent level.

equations are more or less like their old M-1 counterpart in Table 5.1. Comparison of the prediction results of equation 5.2.A, reported in Table 5.2.A, and equation 5.2.B, reported in Table 5.2.B, shows that the nominal adjustment version of the equation, equation 5.2.B, provides better prediction results. For both equations, the percentage errors of prediction for 27 out-of-sample quarters, starting from the first quarter of 1974, have an upward trend. The RMSE of equation 5.2.B is about $1.1 billion less than that of equation 5.2.A. For the first eight quarters, equation 5.2.B resulted in an average lower percentage error of more than two percentage points. For the rest of the prediction period, it was a little less than one percentage point better.

For M-1B, in addition to the real adjustment version, equation 5.3.A, and the nominal version, equation 5.3.C, currency was subtracted from the money stock to leave only checkable deposits as a dependent variable, equation 5.3.B. The estimation results of these equations and the equation estimated with the nonlinear method, equation 5.3.D, are reported in Table 5.3. Equations 5.3.B and 5.3.D were estimated with the assumption of the real adjustment. The coefficients of the first three equations have the right sign, and the coefficient of each variable differs only slightly from one equation to the other. The prediction results of equations 5.3.A, 5.3.B, and 5.3.C, shown in Tables 5.3.A, 5.3.B, and 5.3.C, respectively, follow almost the same pattern. The percentage errors rise systematically for the first 12 quarters. For the rest of the prediction period, the percentage errors have an upward trend, but they are a little erratic. The demand deposit version, equation 5.3.B, gave

TABLE 5.2.A. DYNAMIC SIM. OF M-1A BASED ON EQUATION 5.2.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	240.957363	241.239233	-.281869882	-.116979153
2	237.272673	240.981824	-3.70915098	-1.56324406
3	233.098241	240.61605	-7.517809	-3.22516763
4	229.366234	240.449778	-11.0835436	-4.8322473
5	225.076422	240.603065	-15.5266425	-6.89838695
6	225.567624	241.339963	-15.7723388	-6.99228841
7	225.481925	241.889691	-16.4077665	-7.27675468
8	223.08436	242.958786	-19.8744255	-8.90892822
9	224.094985	244.874657	-20.7796719	-9.27270726
10	225.281336	246.407624	-21.1262885	-9.37773581
11	224.483004	247.774019	-23.2910152	-10.3754025
12	224.860453	249.465016	-24.6045629	-10.9421477
13	226.652952	251.470992	-24.8180405	-10.949798
14	226.693753	253.238992	-26.5452386	-11.7097354
15	227.070377	254.587589	-27.5172121	-12.1183628
16	228.324988	255.316479	-26.9914912	-11.8215231
17	228.962905	255.959042	-26.9961368	-11.790616
18	228.553427	256.971014	-28.417587	-12.4336735
19	228.503151	257.552946	-29.0497955	-12.7130831
20	226.143556	257.688429	-31.5448732	-13.949048
21	221.736557	257.75509	-36.0185323	-16.2438403
22	221.506072	257.683285	-36.1772129	-16.3323798
23	221.579181	257.787593	-36.2084122	-16.3410714
24	219.80043	257.10774	-37.3073098	-16.9732651
25	217.426313	256.257464	-38.8311511	-17.8594534
26	210.063528	256.041455	-45.977927	-21.8876296
27	211.408018	256.369095	-44.9610769	-21.2674417

RMSE = 27.5594982

TABLE 5.2.B. DYNAMIC SIM. OF M-1A BASED ON EQUATION 5.2.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	240.957363	240.731019	.226343883	.0939352428
2	237.272673	238.782501	-1.50982777	-.636326026
3	233.098241	236.785851	-3.68761022	-1.5819983
4	229.366234	234.630932	-5.26469825	-2.29532402
5	225.076422	233.505728	-8.42930585	-3.74508612
6	225.567624	235.622978	-10.0553539	-4.45780016
7	225.481925	236.473976	-10.9920509	-4.87491442
8	223.08436	237.665807	-14.5814469	-6.53629274
9	224.094985	241.426765	-17.3317799	-7.73412219
10	225.281336	244.634361	-19.353025	-8.59060293
11	224.483004	246.884522	-22.4015187	-9.97916025
12	224.860453	248.552896	-23.6924433	-10.5365096
13	226.652952	250.961473	-24.3085208	-10.7249964
14	226.693753	252.659479	-25.9657262	-11.4540987
15	227.070377	254.833702	-27.7633255	-12.2267492
16	228.324988	255.967741	-27.6427531	-12.1067577
17	228.962905	257.268825	-28.3059207	-12.3626667
18	228.553427	256.487557	-27.9341295	-12.2221442
19	228.503151	257.131827	-28.6286765	-12.5287885
20	226.143556	256.47865	-30.3350946	-13.4140876
21	221.736557	256.61076	-34.8742027	-15.7277641
22	221.506072	256.895091	-35.3890191	-15.9765459
23	221.579181	257.327132	-35.7479507	-16.1332624
24	219.80043	256.933334	-37.1329036	-16.8939176
25	217.426313	255.828698	-38.4023856	-17.6622531
26	210.063528	254.875372	-44.8118444	-21.3325201
27	211.408018	254.802243	-43.3942253	-20.5262912

RMSE = 26.4575237

Table 5.3. The regression results of M-1B, (1959:2-1973:4)[a]

Equation	Intercept	GNP	TBR	SR	LM	GNP long-run	ρ	R^2
5.3.A	0.461	0.103	-0.015	-0.016	0.792	0.459	0.390	0.983
	(1.326)	(2.797)*	(3.177)*	(0.871)	(7.699)*			
5.3.B	0.443	0.096	-0.019	-0.019	0.798	0.473	0.359	0.966
	(1.170)	(2.775)*	(3.493)*	(0.888)	(7.478)*			
5.3.C	0.212	0.103	-0.012	0.016	0.839	0.640	0.351	0.986
	(0.620)	(3.041)*	(2.830)*	(0.917)	(8.523)*			
5.3.D	0.461	0.103	-0.015	-0.016	0.792	0.495	0.429	

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the tabled value of the t-statistic at five percent level.

TABLE 5.3.A. DYNAMIC SIM. OF M-1B BASED ON EQUATION 5.3.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	241.229799	241.514806	-.285006952	-.11814749
2	237.536193	241.254626	-3.7184332	-1.56541753
3	233.357124	240.88764	-7.53051643	-3.22703516
4	229.701353	240.724346	-11.0229932	-4.79883686
5	225.565369	240.887826	-15.3224572	-6.79291209
6	226.050856	241.630882	-15.5800257	-6.89226575
7	226.114159	242.179602	-16.065443	-7.10501418
8	223.862047	243.248105	-19.3860574	-8.65982314
9	225.020161	245.161932	-20.1417713	-8.9510963
10	226.50341	246.695933	-20.1925225	-8.91488678
11	225.99209	248.06555	-22.0734598	-9.76735948
12	226.716424	249.761213	-23.0447893	-10.1645875
13	228.775231	251.769079	-22.9938475	-10.0508466
14	228.926273	253.539657	-24.6133844	-10.7516643
15	229.627861	254.888799	-25.2609388	-11.0008161
16	231.053665	255.619095	-24.5654303	-10.6319155
17	232.318669	256.262025	-23.9433559	-10.3062556
18	231.715425	257.269529	-25.5541041	-11.0282274
19	231.606543	257.846295	-26.2397519	-11.3294519
20	230.467534	257.97335	-27.5058167	-11.9347903
21	228.754642	258.030014	-29.2753714	-12.7977169
22	230.315475	257.951732	-27.6362564	-11.999305
23	231.444476	258.047482	-26.6030059	-11.4943361
24	229.772571	257.358367	-27.5857957	-12.0056957
25	227.996437	256.495366	-28.4989294	-12.4997258
26	221.30238	256.277972	-34.9755917	-15.8044354
27	224.411181	256.603171	-32.1919896	-14.3450916

RMSE = 23.0676518

TABLE 5.3.B. DYNAMIC SIM. OF M-1B BASED ON EQUATION 5.3.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	184.629294	185.082253	-.452958856	-.245334229
2	180.888352	184.665744	-3.77739191	-2.08824497
3	177.017748	184.218042	-7.2002937	-4.06755468
4	173.509092	184.064306	-10.5552148	-6.08337849
5	169.479165	184.355246	-14.876081	-8.77752793
6	169.618195	185.100754	-15.4825587	-9.12788789
7	169.330089	185.518913	-16.1888239	-9.56051223
8	166.9259	186.404137	-19.4782377	-11.668793
9	167.281831	187.998792	-20.7169612	-12.3844659
10	167.683789	189.245302	-21.5615128	-12.858436
11	166.667365	190.350615	-23.6832498	-14.2098903
12	167.12466	191.75944	-24.6347802	-14.7403622
13	168.838054	193.373204	-24.5351493	-14.531765
14	168.741844	194.747833	-26.0059889	-15.4117012
15	168.73847	195.684099	-26.9456293	-15.9688715
16	169.546971	196.07694	-26.5299696	-15.6475633
17	170.219708	196.400164	-26.1804564	-15.3803909
18	169.818463	196.992398	-27.1739355	-16.0017557
19	169.396141	197.187184	-27.7910431	-16.4059482
20	168.074948	196.939086	-28.864138	-17.1733731
21	166.224619	196.635868	-30.4112489	-18.2952737
22	167.648579	196.306027	-28.6574478	-17.0937612
23	168.30032	196.127416	-27.8270964	-16.5341911
24	166.537415	195.24712	-28.7097053	-17.2391923
25	164.865502	194.196004	-29.3305024	-17.7905638
26	158.489762	193.971388	-35.4816258	-22.3873298
27	161.234528	194.225461	-32.990933	-20.4614566

RMSE = 24.0800855

TABLE 5.3.C. DYNAMIC SIM. OF M-1B BASED ON EQUATION 5.3.C.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	241.229799	241.001748	.228051065	.0945368551
2	237.536193	239.033022	-1.49682921	-.630147849
3	233.357124	237.01032	-3.65319564	-1.56549566
4	229.701353	234.826708	-5.12535511	-2.23131255
5	225.565369	233.682812	-8.11744358	-3.59871004
6	226.050856	235.791664	-9.74080844	-4.30912257
7	226.114159	236.627229	-10.5130703	-4.64945245
8	223.862047	237.806927	-13.9448801	-6.22922923
9	225.020161	241.567804	-16.5476432	-7.35384915
10	226.50341	244.792492	-18.2890816	-8.07452817
11	225.99209	247.067876	-21.0757861	-9.32589549
12	226.716424	248.760986	-22.044562	-9.72340764
13	228.775231	251.190881	-22.4156495	-9.79811031
14	228.926273	252.909186	-23.9829133	-10.4762608
15	229.627861	255.105459	-25.4775983	-11.0951686
16	231.053665	256.263326	-25.2096612	-10.9107385
17	232.318669	257.588353	-25.2696837	-10.8771645
18	231.715425	256.804158	-25.0887327	-10.82739
19	231.606543	257.446177	-25.8396334	-11.156694
20	230.467534	256.777721	-26.310187	-11.4160058
21	228.754642	256.892574	-28.1379316	-12.3004855
22	230.315475	257.16773	-26.8522548	-11.6589017
23	231.444476	257.588099	-26.1436227	-11.2958508
24	229.772571	257.182339	-27.4097681	-11.9290862
25	227.996437	256.055691	-28.059254	-12.3068827
26	221.30238	255.093291	-33.7909107	-15.2691131
27	224.411181	255.007448	-30.5962662	-13.6340204

RMSE = 21.8150265

the worst prediction result and the nominal adjustment version, equation 5.3.C, gave the best. The RMSE of equation 5.3.C is about $1.25 billion less than that of equation 5.3.A. Although the percentage errors of equation 5.3.C, in Table 5.3.C, were, in general, lower than those of equation 5.3.A, in Table 5.3.A, the average difference over the first eight quarters was much greater than that over the rest of the prediction period. Comparison of the prediction results of the nominal version of old M-1, in Table 5.1.G, and M-1B, in Table 5.3.C, shows that the percentage errors associated with M-1B are higher for the first eight quarters (except for one quarter), and they are lower for the rest of the prediction period. The percentage errors of M-1B, after 1976, are not only lower, but their variation is less than that of old M-1.

The coefficients estimated with the nonlinear method are shown in equation 5.3.D, in Table 5.3. The estimated coefficients of this equation are almost the same as the ones in equation 5.3.A. Equation 5.3.D has only a little higher serial correlation coefficient. The prediction results of equation 5.3.D, shown in Table 5.3.D, are almost the same as the results of equation 5.3.A.

As we see, the introduction of M-1B, although helping a little, does not solve the problem. Next, some other new aggregates, namely M-1C, M-1D, and M-1E, will be tried. The components of these aggregates are described in Chapter III.

M-1C

The first of the proposed aggregates is M-1C--defined as the sum of M-1B and RPs. Table 5.4 shows the regression results for the different

TABLE 5.3.D. DYNAMIC SIM. OF M-1B BASED ON EQUATION 5.3.D.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	241.229799	241.507196	-.277397302	-.114992967
2	237.536193	241.240682	-3.70448915	-1.55954725
3	233.357124	240.868692	-7.51156815	-3.21891529
4	229.701353	240.701899	-11.0005454	-4.78906428
5	225.565369	240.863428	-15.2980592	-6.78209571
6	226.050856	241.605193	-15.5543365	-6.88090139
7	226.114159	242.152275	-16.0381163	-7.09292883
8	223.862047	243.219821	-19.3577734	-8.64718858
9	225.020161	245.133292	-20.1131319	-8.93836882
10	226.50341	246.666842	-20.1634319	-8.90204343
11	225.99209	248.036082	-22.0439915	-9.75431994
12	226.716424	249.731749	-23.0153256	-10.1515917
13	228.775231	251.739606	-22.9643749	-10.0379638
14	228.926273	253.509985	-24.5837121	-10.7387028
15	229.627861	254.858471	-25.23061	-10.9876084
16	231.053665	255.587819	-24.534154	-10.6183791
17	232.318669	256.229841	-23.9111719	-10.2924022
18	231.715425	257.236483	-25.521058	-11.013966
19	231.606543	257.812097	-26.2055532	-11.314686
20	230.467534	257.93758	-27.4700465	-11.9192695
21	228.754642	257.992696	-29.2380541	-12.7814036
22	230.315475	257.913201	-27.5977259	-11.9825756
23	231.444476	258.007855	-26.5633788	-11.4772144
24	229.772571	257.317161	-27.5445893	-11.9877621
25	227.996437	256.452434	-28.4559972	-12.4808956
26	221.30238	256.234789	-34.9324086	-15.7849222
27	224.411181	256.560057	-32.1488754	-14.3258795

RMSE = 23.0176333

Table 5.4. The regression results of M-1C, (1959:2-1973:4)[a]

Equation	Intercept	GNP	TBR	CPR	SR
5.4.A	0.240 (0.915)	0.109 (3.194)*	-0.015 (3.409)*		-0.023 (1.297)
5.4.B	0.091 (0.388)	0.101 (3.204)*		-0.019 (4.570)*	-0.024 (1.474)
5.4.C	0.308 (1.091)	0.105 (2.944)*	-0.015 (3.272)*		-0.019 (1.028)
5.4.D	-0.245 (0.617)	0.157 (3.205)*	-0.019 (4.000)*		-0.012 (0.662)
5.4.E	0.048 (0.165)	0.102 (2.960)*	-0.012 (2.778)		-0.018 (1.039)
5.4.F	-0.439 (1.077)	0.151 (3.097)*	-0.015 (3.295)*		-0.012 (0.697)
5.4.G	0.442	0.119	-0.014		-0.018
5.4.H[b]	2.212	0.495	-0.009		-0.142

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the table value of the t-statistic at five percent level.

[b]The coefficient of each variable in equation 5.4.H is the arithmetic sum of the coefficients of the current and the past three lags of the variable.

N	LM	GNP long-run	ρ	R^2
	0.282 (10.057)*	0.634	0.311	0.989
	0.868 (11.623)*	0.761	0.236	0.991
	0.819 (9.230)*	0.580	0.323	0.988
-0.001 (1.629)	0.858 (10.205)*	1.109	0.239	0.991
	0.871 (9.715)*	0.792	0.295	0.990
-0.001 (1.493)	0.902 (10.331)*	1.538	0.249	0.991
	0.776	0.531	0.364	0.988
				0.988

specifications of the demand equation for this aggregate. Equation 5.4.A is based on the old data set, and so is equation 5.4.B. In equation 5.4.A, TBR is assumed to be a proxy for the market interest rate while, in equation 5.4.B, CPR is assumed to be a proxy for the market rate. The estimated coefficients for both equations have the right sign, and the coefficients of all variables differ very little from one equation to the other. Equation 5.4.A has a higher short-run income elasticity, lower long-run income elasticity, and lower interest elasticity than equation 5.4.B. Equation 5.4.B has a better sample fit and lower serial correlation coefficient than equation 5.4.A. Prediction results of equations 5.4.A and 5.4.B, respectively shown in Tables 5.4.A and 5.4.B, show a better performance for equation 5.4.A. For equation 5.4.A, the percentage errors are lower, and it has a RMSE of $20.18 billion--$2.35 billion less than that of equation 5.4.B.

Equation 5.4.C differs from equation 5.4.A only in the data set used in estimating the equations. Equation 5.4.C is based on the revised data. The estimated coefficients of equation 5.4.C are not much different from those of equation 5.4.A, but analysis of the prediction results of equation 5.4.C, shown in Table 5.4.C, shows a better performance for this equation. The RMSE of equation 5.4.C is $1.25 billion lower than that of equation 5.4.A. The differences in percentage errors of equations 5.4.A and 5.4.C are mixed, but the mean percentage errors over the period of 1976:1 through 1980:3 are -9.43 and -8.89, respectively, for equations 5.4.A and 5.4.C. The mean square errors of the percentage errors, for the same period, are 2.45 and 1.46, respectively, for equations 5.4.A and

TABLE 5.4.A. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.494578	246.768695	-.27411683	-.111206028
2	242.69609	245.817896	-3.12180608	-1.28630258
3	238.428625	244.871138	-6.44251262	-2.70207179
4	233.520531	244.030489	-10.5099573	-4.50065665
5	228.496296	243.792079	-15.2957826	-6.69410529
6	228.978932	244.364952	-15.3860191	-6.71940383
7	229.347885	244.902022	-15.5541374	-6.78189702
8	227.677465	245.934023	-18.2565579	-8.01860556
9	228.843874	247.918962	-19.0750882	-8.3354157
10	231.342662	249.665971	-18.3233086	-7.92041917
11	232.01221	251.330534	-19.3183248	-8.32642592
12	233.490175	253.327705	-19.83753	-8.49608768
13	235.407958	255.646364	-20.2384064	-8.59716322
14	236.190811	257.73814	-21.5473284	-9.12284788
15	237.819029	259.458886	-21.6398573	-9.09929596
16	240.314865	260.584178	-20.269313	-8.43448159
17	241.005559	261.509996	-20.5044372	-8.50786898
18	240.353318	262.771061	-22.4177433	-9.32699555
19	240.73097	263.573839	-22.8428695	-9.48896172
20	241.384235	263.933133	-22.5488984	-9.34149592
21	239.606981	264.004034	-24.3970531	-10.1821128
22	242.109475	263.888921	-21.7794462	-8.99570173
23	242.703371	263.904048	-21.2006771	-8.73522152
24	239.183252	263.226636	-24.0433842	-10.0522859
25	237.104269	262.221403	-25.1171337	-10.5932861
26	228.16978	261.85316	-33.6833806	-14.7624197
27	234.458828	261.962758	-27.5039296	-11.7308142

RMSE = 20.1836965

TABLE 5.4.B. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.494578	246.921288	-.426709707	-.173111194
2	242.69609	245.336971	-2.64088022	-1.08814288
3	238.428625	243.375258	-4.94663215	-2.07468048
4	233.520531	242.330953	-8.81042212	-3.77286831
5	228.496296	242.565786	-14.0694905	-6.15742608
6	228.978932	243.664242	-14.6853094	-6.41338888
7	229.347885	244.679025	-15.3311407	-6.68466626
8	227.677465	246.127146	-18.449681	-8.10342868
9	228.843874	248.636897	-19.793023	-8.64913823
10	231.342662	250.825941	-19.4832782	-8.42182675
11	232.01221	252.969954	-20.9577441	-9.033035
12	233.490175	255.566647	-22.0764715	-9.45498949
13	235.407958	258.573841	-23.1658831	-9.84073916
14	236.190811	261.092271	-24.90146	-10.5429419
15	237.819029	263.225427	-25.4063985	-10.6830806
16	240.314865	264.597994	-24.2831285	-10.1047134
17	241.005559	265.762634	-24.7570748	-10.2724082
18	240.353318	267.018544	-26.6652256	-11.0941783
19	240.73097	267.755369	-27.0243994	-11.2259754
20	241.384235	267.722753	-26.3385181	-10.9114492
21	239.606981	267.672638	-28.0656572	-11.7132052
22	242.109475	267.59548	-25.4860046	-10.5266449
23	242.703371	267.326999	-24.6236281	-10.1455649
24	239.183252	266.179266	-26.9960149	-11.2867497
25	237.104269	264.842445	-27.738176	-11.6987248
26	228.16978	264.43809	-36.2683103	-15.8953172
27	234.458828	264.692087	-30.2332586	-12.8949116

RMSE = 22.5317086

TABLE 5.4.C. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.C.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.114417	248.984893	-.87047513	-.350836174
2	248.010231	248.259094	-.24886352	-.100344054
3	244.860828	247.498383	-2.63755548	-1.07716514
4	241.010379	246.98906	-5.97868101	-2.48067367
5	236.391659	246.840405	-10.4487465	-4.4200995
6	231.270958	247.342359	-16.071401	-6.94916523
7	232.16771	247.737778	-15.5700677	-6.70638811
8	232.520874	248.70113	-16.1802563	-6.95862527
9	230.154311	250.574264	-20.4199527	-8.87228775
10	231.48614	252.134225	-20.6480851	-8.91979328
11	234.590162	253.57278	-18.9826179	-8.0918218
12	235.036307	255.369538	-20.3332313	-8.65110228
13	236.141216	257.530026	-21.3888096	-9.05763506
14	238.216518	259.496463	-21.2799451	-8.93302669
15	239.508762	261.075884	-21.5671218	-9.00473186
16	240.993509	262.039723	-21.0462133	-8.73310381
17	243.089576	262.903909	-19.8143327	-8.1510417
18	244.532934	264.135423	-19.6024883	-8.01629784
19	243.893096	264.936391	-21.0432953	-8.62808159
20	243.956517	265.279566	-21.3230497	-8.74051246
21	244.015074	265.528425	-21.5133517	-8.81640276
22	242.73007	265.603994	-22.8739248	-9.42360573
23	246.075893	265.835734	-19.7598406	-8.02997822
24	247.091818	265.2615	-18.1696816	-7.35341289
25	243.624962	264.481863	-20.8569009	-8.56106891
26	241.603994	264.279138	-22.6751432	-9.38525177
27	232.998031	264.61843	-31.6203995	-13.5711016

RMSE = 18.9352928

5.4.C. This analysis shows that in the period under study, equation 5.4.C, has lower average percentage error, in absolute terms, than equation 5.4.A, and the mean square error of the percentage errors is also lower for equation 5.4.C.

These statistics reveal an interesting point. For M-1C the percentage error rises from 1974:1 to 1976:1 and later it varies in a relatively small range. For the period of four years, starting at 1976:1, the mean percentage error is -8.59 with a mean square error of 0.256 for equation 5.4.C. This, indeed, is a promising point. It implies that there has been a period of adjustment to a new position characterized by a less overall demand for money, and after the adjustment the average economizing on real money holdings has remained about 8.59 percent of projected levels. In other words, if the actual money balances, for the period under study (1976:1-1980:1), is adjusted upward by 8.59 percent, the mean percentage error, over this period, will be about zero. It is evident from Table 5.4.C that inclusion of the first three quarters of 1980 in the period under study, not only increases the mean percentage error to 8.89 but it also increases the mean square error of the percentage errors to 1.46.

In equation 5.4.D, another variable is introduced to explain a part of this economizing. This variable is a time variable, and is denoted by N.[1] This time variable appears in equation 5.4.D in nonlogarithmic form. It is intended to pick up the effect of the variables with a time trend, specifically the technological effect. Except for N, equation

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[1]This model is adapted from Lieberman [13].

5.4.D is the same as equation 5.4.C. Equation 5.4.D has higher short-run and long-run income elasticity, lower SR and, higher TBR elasticities than equation 5.4.C. The estimated coefficient of N, as it was expected, turned out to be negative. The high income elasticity (the long-run income elasticity is greater than unity) could be because of interaction between the independent variables; i.e. the time trend involved in GNP and LM and inclusion of N interacts with these components.

The prediction percentage errors of equation 5.4.D, shown in Table 5.4.D, follow the same pattern as the percentage prediction errors of equation 5.4.C. The average percentage error of equation 5.4.D is about 2.75 and 2.98 percentage points lower than that of equation 5.4.C over the periods 1976:1-1978:1 and 1976:1-1980:4, respectively. The average percentage error of this equation, over the period of 1976:1-1980:1, is -5.84 with a mean square error of 0.41. The RMSE of equation 5.4.D is $12.62 billion which is about $6.31 billion lower than that of equation 5.4.C. As far as the prediction results are concerned, this equation is a major improvement. The major portion of the average percentage error of 8.59, in the case of equation 5.4.C, and 5.84 for equation 5.4.D, could be an overall economizing in cash holdings by the public, over the period of 1976:1-1980:1. That much economizing seems to be plausible, considering all the developments discussed in Chapter III. Stating the problem differently, the assumption of fixed institutions and fixed state of art could account for most of the above errors.

The nominal adjustment version of equations 5.4.C and 5.4.D are, respectively, represented by equations 5.4.E and 5.4.F. The noticeable

TABLE 5.4.D. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.D.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.114417	248.60297	-.48855237	-.196906079
2	248.010231	247.306564	.703666571	.283724816
3	244.860828	245.789099	-.928271757	-.37910178
4	241.010379	244.387141	-3.37676124	-1.4010854
5	236.391659	243.22206	-6.83040082	-2.8894424
6	231.270958	242.907171	-11.6362136	-5.03142016
7	232.16771	242.597984	-10.4302737	-4.49256003
8	232.520874	243.008589	-10.4877156	-4.5104405
9	230.154311	244.654675	-14.5003642	-6.30027923
10	231.48614	245.975125	-14.4889855	-6.25911576
11	234.590162	247.17486	-12.5846981	-5.36454642
12	235.036307	248.849443	-13.813136	-5.87702223
13	236.141216	251.106696	-14.9654795	-6.33751268
14	238.216518	253.20177	-14.9852518	-6.29060146
15	239.508762	254.902572	-15.3938099	-6.4272429
16	240.993509	255.819189	-14.8256795	-6.15189992
17	243.089576	256.578721	-13.4891454	-5.54904311
18	244.532934	257.842563	-13.3096285	-5.44287768
19	243.893096	258.568528	-14.6754321	-6.01715765
20	243.956517	258.728299	-14.7717818	-6.055088
21	244.015074	258.719902	-14.7048284	-6.02619673
22	242.73007	258.356071	-15.6260009	-6.43760407
23	246.075893	258.147042	-12.0711484	-4.90545753
24	247.091818	256.884789	-9.79297094	-3.96329227
25	243.624962	255.314528	-11.6895661	-4.79818079
26	241.603994	254.153965	-12.5499701	-5.19443819
27	232.998031	253.637599	-20.6395681	-8.85825861

RMSE = 12.624688

difference between the two sets of equations is a large coefficient for the lagged dependent variable (LM) for the latter set. The prediction results of equations 5.4.E and 5.4.F are shown in Tables 5.4.E and 5.4.F, respectively. Although the pattern of percentage errors of these two equations is different from their real adjustment version, the percentage errors seem to be fairly stable after 1976. For equation 5.4.F, the percentage errors are very low for the first eight quarters, and they have a different sign. If one was only concerned with the prediction results for the period of 1974:1-1976:1, he/she might have been satisfied with the outcome. While the nominal adjustment version of equation 5.4.C, equation 5.4.E, did not reduce the average percentage error over 1976:1-1980:1 (or 1980:4), the nominal adjustment version of equation 5.4.D, equation 5.4.F, reduced the average percentage error by one percentage point with the same mean square error of percentage errors, over the period of 1976:1-1980:1.

Equation 5.4.G is the same as equation 5.4.C with the exception of using a nonlinear method of estimation (see Table. 5.4.G). As far as the prediction results are concerned, using the nonlinear method did not improve the results much. It reduced the RMSE by $0.62 billion and the average percentage error, over the period of 1976:1-1980:1, by 0.28 of a percentage point in absolute terms.

In equation 5.4.H, instead of having the lagged dependent variable among the regressors, three lags of independent variables have been introduced into the equation.[1] The general form of the equation could be shown as:

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[1]For a more detailed explanation see Dickson and Starleaf [6].

TABLE 5.4.E. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.E.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.114417	248.676948	-.56253104	-.226722432
2	248.010231	246.283167	1.72706338	.696367797
3	244.860828	243.814632	1.046196	.427261482
4	241.010379	241.138168	-.127788887	-.0530221511
5	236.391659	239.520731	-3.12907196	-1.3236812
6	231.270958	241.342287	-10.0713289	-4.35477459
7	232.16771	241.943298	-9.77558811	-4.21057179
8	232.520874	242.936269	-10.4153957	-4.47933792
9	230.154311	246.677982	-16.5236708	-7.17938794
10	231.48614	250.012723	-18.5265831	-8.00332285
11	234.590162	252.456316	-17.8661543	-7.61590092
12	235.036307	254.322246	-19.2859394	-8.20551497
13	236.141216	256.987474	-20.8462577	-8.82787765
14	238.216518	258.966009	-20.7494906	-8.7103492
15	239.508762	261.506073	-21.997311	-9.184345
16	240.993509	263.018302	-22.0247928	-9.13916433
17	243.089576	264.714854	-21.6252783	-8.8960122
18	244.532934	264.144755	-19.611821	-8.02011439
19	243.893096	265.05487	-21.1617739	-8.67665967
20	243.956517	264.583186	-20.6266692	-8.45505974
21	244.015074	264.901054	-20.8859802	-8.55929917
22	242.73007	265.376598	-22.6465278	-9.32992269
23	246.075893	265.987646	-19.9117528	-8.0917121
24	247.091818	265.757711	-18.6658924	-7.55423328
25	243.624962	264.73598	-21.111018	-8.66537561
26	241.603994	263.786864	-22.1828694	-9.18149945
27	232.998031	263.703804	-30.7057734	-13.1785549

RMSE = 18.0136859

TABLE 5.4.F. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.F.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.114417	248.29137	-.176952961	-.0713190968
2	248.010231	245.289611	2.72061931	1.09697866
3	244.860828	241.985966	2.87486154	1.17407981
4	241.010379	238.273077	2.73730242	1.13576122
5	236.391659	235.435595	.956064039	.404440683
6	231.270958	236.206404	-4.93544641	-2.13405369
7	232.16771	235.900489	-3.73277824	-1.60779388
8	232.520874	236.11501	-3.59413596	-1.54572616
9	230.154311	239.365756	-9.21144498	-4.00229088
10	231.48614	242.265507	-10.779367	-4.65659282
11	234.590162	244.328272	-9.73810982	-4.15111604
12	235.036307	245.935171	-10.8988645	-4.63709827
13	236.141216	248.54246	-12.4012435	-5.25162176
14	238.216518	250.520448	-12.3039298	-5.16501959
15	239.508762	253.080016	-13.5712541	-5.66628712
16	240.993509	254.509563	-13.516054	-5.60847223
17	243.089576	256.091483	-13.0019072	-5.34860747
18	244.532934	255.552495	-11.0195609	-4.50637088
19	243.893096	256.356599	-12.4635033	-5.11023209
20	243.956517	255.706053	-11.7495363	-4.81624203
21	244.015074	255.758663	-11.7435894	-4.81264918
22	242.73007	255.79774	-13.0676707	-5.38362253
23	246.075893	255.973722	-9.89782853	-4.02226662
24	247.091818	255.109004	-8.01718542	-3.24461792
25	243.624962	253.369675	-9.74471294	-3.99988279
26	241.603994	251.482637	-9.87864246	-4.08877447
27	232.998031	250.492244	-17.4942134	-7.50830954

RMSE = 10.0284781

TABLE 5.4.G. DYNAMIC SIM. OF M-1C BASED ON EQUATION 5.4.G.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.114417	248.898543	-.784125854	-.316033975
2	248.010231	248.157252	-.14702148	-.0592804095
3	244.860828	247.395144	-2.5343163	-1.03500275
4	241.010379	246.838822	-5.82844303	-2.41833694
5	236.391659	246.54081	-10.1491513	-4.29336268
6	231.270958	246.950521	-15.6795632	-6.77973722
7	232.16771	247.372839	-15.2051287	-6.54920045
8	232.520874	248.339914	-15.8190409	-6.80327778
9	230.154311	250.208889	-20.0545777	-8.71353555
10	231.48614	251.719815	-20.233675	-8.74077169
11	234.590162	253.072441	-18.4822795	-7.87853989
12	235.036307	254.743573	-19.7072664	-8.38477538
13	236.141216	256.802444	-20.6612278	-8.74952204
14	238.216518	258.653504	-20.4369863	-8.57916423
15	239.508762	260.15241	-20.6436477	-8.6191618
16	240.993509	261.034701	-20.0411918	-8.3160712
17	243.089576	261.831935	-18.7423597	-7.71006311
18	244.532934	263.055552	-18.5226173	-7.57469226
19	243.893096	263.86926	-19.976164	-8.190541
20	243.956517	264.287922	-20.3314055	-8.33402844
21	244.015074	264.638301	-20.6232271	-8.45162011
22	242.73007	264.766904	-22.0368345	-9.07874106
23	246.075893	265.080847	-19.0049539	-7.72320832
24	247.091818	264.628903	-17.5370844	-7.09739585
25	243.624962	264.035481	-20.4105193	-8.37784403
26	241.603994	263.827912	-22.2239178	-9.19848939
27	232.998031	264.167021	-31.1689905	-13.3773622

RMSE = 18.311804

$$M_t = \alpha_0 + \sum_{n=0}^{3} \alpha_{1+n} (GNP)_{t-n} + \sum_{n=0}^{3} \alpha_{5+n} (TBR)_{t-n} + \sum_{n=0}^{3} \alpha_{9+n} (SR)_{t-n};$$

where n is the number of lags and t represents the time. For current GNP, n=0.

Since the old data set is used in estimating the coefficients of this equation, it is comparable to equation 5.4.A. The prediction results of equation 5.4.H are shown in Table 5.4.H. Equation 5.4.H proved to be a little better than equation 5.4.A. The RMSE of equation 5.4.H is $2.18 billion lower than that of equation 5.4.A, and its average percentage error over the period of 1976:1-1980:1 (or 1980:4) is about 0.95 of a percentage point lower, in absolute terms.

M-1D

Another aggregate, M-1D, was tried and it is equal to M-1C plus MMMF. The same set of specifications (except the nonlinear form) that was tried for M-1C was tried for M-1D. Since the value of MMMF was zero before the last quarter of 1973, the estimated coefficients of different specifications of M-1D are very similar to the coefficients of M-1C. The estimation results of all the specifications are reported in Table 5.5.

Equation 5.5.A is the standard form. In equation 5.5.B, TBR is replaced with CPR, as a proxy for the market interest rate. Both of these equations are estimated by using old GNP and price data set. Although equation 5.5.B fits the sample better, equation 5.5.A has lower out-of-sample prediction errors. As we can see in Tables 5.5.A and 5.5.B, the prediction results of equations 5.5.A and 5.5.B, respectively, the

Table 5.4.H. Dynamic simulation of M-1C based on equation 5.4.H (RMSE = 18.00)

Observ.	Real	Estim.	Error	Per. error
1	246.49	243.14	3.35	1.36
2	242.69	243.11	-0.414	-0.17
3	238.43	241.54	-3.11	-1.31
4	233.52	238.44	-4.92	-2.11
5	228.49	237.15	-8.65	-3.79
6	228.98	239.75	-10.77	-4.71
7	229.35	243.36	-14.02	-6.11
8	227.68	243.72	-16.05	-7.05
9	228.84	246.23	-17.39	-7.50
10	231.34	247.78	-16.44	-7.11
11	232.01	249.66	-17.65	-7.61
12	233.49	249.69	-16.20	-6.94
13	235.41	252.65	-17.25	-7.33
14	236.19	254.33	-18.14	-7.68
15	237.82	257.13	-19.31	-8.12
16	240.31	257.10	-16.79	-6.98
17	241.01	257.48	-16.47	-6.83
18	240.35	259.58	-19.23	-8.00
19	240.73	260.59	-19.86	-8.25
20	241.38	263.23	-21.84	-9.05
21	239.61	262.31	-22.71	-9.47
22	242.11	261.26	-19.15	-7.91
23	242.70	262.46	-19.76	-8.14
24	239.18	263.14	-23.96	-10.02
25	237.10	263.63	-26.52	-11.18
26	228.17	258.15	-29.98	-13.14
27	234.46	259.82	-25.36	-10.82

Table 5.5. The regression results of M-1D, (1959:2-1973:4)[a]

Equation	Intercept	GNP	TBR	CPR	SR
5.5.A	0.238 (0.908)	0.109 (3.187)*	-0.015 (3.413)*		-0.023 (1.287)
5.5.B	0.090 (0.382)	0.100 (3.196)*		-0.019 (4.569)*	-0.024 (1.463)
5.5.C	0.306 (1.084)	0.104 (2.939)*	-0.015 (3.275)*		-0.018 (1.019)
5.5.D	-0.245 (0.618)	0.156 (3.195)*	-0.019 (4.000)*		-0.012 (0.653)
5.5.E	0.047 (1.162)	0.102 (2.957)*	-0.012 (2.777)*		-0.018 (1.031)
5.5.F	-0.439 (1.074)	0.151 (3.089)*	-0.015 (3.289)*		-0.012 (0.690)
5.5.G[b]	2.212	0.496	-0.008		-0.142

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the tabled value of the t-statistic at five percent level.

[b]The coefficient of each variable in equation 5.4.G is the arithmetic sum of the coefficients of the current and the past three lags of the variable.

N	LM	GNP long-run	ρ	R^2
	0.829 (10.078)*	0.634	0.313	0.989
	0.868 (11.643)*	0.762	0.237	0.991
	0.820 (9.247)*	0.581	0.324	0.988
-0.001 (1.623)	0.859 (10.221)*	1.110	0.241	0.991
	0.871 (9.721)	0.790	0.296	0.990
-0.001 (1.486)	0.902 (10.332)*	1.540	0.250	0.991
				0.988

TABLE 5.5.A. DYNAMIC SIM. OF M-1D BASED ON EQUATION 5.5.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.674585	246.856005	-.181419735	-.0735461803
2	243.048254	245.902025	-2.85377043	-1.17415796
3	239.192819	244.952358	-5.75953878	-2.40790623
4	235.172667	244.11035	-8.93768265	-3.80047679
5	231.07215	243.871677	-12.7995271	-5.53919073
6	232.077182	244.442872	-12.3656895	-5.32826596
7	232.232726	244.976697	-12.7439711	-5.4875862
8	230.444488	246.006052	-15.5615639	-6.75284712
9	231.659819	247.987936	-16.3281173	-7.04831653
10	233.97634	249.733122	-15.756782	-6.73434842
11	234.465863	251.396915	-16.9310525	-7.22111624
12	235.985414	253.394178	-17.4087631	-7.37705047
13	238.085535	255.712699	-17.6271642	-7.4037107
14	238.748334	257.805146	-19.0568127	-7.98196678
15	240.201943	259.526474	-19.3245307	-8.0451184
16	242.805327	260.652995	-17.847668	-7.35060807
17	244.271424	261.580271	-17.3088473	-7.08590756
18	244.530489	262.841491	-18.3110015	-7.4882284
19	245.812734	263.64446	-17.8317261	-7.25419137
20	247.447887	264.003079	-16.5551924	-6.69037536
21	248.658384	264.073347	-15.4149628	-6.19925321
22	255.478945	263.958291	-8.47934643	-3.3190001
23	261.18527	263.972636	-2.7873664	-1.06719893
24	262.98579	263.293859	-.308068621	-.117142687
25	268.970041	262.2865	6.68354125	2.48486457
26	265.658062	261.918383	3.73967881	1.40770386
27	278.010811	262.02771	15.983101	5.74909332

RMSE = 13.8396084

TABLE 5.5.B. DYNAMIC SIM. OF M-1D BASED ON EQUATION 5.5.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.674585	247.012144	-.337558209	-.13684353
2	243.048254	245.428338	-2.3800838	-.979263894
3	239.192819	243.466627	-4.27380854	-1.7867629
4	235.172667	242.422045	-7.24937767	-3.08257662
5	231.07215	242.656418	-11.5842682	-5.01326887
6	232.077182	243.753018	-11.6758356	-5.03101403
7	232.232726	244.765136	-12.5324092	-5.39648712
8	230.444488	246.210909	-15.7664208	-6.84174353
9	231.659819	248.717398	-17.0575786	-7.3632012
10	233.97634	250.904661	-16.9283213	-7.23505687
11	234.465863	253.047985	-18.582122	-7.92529957
12	235.985414	255.644589	-19.6591744	-8.33067352
13	238.085535	258.651578	-20.5660432	-8.63809018
14	238.748334	261.171146	-22.4228121	-9.39181932
15	240.201943	263.30584	-23.1038966	-9.6185303
16	242.805327	264.681112	-21.8757848	-9.00959836
17	244.271424	265.848747	-21.5773228	-8.83333894
18	244.530489	267.106434	-22.5759451	-9.23236409
19	245.812734	267.845204	-22.0324709	-8.96311211
20	247.447887	267.814059	-20.366172	-8.23048935
21	248.658384	267.764989	-19.1066049	-7.68387723
22	255.478945	267.689174	-12.2102296	-4.77934869
23	261.18527	267.421296	-6.23602577	-2.38758709
24	262.98579	266.273939	-3.28814881	-1.25031425
25	268.970041	264.936554	4.03348685	1.4996045
26	265.658062	264.532384	1.12567766	.423731788
27	278.010811	264.785804	13.2250074	4.75701192

RMSE = 15.6724639

percentage errors in both tables follow the same pattern, which is different from the pattern of percentage errors of M-1C. For both of these equations, after the percentage error reaches a peak point (in absolute terms) in 1977:3, it starts to fall off and finally it becomes positive in sign, i.e. the equations underestimate actual real money balances. The problem must be inclusion of MMMF in the monetary aggregate. By reference to Table 5.4.A, the prediction results of the conventional equation of M-1C, the problem probably started in about the second or third quarter of 1978. For the second quarter of 1978 the gap between the two sets of errors started to increase. The MMMF also started to grow faster beginning in 1978. What they imply is that the major portion of MMMFs do not come from demand deposits. They attract either new funds or funds from other deposits and financial instruments.

As is true of other aggregates, the revised data set for GNP and price level improved the prediction results of M-1D. In equation 5.5.C, the revised data is used in estimation of the coefficients. Comparison of the percentage errors of equations 5.5.A and 5.5.C, respectively, shown in Tables 5.5.A and 5.5.C, shows that until 1978:3 equation 5.5.C gave less than one percentage point smaller percentage errors. Also, the RMSE of equation 5.5.C is $13.14 billion, which is about $0.7 billion lower than that of equation 5.5.A.

Equation 5.5.D, with the time variable N among its regressors, has lower percentage errors (in absolute terms) than equation 5.5.C. These errors are generally more than one percentage point (in absolute terms)

TABLE 5.5.C. DYNAMIC SIM. OF M-1D BASED ON EQUATION 5.5.D.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.191345	247.913434	.277910401	.111974252
2	245.213682	247.394443	-2.18076094	-.889330859
3	241.785265	246.802945	-5.0176793	-2.07526265
4	238.064108	246.43201	-8.36790197	-3.51497839
5	233.88043	246.397508	-12.5170779	-5.35191334
6	235.309107	246.991137	-11.6820303	-4.9645466
7	235.447981	247.460531	-12.0125502	-5.10199756
8	232.949106	248.483885	-15.534779	-6.66874377
9	234.334598	250.40503	-16.070432	-6.85789984
10	237.26081	252.005798	-14.744988	-6.21467489
11	237.524315	253.478902	-15.9545872	-6.71703323
12	238.664787	255.304611	-16.6398248	-6.97204855
13	240.92604	257.488586	-16.5625464	-6.87453561
14	242.099791	259.475149	-17.3753583	-7.17694065
15	243.410666	261.071354	-17.6606884	-7.25551131
16	245.608794	262.049865	-16.4410707	-6.69400736
17	247.84412	262.926232	-15.0821126	-6.08532193
18	248.131786	264.166698	-16.0349118	-6.46225624
19	249.108863	264.97505	-15.8661878	-6.36917837
20	250.144813	265.323584	-15.1787709	-6.06799349
21	251.896931	265.576213	-13.6792815	-5.43050739
22	259.664393	265.655419	-5.99102611	-2.30721896
23	265.907898	265.889357	.0185410921	6.97274965E-03
24	267.869521	265.316589	2.55293224	.95305066
25	274.074509	264.536856	9.53765278	3.47994888
26	271.279594	264.336059	6.94353483	2.55954926
27	284.294309	264.676485	19.6178239	6.90053348

RMSE = 13.1439839

smaller than the percentage errors of equation 5.4.D, in Table 5.4.D. The percentage errors of equation 5.5.D follow the same pattern as that of the errors of equation 5.5.C. The RMSE of equation 5.5.D, shown in Table 5.5.D, is $11.01 billion, which is $2.13 billion less than that of equation 5.5.C.

Equation 5.5.E, the nominal adjustment version of the conventional equation, has a lower prediction error, shown in Table 5.5.E, than equation 5.5.C. The RMSE of equation 5.5.E is $11.97 billion, which is $1.17 billion lower than that of equation 5.5.C. The nominal adjustment version of equation 5.5.D (M-1D counterpart of equation 5.4.D), equation 5.5.F, also resulted in a better prediction result than equation 5.5.D did, but the patterns of their percentage errors appear to be different. The percentage errors of equation 5.5.F are positive and small for the first four quarters. For the rest of the prediction period until it reaches its peak in 1977:2, although their sign changes (except for 1975:3), they retain a relatively low value, in absolute terms. These results are interesting. Note that the difference between the percentage errors of equations 5.5.F and 5.4.F is due to two things. First, the sum of RPs and MMMFs in M-1D (of 5.5.F) is equal to the value of RPs in M-1C (of 5.4.F) for all of the sample period except for the last quarter of the sample period when the sum exceeds RPs by $7 million. Second, for the prediction period, until 1978, the monetary aggregate (M-1D) is greater in equation 5.5.F, but not by more than $4.0 billion. What this means is that a little upward adjustment in the volume of RPs for the last quarter of 1973 and a little more for the period of 1975-1977 would have given the percentage

TABLE 5.5.D. DYNAMIC SIM. OF M-1D BASED ON EQUATION 5.5.D.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.191345	247.483434	.70791068	.285227787
2	245.213682	246.363576	-1.1498941	-.468935539
3	241.785265	244.998298	-3.21303216	-1.3288784
4	238.064108	243.726885	-5.66277633	-2.37867706
5	233.88043	242.674559	-8.7941291	-3.76009617
6	235.309107	242.452224	-7.14311678	-3.03563125
7	235.447981	242.220289	-6.77230839	-2.87635017
8	232.949106	242.69499	-9.74588345	-4.18369644
9	234.334598	244.392336	-10.0577383	-4.29204153
10	237.26081	245.75854	-8.4977301	-3.58159871
11	237.524315	246.998723	-9.47440811	-3.98881609
12	238.664787	248.707858	-10.0430714	-4.20802396
13	240.92604	250.993319	-10.0672795	-4.17857676
14	242.099791	253.113592	-11.0138008	-4.5492814
15	243.410666	254.836686	-11.4260202	-4.69413291
16	245.608794	255.774524	-10.1657296	-4.13899252
17	247.84412	256.552725	-8.70860563	-3.51374309
18	248.131786	257.83075	-9.69896431	-3.90879559
19	249.108863	258.569615	-9.46075182	-3.79783831
20	250.144813	258.740376	-8.5955631	-3.4362348
21	251.896931	258.741042	-6.84411056	-2.71702816
22	259.664393	258.386257	1.27813595	.492226114
23	265.907898	258.183989	7.72390962	2.90473118
24	267.869521	256.928371	10.9411508	4.08450754
25	274.074509	255.362754	18.7117549	6.82725108
26	271.279594	254.20839	17.071204	6.29284487
27	284.294309	253.69602	30.5982887	10.7628918

RMSE = 11.0099647

TABLE 5.5.E. DYNAMIC SIM. OF M-1D BASED ON EQUATION 5.5.E.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.191345	247.537206	.654139154	.263562436
2	245.213682	245.308929	-.0952472917	-.0388425683
3	241.785265	242.982952	-1.19768639	-.495351273
4	238.064108	240.429407	-2.36529902	-.99355549
5	233.88043	238.914996	-5.03456564	-2.15262373
6	235.309107	240.818178	-5.50907058	-2.34120585
7	235.447981	241.492948	-6.04496761	-2.56743235
8	232.949106	242.549444	-9.60033792	-4.1212169
9	234.334598	246.343084	-12.0084864	-5.12450425
10	237.26081	249.725461	-12.4646508	-5.25356498
11	237.524315	252.212776	-14.6884611	-6.18398206
12	238.664787	254.117742	-15.4529556	-6.47475308
13	240.92604	256.816661	-15.8906217	-6.59564308
14	242.099791	258.8256	-16.7258088	-6.90864241
15	243.410666	261.392731	-17.9820649	-7.38754192
16	245.608794	262.929927	-17.3211334	-7.05232624
17	247.84412	264.648739	-16.8046195	-6.78031803
18	248.131786	264.097483	-15.9656975	-6.43436206
19	249.108863	265.024025	-15.9151623	-6.38883825
20	250.144813	264.566557	-14.421744	-5.76535803
21	251.896931	264.896652	-12.9997205	-5.16073002
22	259.664393	265.38326	-5.71886767	-2.20240735
23	265.907898	266.003827	-.0959286415	-.0360758903
24	267.869521	265.782604	2.08691777	.779079965
25	274.074509	264.768026	9.3064832	3.39560335
26	271.279594	263.825095	7.45449901	2.7479026
27	284.294309	263.746953	20.5473558	7.2274946

RMSE = 11.9731833

errors similar to the ones in Table 5.5.F--for the period when the values were adjusted. Considering that the overnight RPs are only a proxy for the transaction related part of the total RPs, the revision is not totally out of the question.

Finally, the equation with the three lags of independent variables among the regressors, instead of lagged dependent variable, is represented by equation 5.5.G. This equation is estimated using old data. Comparing the prediction results of this equation, Table 5.5.G, to the results of equation 5.5.A, in Table 5.5.A, shows a much better performance for equation 5.5.G. Equation 5.5.G has a much lower percentage error, for the first three years of the prediction period than equation 5.5.A; and the percentage errors are more stable for the period of 1975:4-1979:2. The RMSE of equation 5.5.G is also $2.13 billion lower than that of equation 5.5.A.

M-1E

By excluding RPs from M-1D the prediction results deteriorate. M-1E represents this aggregate--M-1B plus MMMF. Table 5.6 shows the estimation results of the specifications tried for this aggregate. Equation 5.6.A has the standard form and holds the assumption of the real adjustment. As we see in Table 5.6.A, the prediction results of equation 5.6.A, the percentage errors are rising in absolute terms until 1979, and after that they fall off and finally attain a positive sign. Comparison of these results to the results in Table 5.5.C (of M-1D counterpart of equation 5.6.A) shows a higher percentage error (for the rising phase of the

TABLE 5.5.F. DYNAMIC SIM. OF M-1D BASED ON EQUATION 5.5.F.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	248.191345	247.11484	1.07650439	.433739699
2	245.213682	244.253058	.960623609	.391749597
3	241.785265	241.075604	.709661324	.293508921
4	238.064108	237.476464	.587644798	.246843089
5	233.88043	234.737907	-.857476976	-.366630494
6	235.309107	235.586527	-.277420282	-.117896109
7	235.447981	235.35293	.0950504918	.0403700604
8	232.949106	235.630658	-2.6815517	-1.151132
9	234.334598	238.931574	-4.59697608	-1.96171462
10	237.26081	241.878979	-4.61816917	-1.94645259
11	237.524315	243.987199	-6.4628838	-2.72093566
12	238.664787	245.635654	-6.97086753	-2.92077756
13	240.92604	248.278639	-7.3525992	-3.0518076
14	242.099791	250.29001	-8.19021934	-3.38299315
15	243.410666	252.880041	-9.46937567	-3.8902879
16	245.608794	254.339571	-8.7307776	-3.5547496
17	247.84412	255.94918	-8.10505986	-3.2702248
18	248.131786	255.43475	-7.30296402	-2.94317956
19	249.108863	256.26108	-7.1522177	-2.87112133
20	250.144813	255.631318	-5.48650579	-2.19333183
21	251.896931	255.702592	-3.80566066	-1.51080072
22	259.664393	255.759612	3.90478057	1.50377976
23	265.907898	255.951594	9.95630401	3.74426788
24	267.869521	255.102902	12.7666197	4.76598444
25	274.074509	253.378119	20.6963899	7.55137352
26	271.279594	251.504858	19.7747355	7.28942978
27	284.294309	250.526006	33.7683027	11.8779383

RMSE = 10.3326259

Table 5.5.G. Dynamic simulation of M-1D based on equation 5.4.G (RMSE = 11.7138)

Observ.	Real	Estim.	Error	Per. error
1	246.68	243.16	3.52	1.43
2	243.04	243.12	-0.08	-0.03
3	239.19	241.56	-2.37	-0.99
4	235.17	238.46	-3.29	-1.40
5	231.08	237.17	-6.09	-2.64
6	232.07	239.76	-7.89	-3.31
7	232.23	243.37	-11.14	4.79
8	230.44	243.74	-13.30	-5.77
9	231.66	246.24	-14.58	-6.29
10	233.98	247.79	-13.81	-5.90
11	234.46	249.67	-15.21	-6.48
12	235.98	249.71	-13.73	-5.81
13	238.08	252.66	-14.58	-6.12
14	238.75	254.35	-15.60	-6.53
15	240.20	257.14	-16.94	-7.05
16	242.80	257.12	-14.32	-5.89
17	244.27	257.50	-13.23	-5.41
18	244.53	259.60	-15.07	-6.16
19	245.81	260.61	-14.80	-6.02
20	247.45	263.24	-15.79	-6.38
21	248.66	262.34	-13.68	-5.5
22	255.48	261.28	-5.8	-2.27
23	261.18	262.48	-1.30	-0.49
24	262.99	263.16	-0.17	-0.07
25	268.96	263.64	5.32	1.98
26	265.65	258.18	7.47	2.81
27	278.01	259.83	18.18	6.54

Table 5.6. The regression results of M-1E, (1959:2-1973:4)[a]

Equation	Intercept	GNP	TBR	SR	LM	GNP long-run	ρ	R^2
5.6.A	0.463	0.103	-0.015	-0.016	0.792	0.496	0.391	0.983
	(1.334)	(2.808)*	(3.179)*	(0.869)	(7.709)*			
5.6.B	0.215	0.104	-0.012	-0.016	0.837	0.638	0.351	0.986
	(0.632)	(3.055)*	(2.826)*	(0.916)	(8.521)*			

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the tabled value of the t-statistic at five percent level.

TABLE 5.6.A. DYNAMIC SIM. OF M-1E BASED ON EQUATION 5.6.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	241.410789	241.598077	-.187288303	-.0775807512
2	237.890385	241.331531	-3.44114595	-1.44652586
3	234.130816	240.959366	-6.82855033	-2.91655343
4	231.37274	240.791068	-9.41832867	-4.07063022
5	228.172061	240.948754	-12.7766927	-5.59958682
6	229.189689	241.687357	-12.4976682	-5.45298011
7	229.040764	242.233846	-13.1930811	-5.76014542
8	226.657484	243.300236	-16.642752	-7.34268806
9	227.866516	245.212216	-17.3457007	-7.61222009
10	229.173647	246.744168	-17.570521	-7.6669029
11	228.478017	248.111564	-19.6335472	-8.59318874
12	229.240117	249.804697	-20.5645804	-8.97075986
13	231.483825	251.81061	-20.3267855	-8.78108245
14	231.516234	253.579319	-22.0630846	-9.52982179
15	232.042373	254.927344	-22.8849707	-9.86241022
16	233.574246	255.656736	-22.0824899	-9.45416297
17	235.631702	256.299084	-20.6673825	-8.77105343
18	235.954738	257.306898	-21.3521594	-9.04926069
19	236.75835	257.884396	-21.1260466	-8.92304187
20	236.595043	258.013167	-21.4181241	-9.05265123
21	237.923692	258.071942	-20.1482495	-8.46836616
22	243.902852	257.995092	-14.0922394	-5.77780838
23	250.259905	258.092637	-7.83273181	-3.12983888
24	254.016697	257.405912	-3.38921571	-1.33424919
25	260.467996	256.546146	3.92184983	1.50569356
26	259.58391	256.32916	3.25474945	1.25383328
27	268.948524	256.6547	12.2938239	4.57106946

RMSE = 15.9740193

period) for equation 5.6.A. The RMSE of equation 5.6.A is about $15.97 billion, which is $2.83 billion higher than that of equation 5.5.C.

In equation 5.6.B, the assumption of the real adjustment has been replaced by the assumption of the nominal adjustment. Nothing unusual happened to the estimated coefficients. The prediction results of this equation, Table 5.6.B, show an improvement from equation 5.6.A. The percentage errors of equation 5.6.B are much lower (in absolute terms), than those of equation 5.6.A, for the first two years of the prediction period. After 1975, the results are mixed. But, these percentage errors are still higher than those in Table 5.5.E (of M-1D counterpart of equation 5.6.B). In general, the nominal adjustment version gave better results, although not homogeneous over all the prediction period. The RMSE of equation 5.6.B is $1.12 billion lower than that of equation 5.6.A; but, it is still higher than the RMSE of equation 5.5.E.

Some Wider Monetary Aggregates

Five more aggregates were tried in this study. Only the conventional form of the equations, with the assumption of the real adjustment mechanism, was tried. All the equations were estimated with the new set of data for GNP and the price level. The estimation results of these aggregates are reported in Table 5.7.

The first of these equations, equation 5.7.A, is for the familiar new M-2 aggregate--explained in Chapter III. The next three equations (5.7.B, 5.7.C, and 5.7.D) are for aggregates directly derived from M-2. M-1F is obtained by subtracting all small time deposits from M-2. M-1G is obtained by subtracting all savings deposits from M-1F. The only

TABLE 5.6.B. DYNAMIC SIM. OF M-1E BASED ON EQUATION 5.6.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	241.410789	241.090335	.320453676	.132742069
2	237.890385	239.121534	-1.23114876	-.51752775
3	234.130816	237.100697	-2.9698811	-1.26847083
4	231.37274	234.919507	-3.54676702	-1.53292347
5	228.172061	233.776239	-5.60417785	-2.45611922
6	229.189689	235.885038	-6.69534865	-2.9213132
7	229.040764	236.722148	-7.68138373	-3.35371904
8	226.657484	237.902386	-11.244902	-4.96118716
9	227.866516	241.661672	-13.7951565	-6.05405165
10	229.173647	244.881448	-15.7078011	-6.85410443
11	228.478017	247.14999	-18.6719736	-8.17232827
12	229.240117	248.835636	-19.5955188	-8.54803211
13	231.483825	251.258868	-19.7750431	-8.54273212
14	231.516234	252.970787	-21.4545521	-9.26697523
15	232.042373	255.16126	-23.1188869	-9.96321774
16	233.574246	256.31339	-22.7391438	-9.73529581
17	235.631702	257.632908	-22.0012063	-9.33711639
18	235.954738	256.847628	-20.8928895	-8.85461748
19	236.75835	257.489739	-20.7313898	-8.75635002
20	236.595043	256.824367	-20.2293236	-8.5501891
21	237.923692	256.943246	-19.0195538	-7.99397221
22	243.902852	257.220885	-13.3180326	-5.4603841
23	250.259905	257.644161	-7.38425579	-2.95063478
24	254.016697	257.242191	-3.22549382	-1.26979599
25	260.467996	256.121501	4.34649553	1.66872537
26	259.58391	255.161034	4.42287569	1.70383276
27	268.948524	255.077526	13.870998	5.15749178

RMSE = 14.8470711

Table 5.7. The regression results of some wider monetary aggregates, (1959:2-1973:4)[a]

Equation	Aggregate	Intercept	GNP	TBR	SR	LM	ρ	R^2
5.7.A	M-2	-0.133 (1.510)	0.005 (0.101)	-0.033 (8.465)*	0.017 (1.068)	1.021 (23.417)*	0.354	0.999
5.7.B	M-1F	-0.101 (0.744)	0.020 (0.940)	-0.035 (6.951)*	0.006 (0.304)	1.002 (45.499)*	(0.430)	0.992
5.7.C	M-1G	0.299 (1.075)	0.103 (2.958)*	-0.015 (3.206)*	-0.019 (1.038)	0.823 (9.448)*	0.344	0.988
5.7.D	M-1H	-0.167 (1.209)	0.020 (1.006)	-0.030 (7.150)*	0.009 (0.515)	1.011 (33.630)*	0.365	0.992
5.7.E	M-1I	-0.170 (1.238)	0.021 (1.058)	-0.030 (7.208)*	0.008 (0.480)	1.011 (33.913)*	0.353	0.992

[a]The numbers in parentheses are t-ratios, and the ones indicated by (*) are larger than the tabled value of the t-statistic at five percent level.

difference between M-1G and M-1D is inclusion of overnight Eurodollars and the M-2 consolidation component in M-1G. M-1H is calculated by subtracting two-thirds of the savings deposits at thrift institutions and one-third of the savings deposits at commercial banks from M-1F. The last aggregate, M-1I, is calculated by adding one-third of the savings at thrift institutions and two-thirds of the savings at commercial banks to M-1C. Looking from the other side, M-1I is equal to M-1H minus the sum of MMMFs, overnight Eurodollars, and the M-2 consolidation component.

Estimated demand equations for these aggregates are respectively represented by equations 5.7.A, 5.7.B, 5.7.C, 5.7.D, and 5.7.E in Table 5.7. The estimation results of these equations are somewhat different from those we had before--except for M-1G, equation 5.7.C, that has estimated coefficients very similar to the ones in equation 5.5.C of M-1D. The income elasticity of four wider aggregates turned out to be very low and not significantly different from zero. They have a relatively high interest (TBR) elasticity, and the coefficient of SR has a positive sign. This latter phenomenon is because savings (or at least some part of them) are part of these aggregates; and, naturally, as interest paid on these deposits increases, the volume of the savings go up. Moreover, the four wider aggregates have elasticity of lagged dependent variables greater than one; which is contrary to what the theory suggests. But, as long as we are concerned with the prediction results, these equations are helpful in providing an insight into what may have been happening in the financial markets.

The percentage errors of prediction of M-2, shown in Table 5.7.A, have an upward trend and equation 5.7.A overestimates the actual volume of M-2. When small time deposits are subtracted from M-2, the new aggregate M-1F is underestimated by equation 5.7.B (except for four quarters). The prediction results of M-1F are shown in Table 5.7.B. The prediction results of equation 5.7.C (of M-1G which is obtained by excluding the savings deposits in all depository institutions from M-1F), Table 5.7.C, show an overprediction of M-1G by this equation. The percentage errors of M-1G are relatively stable over the period of 1975:1-1979:1. Comparison of the prediction results of M-1F and M-1G shows that, with adding savings deposits to M-1G, the resultant aggregate (M-1F) is underestimated by the corresponding equation. This comparison suggests that some components of M-1G (like MMMFs) may have absorbed some funds from the savings deposits, and/or the savings deposits in the second half of the 1970s have absorbed some funds from deposits or assets other than those included in M-1F (like small time deposits).

One of the interesting prediction results is that of M-1H. The difference between M-1H and M-1G is 1/3 of the savings deposits at thrift institutions and 2/3 of the savings at commercial banks. Adding these two to M-1G resulted in the prediction errors, shown in Table 5.7.D, predicted by the corresponding equation, equation 5.7.D. The percentage errors of prediction of M-1H are very small and relatively stable and they are the smallest percentage errors obtained in this study. They are even less than the static percentage errors of prediction of some other aggregates. The percentage error 1.87 for the fourth quarter of 1979 means that the

TABLE 5.7.A. DYNAMIC SIM. OF M-2 BASED ON EQUATION 5.7.A.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	785.444657	785.578033	-.133375906	-.0169809426
2	776.494842	785.322473	-8.82763099	-1.13685636
3	765.179159	784.98325	-19.8040911	-2.58816394
4	754.579017	787.703556	-33.1245392	-4.38980391
5	750.057597	796.151328	-46.0937312	-6.1453589
6	768.23064	807.112803	-38.8821631	-5.0612617
7	782.27004	814.299959	-32.0299189	-4.09448366
8	787.245385	824.651186	-37.4058008	-4.75147921
9	805.545752	839.190346	-33.6445942	-4.17662115
10	823.620612	853.139877	-29.5192652	-3.58408529
11	836.728798	867.644692	-30.9158933	-3.69485231
12	854.990194	885.494592	-30.5043985	-3.56780682
13	872.000502	904.662415	-32.661913	-3.74563006
14	881.795352	923.412305	-41.6169533	-4.7195705
15	891.227745	939.201297	-47.9735516	-5.3828611
16	899.024242	952.058988	-53.0347469	-5.89914536
17	903.196374	964.277655	-61.0812807	-6.76279073
18	897.26388	976.419628	-79.1557487	-8.82190295
19	898.754578	985.131179	-86.3766024	-9.61069959
20	898.835468	988.648547	-89.813079	-9.99216011
21	895.229401	989.87223	-94.6428293	-10.5719081
22	901.067343	991.054251	-89.9869078	-9.98670172
23	907.950626	991.429483	-83.4788573	-9.19420671
24	906.281532	985.277028	-78.995497	-8.71644122
25	902.663647	974.899257	-72.2356096	-8.0024946
26	894.128946	973.508623	-79.3796773	-8.87787803
27	909.586409	974.86169	-65.2752815	-7.17636948

RMSE = 58.0731763

TABLE 5.7.B. DYNAMIC SIM. OF M-1F BASED ON EQUATION 5.7.B.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	539.33128	537.128662	2.2026177	.408397914
2	531.105138	530.599155	.505982276	.0952697009
3	522.02214	524.033098	-2.0109581	-.385224677
4	513.756798	519.602523	-5.84572493	-1.13783894
5	509.49498	518.99042	-9.49544056	-1.86369659
6	519.402961	520.01598	-.613018319	-.118023647
7	526.099311	518.377456	7.72185569	1.46775628
8	526.409803	518.793143	7.61665942	1.44690684
9	538.565972	521.925785	16.6401872	3.08972124
10	550.501676	524.371809	26.1298676	4.74655551
11	555.178675	526.89372	28.2849547	5.09474805
12	564.601403	531.293776	33.3076266	5.89931701
13	574.207024	536.276098	37.9309251	6.60579262
14	577.062166	540.634574	36.427592	6.31259407
15	580.389831	542.842197	37.5476343	6.46938184
16	583.865122	542.933623	40.9314993	7.01043749
17	585.385146	542.429429	42.9557169	7.33802646
18	578.952247	541.79976	37.1524874	6.41719375
19	571.25746	538.993845	32.2636144	5.64782374
20	561.066816	533.147308	27.9195086	4.97614683
21	543.733917	526.070899	17.6630179	3.24846719
22	538.932323	519.002425	19.9298972	3.69803338
23	539.530869	511.628498	27.9023718	5.17159876
24	521.620336	500.798712	20.821624	3.99172013
25	510.055734	488.013407	22.0423265	4.32155255
26	487.904651	480.149377	7.755274	1.58950606
27	511.214874	473.878281	37.3365927	7.30350283

RMSE = 25.7328

TABLE 5.7.C. DYNAMIC SIM. OF M-1G BASED ON EQUATION 5.7.C.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	246.654852	246.180547	.47430457	.192294847
2	243.624962	245.680477	-2.05551476	-.843720917
3	240.324477	245.10656	-4.78208243	-1.9898441
4	236.557191	244.744649	-8.18745863	-3.46109058
5	232.248984	244.708404	-12.4594199	-5.36468222
6	233.536878	245.286486	-11.749608	-5.03115745
7	233.866397	245.746882	-11.8804855	-5.08003101
8	231.395878	246.749469	-15.3535915	-6.6352053
9	232.7186	248.631919	-15.9133184	-6.8380088
10	235.657623	250.206161	-14.5485379	-6.17359104
11	235.940582	251.658559	-15.7179776	-6.66183726
12	236.883865	253.457151	-16.5732865	-6.99637628
13	239.240662	255.609122	-16.3684596	-6.84183844
14	240.73097	257.571907	-16.8409371	-6.99575011
15	242.274166	259.156458	-16.8822925	-6.96825949
16	244.699273	260.138485	-15.4392123	-6.30946388
17	247.084405	261.019474	-13.9350688	-5.63980103
18	247.593923	262.255387	-14.6614637	-5.92157655
19	248.645951	263.069523	-14.4235713	-5.80084704
20	249.887296	263.43392	-13.5466237	-5.42109338
21	251.859149	263.70223	-11.8430814	-4.70226375
22	259.705942	263.797813	-4.0918706	-1.57557835
23	266.277767	264.042216	2.23555135	.839556142
24	267.944535	263.49725	4.4472849	1.65977817
25	274.565541	262.746756	11.8187847	4.30454041
26	271.263317	262.555129	8.70818852	3.21023447
27	284.59582	262.890943	21.7048777	7.62656235

RMSE = 12.9030001

TABLE 5.7.D. DYNAMIC SIM. OF M-1H BASED ON EQUATION 5.7.D.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	382.821951	381.697352	1.12459907	.293765565
2	377.688583	378.6284	-.9398176	-.248833998
3	372.125067	375.4793	-3.35423278	-.901372435
4	366.445571	373.601802	-7.15623045	-1.95287678
5	362.299058	374.069428	-11.7703695	-3.24879936
6	367.951082	375.584664	-7.63358196	-2.0746187
7	371.533858	375.464489	-3.93063033	-1.05794674
8	370.565419	376.648722	-6.08330257	-1.64162716
9	378.160989	379.590938	-1.42994898	-.378132336
10	386.151585	382.145447	4.00613784	1.03745213
11	388.739713	384.790241	3.94947145	1.01596809
12	394.630546	388.678096	5.95245044	1.50836029
13	401.34845	393.016126	8.33232373	2.0760822
14	403.61845	397.031477	6.58697286	1.63198012
15	405.824175	399.745431	6.07874447	1.49787638
16	408.437948	401.144839	7.2931085	1.78560992
17	410.222626	402.189071	8.03355489	1.95834028
18	407.47517	403.189975	4.2851955	1.0516458
19	404.725881	402.800773	1.9251079	.475657227
20	400.670743	400.42931	.241433113	.0602572355
21	393.424821	397.213175	-3.78835428	-.962916949
22	395.353381	393.934584	1.41879725	.358868121
23	399.147092	390.399881	8.74721125	2.19147563
24	391.834674	384.491035	7.34363952	1.87416786
25	390.567184	377.158837	13.4083464	3.4330448
26	377.235628	372.984366	4.25126194	1.12695134
27	395.428505	369.821348	25.6071571	6.4757995

RMSE = 7.87169435

forecasted demand for M-1H in 1979:4, was only 1.87 percent lower than its actual level, which is a quite a low percentage error.

The prediction results of M-1H encouraged me to try the aggregate denoted as M-1I. M-1I was calculated from the M-1B side. It was obtained by adding overnight RPs, 1/3 of the savings at thrift institutions, and 2/3 of the savings at commercial banks to M-1B. So, the difference between M-1I and M-1H is that M-1H contains MMMFs, overnight Eurodollars, and an M-2 consoiidation component as its components. Although the prediction results of M-1I are not as good as the results of M-1H, they make more sense because it sems unlikely that overnight Eurodollars and MMMFs, in particular, are part of the transaction balances. Equation 5.7.E (Table 5.7.E) is very successful in predicting the volume of M-1I until 1979, but the percentage errors for 1979 and three quarters of 1980 are relatively high.

Summary Remarks

Considering the narrow definition of money, the best prediction results are given by equation 5.4.F, of M-1C. Table 5.8 shows the percentage errors of the predictions obtained from equation 5.1.G (of old M-1), equation 5.3.C (of M-1B), and equations 5.4.E and 5.4.F (of M-1C). Comparison of these percentage errors shows how much improvement in prediction is made by equation 5.4.F. Percentage errors of equations 5.1.G and 5.3.C show an upward trend. The percentage errors of equations 5.4.E and 5.4.F are relatively stable after 1975, but the levels of errors obtained by 5.4.F are smaller than those obtained by 5.4.E. The analyses

TABLE 5.7.E. DYNAMIC SIM. OF M-1I BASED ON EQUATION 5.7.E.

OBSERV.	REAL	ESTIM.	ERROR	PRC ERROR
1	384.175701	383.336805	.838896018	.218362592
2	378.921856	380.240461	-1.31860458	-.347988526
3	372.814136	377.062328	-4.24819157	-1.13949316
4	366.280708	375.166256	-8.88554868	-2.42588498
5	361.32217	375.633942	-14.3117713	-3.96094469
6	366.581181	377.163798	-10.5826174	-2.88684143
7	370.187636	377.047461	-6.85982558	-1.85306718
8	369.24486	378.252208	-9.0073478	-2.43939693
9	376.854813	381.2402	-4.38538641	-1.16368062
10	385.083426	383.837999	1.24542761	.323417608
11	387.9087	386.528567	1.380133	.355788101
12	393.889337	390.478447	3.41088926	.865951153
13	400.25026	394.890546	5.35971377	1.33909064
14	402.393313	398.98036	3.41295269	.848163371
15	404.475029	401.759283	2.71574542	.671424743
16	406.8278	403.210029	3.61777169	.889263635
17	407.66673	404.304288	3.36244126	.824801489
18	403.775892	405.362225	-1.58633376	-.392874809
19	400.034183	405.017271	-4.98308791	-1.24566553
20	394.800274	402.671361	-7.8710874	-1.99368844
21	384.287127	399.474608	-15.1874803	-3.95211788
22	381.690473	396.214106	-14.523633	-3.80508136
23	379.980524	392.698519	-12.7179951	-3.34701235
24	367.491431	386.781007	-19.2895764	-5.24898672
25	356.159976	379.426155	-23.2661788	-6.53250798
26	338.959286	375.261544	-36.3022576	-10.7099168
27	350.590894	372.123813	-21.5329191	-6.14189344

RMSE = 12.2300245

Table 5.8. The percentage errors of some selective equations

Observ.	5.1.G PRC error	5.3.C PRC error	5.4.E PRC error	5.4.F PRC error
1	-.0192861944	.0945368551	-.226722432	-.0713190968
2	-.277558937	-.630147849	.696367797	1.09697866
3	-.877214277	-1.56549566	.427261482	1.17407981
4	-1.63463212	-2.23131255	-.0530221511	1.13576122
5	-3.47132886	-3.59871004	-1.3236812	.404440683
6	-3.85535695	-4.30912257	-4.35477459	-2.13405369
7	-4.18338285	-4.64945245	-4.21057179	-1.60779388
8	-5.90507217	-6.22922923	-4.47933792	-1.54572616
9	-7.75266414	-7.35384915	-7.17938794	-4.00229088
10	-7.98276584	-8.07452817	-8.00332285	-4.65659282
11	-9.15290012	-9.32589549	-7.61590092	-4.15111604
12	-9.87922369	-9.72340764	-8.20551497	-4.63709827
13	-11.3710658	-9.79811031	-8.82787765	-5.25162176
14	-11.7046244	-10.4762608	-8.7103492	-5.16501959
15	-11.4968029	-11.0951686	-9.184345	-5.66628712
16	-11.6365148	-10.9107385	-9.13916433	-5.60847223
17	-12.2151271	-10.8771645	-8.8960122	-5.34860747
18	-11.4026229	-10.82739	-8.02011439	-4.50637088
19	-11.6618193	-11.156694	-8.67665967	-5.11023209
20	-12.8673298	-11.4160058	-8.45505974	-4.81624203
21	-15.6427704	-12.3004855	-8.55929917	-4.81264918
22	-15.6608293	-11.6589017	-9.32992269	-5.38362253
23	-15.2852393	-11.2958508	-8.0917121	-4.02226662
24	-15.9657472	-11.9290862	-7.55423328	-3.24461792
25		-12.3068827	-8.66537561	-3.99988279
26		-15.2691131	-9.18149945	-4.08877447
27		-13.6340204	-13.1785549	-7.50830954
RMSE	23.4778999	21.8150265	18.0136859	10.0284781

of the percentage errors are made in previous sections of this chapter and do not need to be repeated here. It suffices only to say that the percentage errors of equations 5.4.E and 5.4.F show an upward trend over the period of 1974:1-1975:4 and become stable after 1975. The averages of percentage errors of equation 5.4.E and 5.4.F over the period of 1976:1-1980:3 are -8.71 an -4.79, respectively. And the mean square errors of the percentage errors of equations 5.4.E and 5.4.F are 1.45 and 0.92, respectively. Possible reasons for obtaining such a percentage error pattern (in Table 5.4.E and 5.4.F) are explained in the next chapter.

Considering that a wider definition of money, equations 5.7.D (of M-1H) and 5.7.E (of M-1I), resulted in the two best prediction results, if we are to be concerned only with the prediction results, regardless of what is defined as money, equation 5.7.D gives the best results. The two wider aggregates, M-1H and M-1I, take some of the problems discussed in the next chapter into account. In defining M-1I, some part of the savings believed to be transaction related were incorporated into the monetary aggregate that measures the transaction balances.

CHAPTER VI. SOME QUALITATIVE EXPLANATIONS FOR THE PREDICTION ERRRORS

This chapter is an attempt to offer an explanation for the errors reported in Tables 5.4.E and 5.4.F--that is, to investigate possible reasons for the overprediction of the demand for money by an average of 8.7 percent in Table 5.4.E and 4.7 percent in Table. 5.4.F. This discussion is a qualitative, as opposed to quantitative, analysis of the matter. As we will see, the factors discussed in this chapter are very hard to quantify.[1] Further, the techniques for quantifying them seem to be arbitrary and not enough data about the developments discussed is available. The factors causing the shift in demand for money are discussed without attaching any quantitative significance to them. It appears to this author that the factors discussed in this chapter collectively account for a large portion of the shift in demand for money in the second half of the 1970s.

Because of very slow changes in the institutions of the economy from the mid-1950s to the late 1960s, the assumption of a constant brokerage cost in an econometric model of demand for money could have been a proper approximation of reality. But, in the 1970s, and particularly from the mid-1970s, some important institutional changes occurred--such as authorization of telephone transfers from savings to demand deposits, preauthorized transfer of funds from savings to demand deposits, bill paying services, overdraft credit line, and automatic payroll deposits--that make

[1] However, this might not be impossible with respect to available techniques in other fields and disciplines.

the above assumption incorrect. Each of these developments had an effect on lowering the brokerage cost of shifting funds in and out of narrow money. They lowered the cost of converting funds from one kind of deposit to another. Some of these developments encouraged the public to make more frequent transfers between interest paying assets and noninterest paying deposits, i.e. demand deposits. This practice, by both firms and households, would in turn lower the average cash holding of the public and their demand for demand deposits and, as many holders become more aware of new opportunities and exploit them vigorously, the demand for money shifts downward.

The introduction of the new monetary aggregates by the Federal Reserve--i.e. including the NOW accounts, share drafts, and demand deposits at thrift institutions in the narrow definition of money--might have lowered the significance of the above factors in affecting the money demanded. But, it certainly would not capture all the effects they might have on the demand. Because, as mentioned before, these developments make savings deposits at commercial banks liquid and transaction related; and these deposits are not part of the narrow money. Neither could M-1C (M-1B + RPs) absorb all the effects. The effect of the factors mentioned above on demand for narrow money might be more significant considering that the state and local governments and businesses were allowed to have savings deposits only since the mid-1970s. It is not clear how much effect these factors might have on demand for money, but it is believed to be considerable.

In addition to the institutional changes, in the last decade corporate financial managers have become more sophisticated in innovating and applying efficient cash management techniques.[1] The practice of cash economizing became very intense in the 1970s. The main function of the techniques in cash management are to speed up collections and to slow down disbursements. Financial managers typically utilize concentration banking and/or a lock-box system to speed up collections. For transfer of funds they use both bank wires and bank drafts. Slowing disbursements means creating float; that is done by selecting the appropriate banks for paying the debts. The lock box is a post office box rented by a company and serviced by a local bank. Firms with defused sales offices may locate the lock boxes in various regional centers and have payments sent there rather than to their headquarters or their cash concentration bank. The box is checked by a local bank several times a day. The bank processes the checks received immediately. The funds at these regional banks are sent via wire or bank draft to the concentration bank--a larger bank that helps the firm with investing the funds. The most popular technique in slowing disbursement is remote disbursing--paying bills on a bank account so located to maximize the sum of time in transit and clearing time. The funds freed by these practices are generally believed to be used in short-term investments, like RPs. The motivation for ever more cash management practices is believed to be high interest rates. If that is true, most of their effect on money demanded might be captured by the coefficient for interest rates in the money demand function. But the point is, after firms have learned and practiced these techniques they are

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[1] A survey of the types of services offered by different sizes of banks is done by Iqbal Mathur and Penny J. Luisada [15].

not likely to abandon them if interest rates happen to go down, particularly if the decline is temporary. Another point--since the proposition is that the freed funds are usually invested in short-term money market instruments such as RPs, we might think that inclusion of RPs in a monetary aggregate (like M-1C) might fill the gap caused by the decrease in demand deposits (via cash management). But since only overnight RPs are included in M-1C and RPs are only one option among many for investing the freed funds, it is believed that some part of their effect remains uncaptured.

One single important factor helping in the economizing of cash holdings in the second half of the 1970s is the extensive use of computers and electronic devices in banking. Most of the cash management techniques would not have been possible without these devices.

To invest the idle balances in short-term money market instruments, particularly on an overnight basis, both firms and banks need to be able to transfer funds on an immediately available basis. The usual way is to transfer funds by wire transfer network. The wire transfer is also used to consolidate balances (transfer the funds from regional banks to the concentration bank), control disbursements, and speed up receipts. Extensive use of wire transfers in the recent past shows how intensive the cash management practices have become. Although wire transfers have been around since shortly after the end of World War I (1918), their use has recently become very extensive. In 1973, the number of wire transfers were 12 million, with the volume of transfers about $23.48 billion. In 1979, the number and volume of transfers accounted to 35 million and

$64.23 billion, respectively. In six years (of our out-of-sample period) both the number and volume of wire transfers have increased nearly three times. According to the "most reasonable" estimtes, 76.5 percent of the dollar volume of total transaction is done by wire transfers [12]. This new way of transferring funds has certainly caused reduction in businesses' demand deposits, for the given volume of transactions. The computer is used in data processing, information retrieval systems, and many other banking activities. For cash management purposes, the information about a bank's transactions is entered in the computer immediately after they take place, like the information on the funds deposited in concentration accounts. So, financial managers have access to the information on deposits in and withdrawals from firm accounts on an up-to-minute basis. With access to this information, the manager can make decisions with more certainty and hold less money in demand deposits for covering the current payments. "In the last few years, corporations and banks have come to appreciate that information flow is almost as important as money flow", explains Chelius--in charge of correspondent bank marketing for New York's Chemical Bank. "If interest is the time value of money, then we can think of money as the time value of information," he continues [1, p. 34]. This information becomes available only through the computer.

The application of computer technology to finance is commonly known as an Electronic Funds Transfer System, or EFTS. The EFTS is very important in today's banking. As Luckett observes, "Some writers seem to feel that there is nothing very basic in the EFTS--that its only impact will be to permit us to do what we now do, except faster and cheaper. This viewpoint is surely wrong. The EFTS is of the same quality as the change from barter to commodity money, from commodity money to paper money, and from paper money to deposit money" [14]. He continues: "In each of these cases, the technological change ushered in historical change that was not only different in degree, but different in kind." In other words, the EFTS represents discontinuous innovations--"characterized by a major change, both in terms of the new product and in terms of the behavior required of the consumer to use the new product" [4]. It would be a serious mistake for us to expect the old relations to hold following drastic technological and institutional changes.

The EFTS is usually classified into three categories, (1) the automated teller machine (ATM), (2) the point-of-sale (POS), and (3) the automated clearing house (ACH). The ATM can duplicate virtually all the routine banking services performed by human tellers. The POS records pecuniary transactions as they take place, like the conventional cash register found in all retail stores. Beyond that, the POS transfers funds instantly from the account of the payer to the acount of the payee. It simultaneously verifies balances, makes all necessary balance-sheet adjustments, and keeps a running inventory record. The ACH is somewhat different from the other two machines. It is currently used for routine and preauthorized payments, such as payrolls and utility bills. ACH has the potential for eliminating much of the paperwork involved in business-to-business transactions and processing the checks at Federal Reserve banks.

These applications of the computer in the banking industry are something new. It is believed that they have contributed to economizing on cash balances, considerably, in the last few years, and they are to become more important in the near future, as Figure 6.1 shows. Figure 6.1 shows the approximate number of ATM installations (in thousands) through recent years. This graph gives only an insight into how important these technologies might be. The "take off point" is projected to be in 1980. We might observe greater error with applying equation 5.4.F and 5.7.E to the data after 1980. As time passes, not only more machines are installed, but the existing machines are believed to be used more intensively. The machine installed by Citibank of New York already handles about 30 percent of the bank's consumer business at one half the cost of transactions handled by human tellers. Computer technology has gone so far that it has turned the customers' living rooms into bank terminals. Citibank has started to install a small computer terminal at the customer's home. This terminal is to be a substitute for the checking account and the customer can pay bills, take out a loan, and check on the balance of their account at any time [21].

One more factor that may have affected the demand for money in the United States is switching from fixed exchange rates to floating exchange rates in the early 1970s. Flexible exchange rates can induce U.S. firms and individuals to diversify their portfolio by demanding less dollars and more foreign currencies. It is true that the firms and individuals in other countries might have demanded more dollars than before, however, this foreign demand for dollars could be met by Eurdollar holdings. Thus, the U.S. reduction in the demand for dollars might not be offset by increase in demand deposits owned by foreign firms and individuals in the United States.

The combination of the factors discussed is believed to have a considerable effect on demand for money. They become more effective when they are used all together--the way the banks have adopted them.

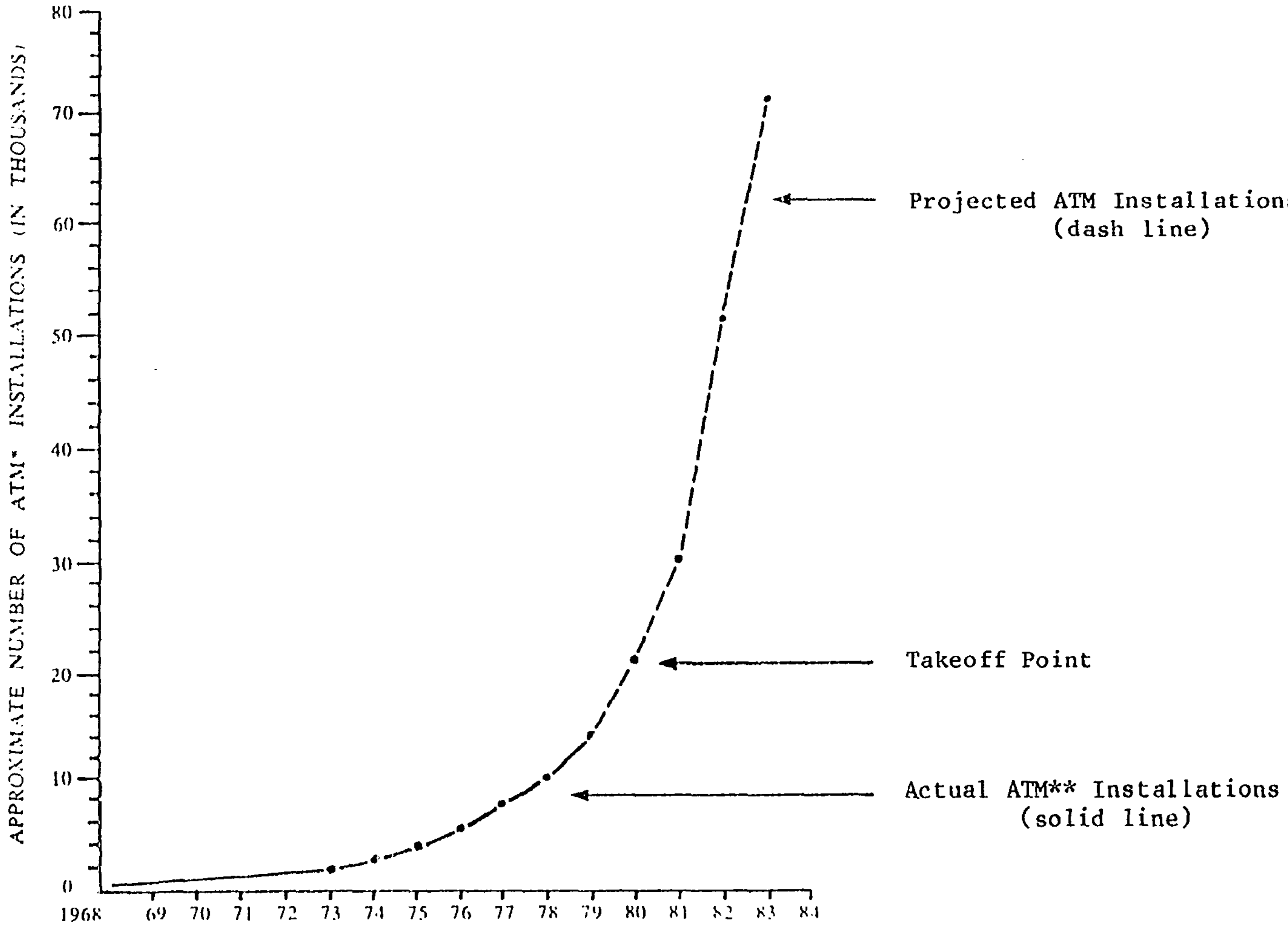

Figure 6.1. ATMs installation/order trend
(*1981-1983 yearly points are determined by applying cumulative event percentages as ranked in Table 1 to a 1980 estimate of 21,000 installations. **Includes cash-dispensing machines.)
(Source: Linda F. Zimmerman, as cited by St. John [25, p. 44])

CHAPTER VII. CONCLUSION

Although the Federal Reserve's new narrow monetary aggregates generally have better prediction performance than the old M-1, they still have large and increasing (in absolute value) cumulative percentage errors of prediction. This study was an attempt to find an aggregate and/or a different specification of the money demand equation (within a certain framework) which would result in better prediction performance. The framework for the demand equations was that of Goldfeld in "The Case of the Missing Money" [8], only slightly different in some cases.

A few equations were estimated by two different methods--namely, linear and nonlinear least squares--to show the difference in the prediction results obtained by these two methods. Since the prediction results obtained by the nonlinear method of estimation were not much different from the results obtained by the linear method, most of the equations were estimated by the linear method, which is less time consuming and less expensive than the nonlinear method.

The evaluation of the performance of different aggregates and specifications is based on their out-of-sample dynamic (cumulative) percentage errors of prediction.

All of the nominal adjustment version of the equations resulted in lower percentage errors of prediction than the real adjustment version of the equations. Adding a time variable to the exogenous variables of a few equations reduced the percentage errors (in absolute terms) and resulted in better prediction performance than the equations without the time variable.

However, combining these respecifications with redefined monetary aggregates improved the prediction results further. Adding overnight Repurchase Agreements (RPs) to M-1B improved the prediction results in two ways. First, it reduced the absolute value of the percentage error. Second, and probably more important, it resulted in fairly stable percentage errors after 1975. The percentage errors depicted an increasing trend for the period of 1974:1-1976:1. This trend may suggest that there has been a period of adjustment to a new financial era from 1974 until 1976--after 1975:4 the percentage errors show only a (roughly) constant percentage reduction in the public's cash holding. Some reasons for this possibility are given in Chapter VI--new financial instruments, sophisticated cash management techniques, institutional changes, and improved computer technology.

Moreover, subtracting all small time deposits in financial institutions, one-third of savings deposits at commercial banks, and two-thirds of savings deposits at thrift institutions resulted in an aggregate (M-1H) with very low percentage errors of prediction. This good prediction performance led to the examination of another aggregate (M-1I) constructed as the sum of M-1B, overnight RPs, two-thirds of savings deposits at commercial banks, and one-third of the savings deposits at thrift institutions. Although the percentage errors of M-1I are not as low as those of M-1H, M-1I makes more sense as a transaction related monetary aggregate than M-1H.

The behavior of the money demand equation in the second half of the 1970s raises some doubts about the accuracy of the proposition that the money demand equation is a stable equation. The authorities think of redefining money only after a long period of poor performance by the prevailing aggregate. The recent past behavior of the money demand equation may have caused some policy errors, too. Probably there are some major changes underway and there may be more to occur in the early 1980s. One should be very cautious in using a behavioral function, fitted to past data, in applying to the current or future, if he/she thinks that there are some substantial changes occurring.

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APPENDIX

Table A.1. Definition of some new monetary aggregates

Aggregate	Definition
M-1C	M-1B[a] + Overnight Repurchase Agreements (RPs)
M-1D	M-1C + Money Market Mutual Funds (MMMFs)
M-1E	M-1B + Money Market Mutual Funds (MMMFs)
M-1F	M-2[a] - small time deposits
M-1G	M-1F - all savings deposits
M-1H	M-1F - 2/3 (savings deposits at thrift institutions) - 1/3 (savings deposits at commercial banks)
M-1I	M-1C + 1/3 (savings deposits at thrift institutions) + 2/3 (savings deposits at commercial banks)

[a]Defined in Table 3.4, page 24.