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Portfolio Substitution and the Reliability of M1, M2 and M3 as Monetary Policy Indicators

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Based on a single system of equations that contains income, prices, a market rate of interest, and the components of M3, we find that M1 became highly susceptible to adjustments in the public's portfolio of liquid assets in the 1980s, and thus is unlikely to be a reliable guide to monetary policy in the future. The behavior of the broader monetary aggregates has not changed significantly from the 1970s, and both M2 and M3 are broad enough to internalize most portfolio adjustments that are likely to occur. Therefore, they are likely to be more reliable as monetary policy indicators than M1, although the analysis does not imply that either will be as reliable as M1 once was.

Last February, Federal Reserve Chairman Paul Volcker testified before the Senate Banking Committee about the Federal Reserve's 1987 plans for monetary policy. An important element of those plans consists of the target ranges for growth in the monetary aggregates. In his testimony, the Chairman reported that the Fed had reaffirmed the 5½ to 8½ percent 1987 target ranges for growth in the broader monetary aggregates, M2 and M3, that had tentatively been set in July 1986.

Volcker also stated that the Fed had decided not to set a target range for the narrow aggregate M1. Instead, it will closely monitor the behavior of M1 ". . . in light of other information, including whether or not changes in that aggregate tend to reinforce or negate concerns arising from movements in M2 and M3."[1] Then, in its July 1987 meeting, the FOMC tentatively planned not to set a range for M1 in 1988. Thus, for the time being, M1 has been given a subordinate role in the formulation and implementation of monetary policy where, traditionally, it has received greater emphasis than the broader monetary aggregates.

The downgrading of M1's role in monetary policy for 1987 reflects concern about that aggregate's continued reliability as an indicator of monetary policy. Traditionally, M1 was considered a primary policy indicator, both by the Fed and by many outside observers, in part because it had the desirable property of containing most of the media of exchange in the economy, that is, currency and checkable deposits. Since M1 offered unique transactions services, the public's demand to hold that aggregate was not highly responsive to the kinds of portfolio considerations — for example, relative interest yields and terms-to-maturity — that determine the public's demand to hold the savings-type instruments that are in M2 and M3.

Because M1 had few close substitutes, its

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behavior was not substantially affected by difficult-to-predict portfolio substitutions, and, as a consequence, movements in M1 were dominated by changes in macroeconomic variables, such as income and prices, that are the concern of Fed policy.

Chairman Volcker's testimony cited two main sources of concern about M1's reliability as a monetary policy indicator. First, deposit-rate deregulation, which began in the case of M1 with the authorization of nationwide NOW accounts at the end of 1980 and was completed in March 1986, may have made M1 more of a savings-type aggregate. In such case, M1 most likely would have lost its unique transactions character and its relationship with income and prices might thus have become less predictable. Second, this change may have led to M1's highly unusual behavior over the past two years. In both 1985 and 1986, M1 grew extremely rapidly while economic growth was moderate and inflation was subdued. In contrast, M2 and M3 behaved much more in accordance with their historical relationships with income and prices.

This paper assesses the changes in the relationship between M1 and economic developments for 1985-86, and draws out the implications for the future reliability of that aggregate as a monetary policy indicator. The paper then assesses the reliability of M2 and M3 as alternative indicators for the Fed.

Based on a vector autoregression, our basic finding is that M1 became highly susceptible to adjustments in the public's portfolio of liquid assets in the 1980s. In particular, the rapid growth in M1 in 1985-86 appears to have been related to a large reduction in the public's demand to hold small time deposits. That change in demand probably was caused by reductions in spreads of yields on small time deposits compared with those on NOW and other more liquid accounts. Movements in M1 in 1985-86 therefore had little to do with general output and price trends. Given the nascent susceptibility of M1 to portfolio disturbances, it is unlikely to be a reliable guide to policy in the future.

The broader monetary aggregates were relatively accurate monetary policy indicators in 1985-86 primarily because they were broad enough to internalize the portfolio shifts that occurred. Moreover, our analysis suggests M2 and M3 should be able to internalize most portfolio reallocations that are likely to occur. Thus, our analysis strongly supports the Fed's recent action to downgrade M1 in favor of greater reliance on M2 and M3.

The remainder of the paper is organized as follows. In Section I, we summarize the major potential problems that can develop in the public's demand to hold money as the result of the financial deregulation in the 1980s. We then go on to review the empirical evidence on the demand for money in the 1980s, focusing special attention on the problems with M1 in 1985-86, as well as the stability of M2 and M3 in this period. In Section II, we use a statistical technique called vector autoregression to analyze the behavior of M1, M2, and M3, and their reliability as monetary policy indicators. Section III presents policy implications and conclusions.

I. The Demand for the Monetary Aggregates

Over most of the period since the mid-1970s, when the Federal Reserve began to express its monetary policy in terms of the monetary aggregates, M1 has received primary emphasis. M1 consists of the outstanding stock of currency and fully checkable deposits, and thus corresponds closely to the theoretical concept of "money" in macroeconomic theory. It has been found to be subject to a reasonable degree of control by the Federal Reserve, and, until recently, has been considered a more reliable leading indicator of real GNP and inflation than the more broadly defined monetary aggregates, M2 and M3, which include liquid savings instruments that do not function as fully as part of the medium of exchange.

An important necessary condition for M1's leading-indicator characteristic is that the public's demand to hold M1 is a stable function of a small number of macroeconomic variables that are of interest to monetary policymakers — income, prices and a market interest rate. M1 traditionally has been considered more likely than M2 and M3 to

have a stable and simple demand function because of M1's unique role as the main part of the medium of exchange, and because its rate of return has not been determined by market considerations but instead has been set by regulation. Such a narrow "medium-of-exchange" aggregate had a good chance of having a stable and relatively uncomplicated demand function because it had few close substitutes. At the same time, the constancy of its own yield meant that changes in the supply of M1 had predictable effects on the interest yields on other financial instruments. The deregulation of deposit interest rates and the introduction of new liquid instruments therefore have the potential to interfere with M1's usefulness for monetary policy by making the public's demand to hold that aggregate more difficult to predict.

In cataloging the effects of such financial market changes on money demand, it is useful to distinguish between the adjustment effects during the transition period after a change and the equilibrium effects, which persist even after full adjustment has been made. For example, deregulation of yields on M1 deposits initially would cause the demand for M1 to shift up as the public pursues the more attractive yields. This shift, in turn, would cause M1 growth rates to increase temporarily, relative to any given changes in income, prices and the market rate of interest, until the new, permanently higher, level of desired M1 balances is achieved. During such transition periods, monetary policy can go off course, since it is difficult to estimate the size, speed and duration of such demand shifts while they are occurring.

However, the problems for monetary policy caused by such transition effects are likely to be temporary since once the new equilibrium level of M1 is attained, the relation of M1 growth to its underlying determinants should return to its historical norm. Since deposit rate deregulation now is complete, these transition effects, which were of primary importance earlier in this decade, no longer are major issues.

Of more immediate concern are the permanent problems deposit-rate deregulation may have caused for M1-targeting if higher yields on M1 have led the public to use M1 as a savings vehicle to a greater degree than in the past. Such a change could contaminate M1's unique transaction character and cause it to become a closer substitute for other financial instruments. As a result, the public's demand to hold M1 might have become more highly responsive to changes in the spreads between M1's own rate of return and rates paid on a wide range of other financial instruments. Shifts in investors' preferences for various maturities and liquidity characteristics also could have larger effects on M1 demand.

In general, since M1 may have become more like financial assets held for investment purposes, changes in the demand for M1 could be dominated at various times by difficult-to-predict shifts in the composition of the public's portfolio, and only incidentally by changes in the variables that are of interest to the policymaker — income and prices. Such portfolio shifts would show up both as instability in estimated M1 demand functions and as unexpected shifts in reduced-form relationships between M1 and nominal GNP.

Deposit rate deregulation also could have made M1 demand more difficult to predict by making it depend on how depository institutions respond to movements in market yields in setting their offering rates both on transactions accounts and on other time and savings deposits that are substitutes for M1. Before deregulation, the "own-rate" on M1 was fixed by government fiat, as were the yields payable on most of its close substitutes. With deregulation, the speed and degree to which banks adjust deposit rates to follow market rates determine how sensitively the opportunity cost of M1 varies with market interest rates, opening up a whole new range of uncertainties for the policymaker. For any given elasticity of M1 demand with respect to the opportunity cost of holding it, the elasticity of demand with respect to market rates will be smaller the more rapidly banks adjust their rates on M1 deposits to changes in yields on market instruments. Thus, banks' deposit rate-setting behavior helps determine the overall relationship between a change in the market rate of interest and the demand for M1.

Deposit rate deregulation can affect the broader monetary aggregates as well. A recent example is the introduction of Money Market Deposit Accounts in December 1982, which caused M2 to grow extremely rapidly relative to M3 in a transition

period that lasted for two months. The introduction into the broader aggregates of instruments with interest rates that can vary freely with market rates undoubtedly has altered the behavior of those aggregates as the general level of rates has varied over the business cycle.

However, recent deregulation most likely has had smaller permanent effects on M2 and M3 than on M1 largely because the interest rate restrictions on the broader aggregates prior to deregulation were less severe than the prohibition of the payment of interest on M1. Prior to mid-1978, all of the time and savings deposits in M2 were subject to interest rate ceilings, but those ceilings were set well above zero. Then, in mid-1978, the deregulation of M2 began in earnest with the introduction of the small denomination six-month money market certificates, which had ceilings that vary with Treasury bill rates.

TABLE 1

Growth of Monetary Aggregates
(Annual Rates)

M1 Growth

	Actual	Simulated	Error
1985 H1	11.6	10.2	1.4
1985 H2	12.1	7.8	4.3
1986 H1	12.8	7.4	5.4
1986 H2	19.1	7.8	11.3
Mean Error			5.6
Root Mean Square Error			6.7

M2 Growth

	Actual	Simulated	Error
1985 H1	8.9	9.8	−0.9
1985 H2	7.1	6.6	0.5
1986 H1	8.1	7.3	0.8
1986 H2	10.0	6.4	3.6
Mean Error			1.0
Root Mean Square Error			1.97

M3 Growth

	Actual	Simulated	Error
1985 H1	7.4	10.1	−2.7
1985 H2	6.7	7.5	−0.8
1986 H1	8.6	8.1	0.5
1986 H2	9.0	6.3	2.7
Mean Error			−0.1
Root Mean Square Error			1.97

Large time deposits in M3 have been free of interest rate restrictions since the early 1970s.

In summary, significant proportions of M2 and M3 offered interest rates that were not far below market rates even before deregulation, so these aggregates were attractive savings vehicles for individuals in the earlier period as well. Thus, a priori, we would expect deposit rate deregulation to have had a smaller impact on the nature of these aggregates. Furthermore, M3 is likely to have been affected even less than M2, since M3 already contained accounts that were free of interest rate ceilings.

Empirical Evidence on Money Demand

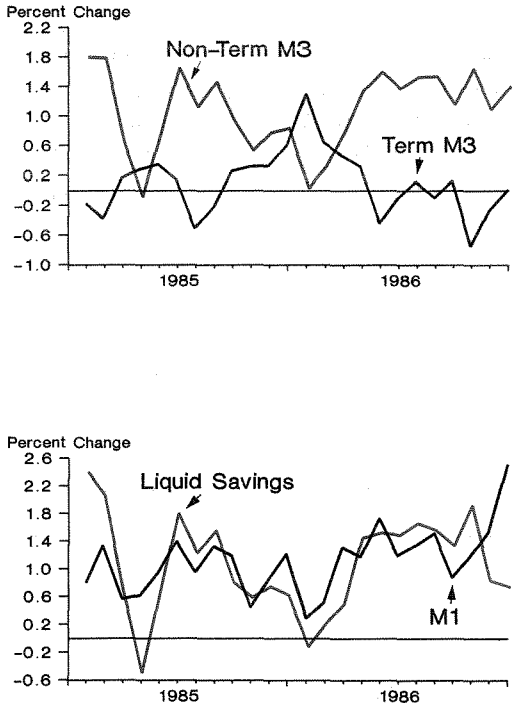
The evidence up to 1985 casts doubt on the hypothesis that the demand for M1 would be seriously affected by deregulation. When there were shifts in M1 demand (1974-76 and 1981), they were in the downward direction.[2,3] This suggests that these episodes of unusual M1 behavior occurred not as a result of deregulation, but rather because of deposit rate regulations that were still in place in a period of rapid inflation and high nominal market interest rates. Moreover, empirical tests for changes in the interest elasticity of M1 demand showed only a slight change — the elasticity had become slightly more negative.[4]

The first clear upward shift in M1 demand during the 1980s occurred over the last two years. On the surface, the timing of this shift is surprising since it occurred after deregulation was largely complete. We offer a tentative explanation for this timing below.

Table 1 shows the money demand simulations obtained from the San Francisco Money Market Model.[5] Except for the first few months in 1985, the model has consistently underpredicted M1 growth, so that the difference between the actual and simulated value of M1 has increased over time. M1 grew at an average annual rate of 13.9 percent from December 1984 to December 1986, while the model predicted mean annual growth of 8.3 percent.

The simulated value of M2 has tracked actual M2 more closely (see Table 1). For the two-year period ending in December 1986, M2 grew at an 8.5 percent annual rate, 1.0 percent more than the value predicted by the model. For the two-year period as a whole the model's simulation of M3 growth at an 8.0 percent annual rate is quite close to the actual rate of 7.9 percent.

Chart 1
Monthly Growth Rates of M3 Components



The stability of the demand for the broader aggregates in combination with the upward shift in M1 demand suggests that M1 has been adversely affected by portfolio substitutions that were internalized within the broader monetary aggregates.

Chart 1 provides a perspective on these portfolio substitutions. The upper panel shows growth rates in the components of M3 that do *not* carry terms to maturity plotted against the components of M3 that do carry terms to maturity. This distinction is based on the liquidity of financial assets, which is an important characteristic of investors' demands for alternative assets. (See the discussion "Defining the

Monetary Aggregates" in the box.) The non-term M3 components include M1, overnight repurchase agreements and eurodollars, money market deposit accounts, passbook savings accounts, and money market mutual fund shares. The term components of M3 include small denomination (less than $100,000) time deposits, large denomination time deposits, and term repurchase agreements and eurodollars. The upper panel shows that the non-term component of M3 and the term component have moved in opposite directions, that is, they have behaved as substitutes. This is true of both trend growth and of the fluctuations in the growth rates of these components over this period.

The bottom panel of Chart 1 shows growth rates of M1 — a component of non-term M3 — and of the remainder of non-term M3. This latter component, which we call liquid savings, contains the instruments in M3 that are not fully checkable, that is, instruments that are not in M1 and do not have fixed terms to maturity. (For these and other monetary definitions see the box labeled "Monetary Aggregates.") Growth in the two non-term components, M1 and liquid savings, has been positively correlated during 1985 and 1986. In other words, M1 has behaved similarly to the liquid savings instruments in M2.

Taken together, these panels suggest that the distinction between term and non-term accounts has been an important margin of substitution within instruments in M3, whereas the distinction between checkable and non-checkable deposits has not been an important consideration over the last two years. The pattern of growth in the components of M3 is consistent with the idea that M1 may have been contaminated with savings balances and that its behavior may no longer be determined by medium-of-exchange characteristics only.

II. Portfolio Substitution

The evidence in Chart 1 is consistent with the idea that M1 has taken on the characteristics of a savings aggregate, but by no means does that evidence represent a rigorous test since it covers only two years of data and does not control for factors other than portfolio substitution that are likely to affect growth in the components of M3. In this section, we formally test the proposition that M1 has become more susceptible to portfolio shifts in the deregulated environment of the 1980s by estimating a vector autoregression (VAR).

Estimating a VAR is a method of examining the relationship between a set of variables and their past values. By imposing relatively few restrictions on the dynamic relationships between the variables in the model, a VAR, in effect, allows the data to speak for themselves. Statistical tests are used to check whether past values of a given variable are significant in a particular equation. The estimated equations can then be transformed to obtain "impulse response functions" that show how the variables respond over time to various shocks, or unpredicted movements, in the variables of the system. Finally, the relative importance of different shocks for predicting future values of the variables in the system can be estimated using "variance decompositions".

The VAR we estimated includes the variables that appear in conventional M1 demand equations (M1, real personal income, RPY, the implicit consumption deflator, DEF, and the 6-month commercial paper rate, R), and, in addition, the *quantities* of monetary assets believed to be close substitutes for M1.[6] We hoped that inclusion of these quantities, in combination with a market interest rate, would enable us to capture the combined effects of portfolio considerations in the demand for M1 — including changes in relevant interest rate spreads, changes in preferences for term-to-maturity and risk, as well as any other factors that consistently cause individuals to re-allocate their portfolios across various assets. We chose to include quantities rather than interest rate spreads because the quantities are likely to pick up the effects of changes in spreads *plus* other factors such as those mentioned above.

To illustrate the last point, in April 1987 there was a large movement in M1 that cannot be attributed to changes in interest rates. M1 increased by $11 billion, apparently because individuals moved

Defining the Monetary Aggregates

In the Federal Reserve's official definitions (lefthand brackets below) of M1, M2, and M3, the rationale for distinguishing the deposits in M1 from those in the broader aggregates is that the former are fully checkable.

The distinction between M2 and M3 is based on whether a deposit or other asset was commonly used by banks as a managed liability. Thus, for example, small denomination time deposits are part of M2 because they were not managed liabilities in 1980 when the definitions were instituted. Large denomination certificates of deposit are parts of M3, but not M2, because they were used as managed liabilities.

The results in this paper suggest that deregulation has blurred these distinctions. The introduction of interest-bearing accounts in M1 (NOWs and Super-NOWs) has led individuals to transfer savings balances into these accounts, thereby blunting the distinction between fully checkable accounts in M1 and other highly liquid savings-type accounts, such as MMDAs.

In addition, the lifting of ceilings on small time deposits has meant that banks are now in a position to meet their borrowing needs by varying rates on these accounts as well as by varying rates on large time deposits. Thus, both accounts now share the same characteristics of managed liabilities.

Under these circumstances, an alternative way to distinguish these accounts is by liquidity (righthand side brackets above). Accounts that have a fixed term to maturity may behave differently from those that do not. Indeed, our empirical analysis suggests that, in the 1980s, this distinction has been more important than the distinction between checkable and non-checkable accounts as well as the prevailing distinction between managed liabilities and the other deposit accounts in M3.

Monetary Aggregates: Components and Definitions
(Billions of Dollars)

Conventional Definitions	Components	Levels as of Dec. 1986	Definitions Used in Paper
M1 ($730.5)	Currency	$183.5	M1 ($730.5)
	Demand Deposits	308.3	
	Other Checkable Deposits (includes NOWs)	232.3	
M2 ($2798.4)	Overnight RP's and Eurodollars	75.9	Non-Term M3 ($1945.1)
	Money Market Deposit Accounts	571.3	Liquid Savings ($1214.6)
NetM2 ($2067.9)	Passbook Savings Deposits	366.2	
	General Purpose & Broker/Dealer Money Market Mutual Funds	207.5	
	Small Denomination Time Deposits	853.3	Small Time Deposits ($853.3)
M3 ($3486.2)	Large Denomination Time Deposits	447.0	Term M3 ($1541.1)
NetM3 ($687.8)	Terms RP's and Eurodollars	163.8	Large Term Accounts ($687.8)
	Institution Only Money Market Mutual Funds	84.1	

funds from non-transactions accounts to pay taxes. To the extent that these funds were moved out of other accounts in M3, they should be picked up by our specification but not by a model that relied on interest rate spreads. (In theory, seasonal adjustments should remove such movements from the data. In practice, however, it is difficult to determine exactly how large such effects are likely to be.)

The specific monetary components we include, in addition to M1, are small time deposits, liquid savings, and large term accounts (see the box "Monetary Aggregates"). As will become evident, this set of monetary components permits us to analyze the important portfolio substitutions that have occurred in recent years between accounts with and accounts without terms to maturity. Further-

TABLE 2

Summary Statistics for Monetary Aggregates in VAR

Pre-Deregulation Period

Equation for:	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
Marginal Significance Levels				
RPY	.14	.22	.36	.11
DEF	.38	.24	.67	.43
R	.07	.13	.20	.36
Large Term Accounts	.01	.27	.14	.96
Small Time Deposits	.60	.00	.13	.86
Liquid Savings	.99	.89	.00	.32
M1	.23	.48	.03	.03
Other monetary components*	.56	.60	.03	.56
$\bar{R}^2$	.75	.71	.87	.32
S.E.E.	.0105	.0029	.0030	.0034

Post-Deregulation Period

Equation for:	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
Marginal Significance Levels				
RPY	.15	.95	.30	.27
DEF	.13	.73	.67	.09
R	.11	.00	.00	.01
Large Term Accounts	.33	.25	.15	.72
Small Time Deposits	.08	.00	.48	.00
Liquid Savings	.47	.19	.15	.00
M1	.04	.31	.42	.86
Other monetary components*	.07	.08	.38	.00
$\bar{R}^2$	.73	.96	.97	.49
S.E.E.	.0069	.0034	.0050	.0039

*For example, in the M1 equation, the null hypothesis is that past values of Small Time Deposits, Large Term Accounts, and Liquid Savings taken together have no influence on M1.

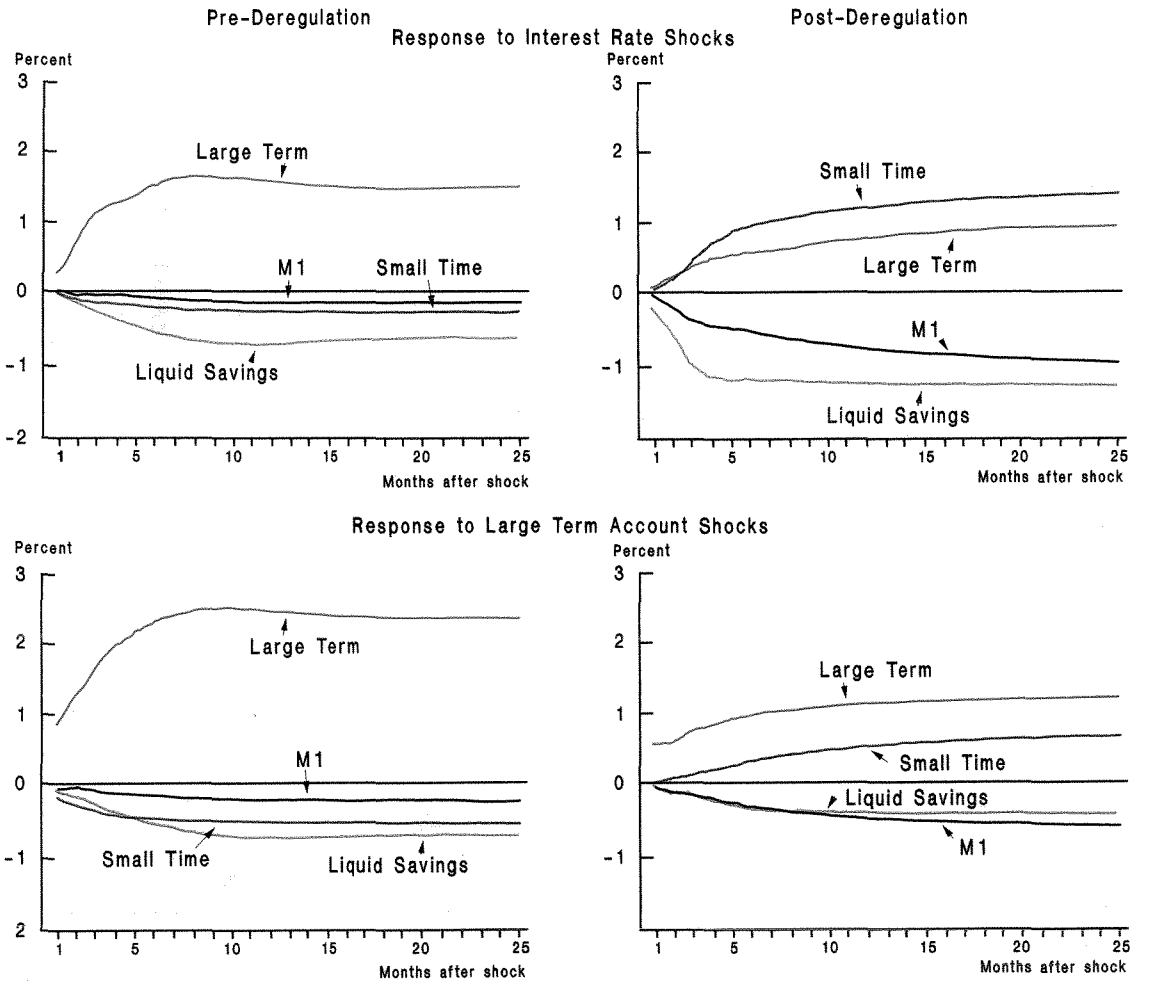
more, by aggregating these components, we can assess the effects of portfolio disturbances on the broader aggregates, M2 and M3.[7] (Note that M2 = M1 + small time deposits + liquid savings, and M3 = M2 + large term accounts.)

To analyze the effects of financial deregulation on the behavior of the monetary aggregates, we have defined two sample periods: the pre-deregulation period extending from January 1974 to June 1979 and the post-deregulation period extending from July 1981 to December 1986. The beginning date for the early period avoids the disturbances caused by the removal (in 1973) of interest rate ceilings on large time deposits. The sample ends in mid-1979 to avoid distortions from the change in Federal Reserve operating procedures later that year (see Spindt and Tarhan, 1987, for a description of the change). We have also included a dummy variable for the period up to June 1976 to capture the well-known downward shift in M1 demand over that period (see Judd and Scadding, 1982).

In the later sample, we omit the first six months of data for 1981 to avoid confusing the one-time portfolio reallocations that may have followed the introduction of nationwide NOW accounts with the interactions that may have occurred once the initial

Chart 2

Impulse Response Functions - Components of M3 in Levels



adjustment was complete. We also have included constant dummy variables for the months from December 1982 to February 1983 to take account of the one-time portfolio re-allocation following the introduction of MMDAs and Super-NOWs.

All variables are included as the first difference of logs. We use Sims' (1980) Chi-square test to determine the appropriate lag length for the VAR over both sample periods. Our tests reveal that in both samples a lag length of 2 months is statistically indistinguishable (at a 5 percent significance level) from lag lengths of 3 to 5 months.

Empirical Results

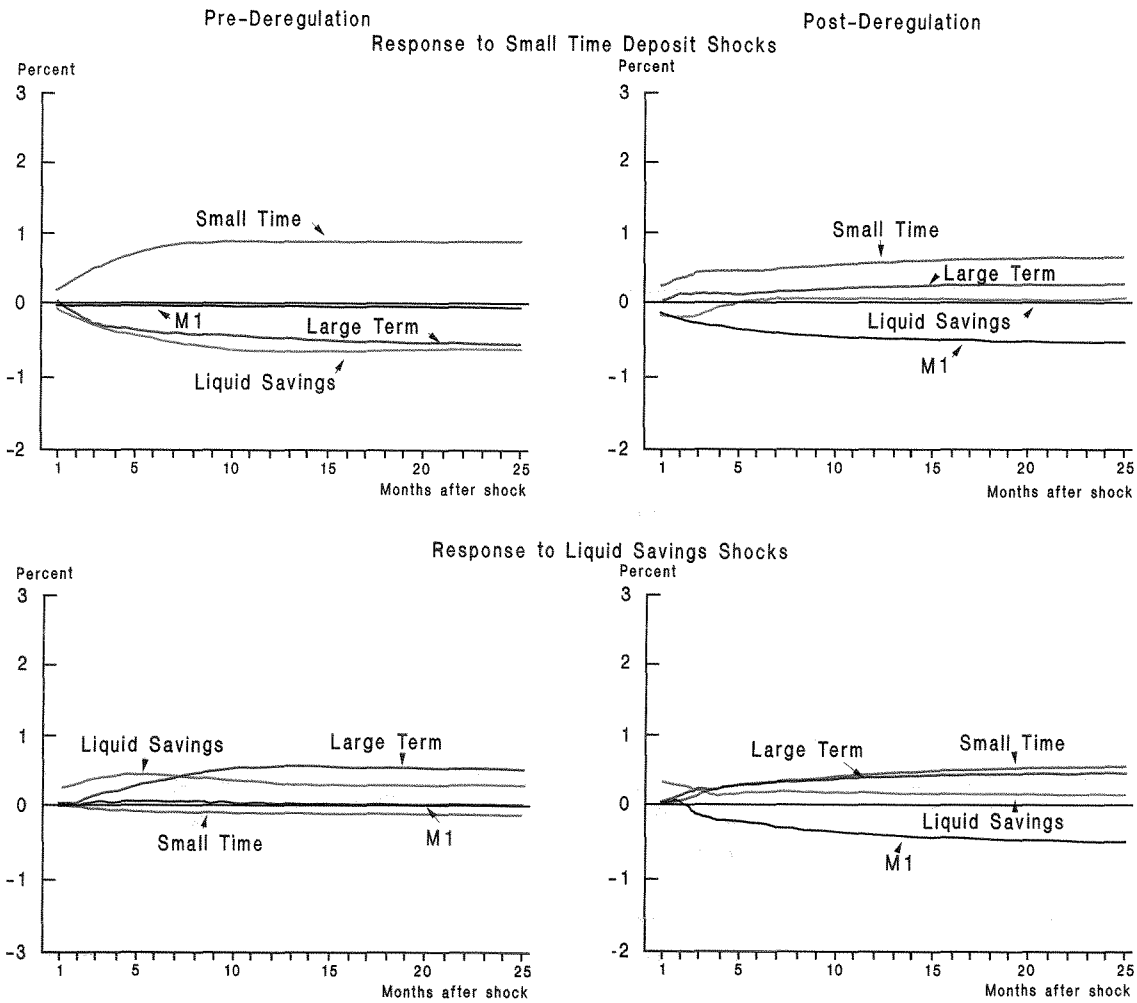
M1 and the Other Components of M3

The results from the VAR support the hypothesis that deregulation has changed the nature of the monetary aggregates. They are consistent with M1 having become more like savings-type assets in the period of deregulation, and hence having lost much of its transactions character.

Table 2 shows summary statistics from the estimated equations for the monetary components over the two sample periods. Abbreviations for the mon-

Chart 3

Impulse Response Functions –
Components of M3 in Levels



etary variables are explained in the box "Monetary Aggregates." The marginal significance levels indicate which variables are important in predicting future values of the various components. According to convention, a significance level less than 0.05 suggests that past values of that variable *do* have an impact on the dependent variable.

In the post-deregulation period, past values of both small time deposits and liquid savings individually provide statistically significant information about M1. By contrast, during the pre-deregulation period, none of the other monetary components provides significant information about M1. For each component of M3 we also tested whether the remaining components of M3 taken together provide statistically significant information about future values of that particular component. For M1, the answer is yes after deregulation, but not before. There is evidence that the same is true for large term deposits and small time deposits, although there the results are weaker. (Correlations between the residuals obtained from the VAR, that is, the prediction errors in the equations, are shown in Table B1 of Appendix B.)

These results show that, in the post-deregulation period, movements in the various components of M3 (with the exception of the liquid savings component) are more closely related to one another than before — even after the effects of past changes in income, prices, and a market rate of interest have been taken into account.

The impulse response functions in Charts 2 and 3 show what typically happens to the levels of M1, liquid savings, small time deposits, and large term accounts over time when there is an unpredicted increase in selected variables, taking into account the full dynamic interactions estimated in the VAR. These responses are plotted in terms of the percent deviation of the responding variable from its initial level in response to a one-standard deviation change

TABLE 3

M1 Variance Decomposition

(Percentage Points)

Pre-Deregulation Period

Months Ahead	Forecast Standard Error	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	.292	2	7	0	2	1	2	87
1	.328	4	6	3	2	1	2	82
3	.333	4	6	3	3	1	3	80
6	.337	4	6	4	3	1	3	78
12	.338	4	6	4	4	1	3	78

Post-Deregulation Period

Months Ahead	Forecast Standard Error	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	.331	3	1	1	3	12	4	76
1	.388	3	11	13	3	12	3	55
3	.484	2	11	24	3	10	14	36
6	.516	4	11	24	6	10	13	32
12	.539	4	11	25	7	9	13	30

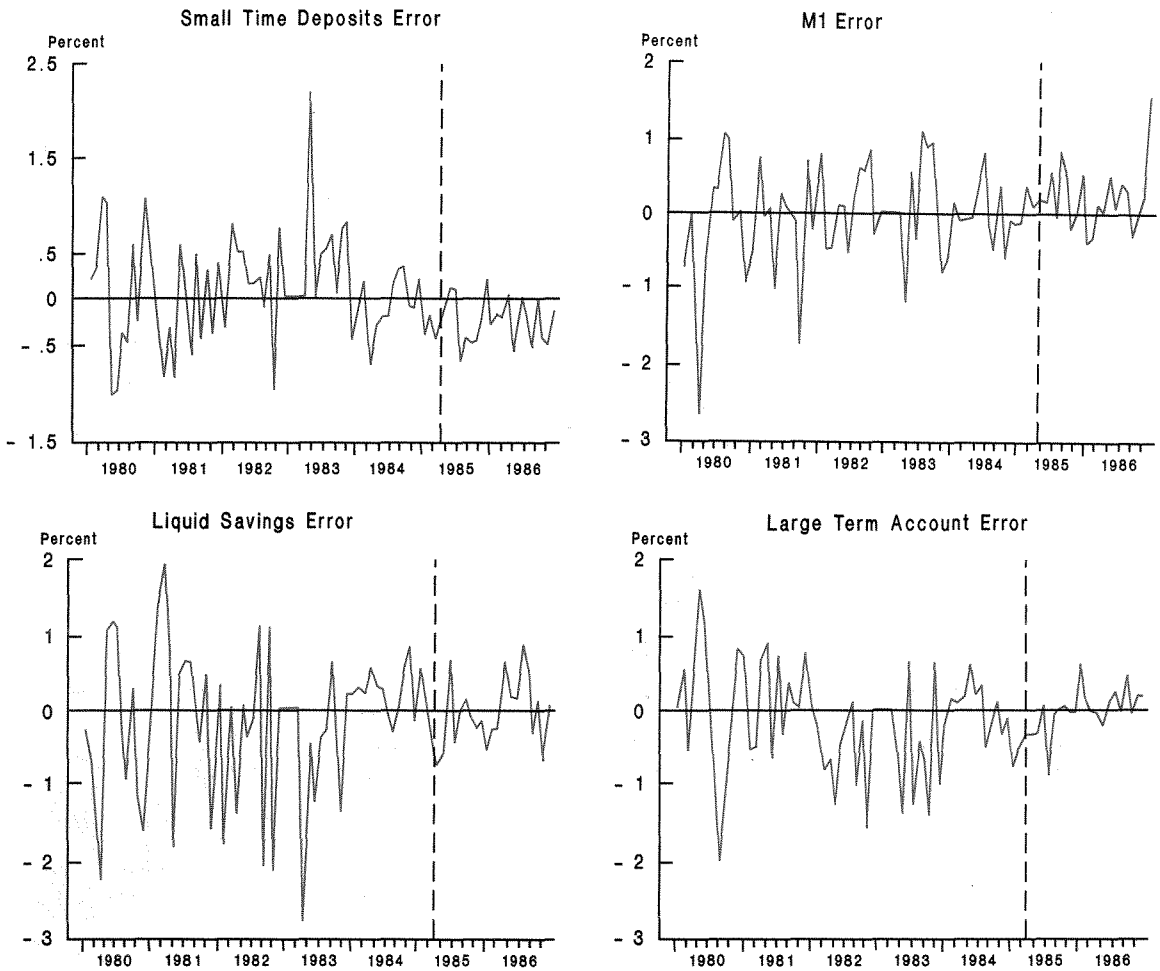
in the "shock" variable. Since our focus is on substitutions between different monetary components, we show the effect of interest rate shocks and shocks to the monetary components (large term accounts, small time deposits and liquid savings) only.[8]

The portfolio-substitution characteristics of M1 across the two periods are strikingly different. Consider, for example, the effects of interest rate shocks. Panel (a) of Chart 2 shows that in the pre-deregulation period, an unanticipated increase in the interest rate had only a small negative effect on the level of M1. In the second period, by contrast, the effect is noticeably larger, with the decline in M1 continuing for at least two years following the interest rate shock.

The response of M1 to shocks to the other monetary components also is markedly different in the two periods. In the pre-deregulation period, M1 stays close to its original level after a shock to any of the components of M3. In the post-deregulation period, by contrast, M1 decreases immediately following shocks to both large term accounts and small time deposits, and then keeps declining for approximately a year before stabilizing at the new lower level. M1 increases contemporaneously with a liq-

Chart 4

Errors in Projecting Growth Rates
of M3 Components 1980:1 - 1986:12



uid savings shock but then falls and keeps declining for nearly a year as well.

The impulse response functions suggest that the reactions of M1 to portfolio shocks have undergone a number of changes after deregulation. M1 reacts noticeably more strongly to innovations in the market interest rate, large terms accounts, liquid savings, and small time deposits in the 1980s than in the pre-deregulation period. In the later period, shocks to large term deposits and small time deposits led to large, permanent changes in the level of M1; these shocks do not appear to have had a significant effect on M1 in the earlier period. Moreover, in the 1980s, M1 and liquid savings accounts react in the same direction and with the same dynamic pattern to interest rate and large term deposits shocks. Such behavior is much less evident in the 1970s.

The behavior of the term components, namely small time deposits and large term accounts, also shows a noticeable difference across the two periods. In the pre-deregulation period, these two components tended to move in opposite directions. In the post-deregulation period, they move in the same direction, which is usually opposite the movement in liquid savings and M1. The change in the behavior of small time deposits probably reflects the removal of the interest rate ceilings on them, which has allowed banks to use these accounts as a managed liability in the post-deregulation period. Small time deposits therefore behave more like the managed liabilities (such as, large certificates of deposit) in the large term accounts component of M3. As discussed below, this result has important implications for the stability of the broader monetary aggregate, M2.

Table 3 presents the variance decompositions for M1 over the two sample periods.[9] In the pre-deregulation period, innovations to M1 itself accounted for around 80 percent of the variance of the error in predicting M1. The interest rate variable accounted for no more than 4 percent of the forecast error variance of M1 at any forecast horizon, while the three monetary components — large term accounts, small time deposits and liquid savings — taken together accounted for only 5 percent of the M1 forecast error variance contemporaneously and did not account for any more than 8 percent at any forecast horizon. This situation is considerably different after deregulation. After the first few months, M1 accounts for only one-third of its own forecast error variance, while interest rate innovations account for around one-fourth. The other three components of M3 account for close to 20 percent of the contemporaneous forecast error variance of M1, and close to 30 percent as the horizon lengthens.

This evidence supports the hypothesis that under deregulation M1 has lost some of its unique characteristics as a transactions aggregate and has taken on the characteristics of a savings-type aggregate. M1 now appears to be much more susceptible to portfolio shocks than it was prior to deregulation and it responds to these shocks much more like the savings-type assets in liquid savings. (Judd and Trehan,

TABLE 4

M1 Variance Decomposition
1981:7 - 1985:3

(Percentage Points)

Months Ahead	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	17	0	9	7	16	4	46
1	13	6	27	5	12	4	31
3	12	5	39	4	8	12	20
6	16	5	38	4	8	11	18
12	17	5	37	4	7	11	18

1987, show that this similarity in response is due to the similarity between NOW accounts and liquid savings.) Moreover, it appears that the term/non-term distinction between monetary components, which is important for investors in choosing among savings-type assets, has become more significant than the transactions/nontransactions distinction.

The 1985-86 Episode

In Section I, we presented evidence showing that structural money demand equations systematically underpredicted M1 in April 1985 through the end of 1986. To be sure that the VAR results are not dominated by developments in 1985-86, we estimated the VAR over the period from July 1981 to March 1985. The M1 variance decomposition from the shorter period (Table 4) shows that the effect of innovations to the other monetary aggregates is similar to that obtained from the larger post-

Chart 5
Selected Interest Rate Differentials

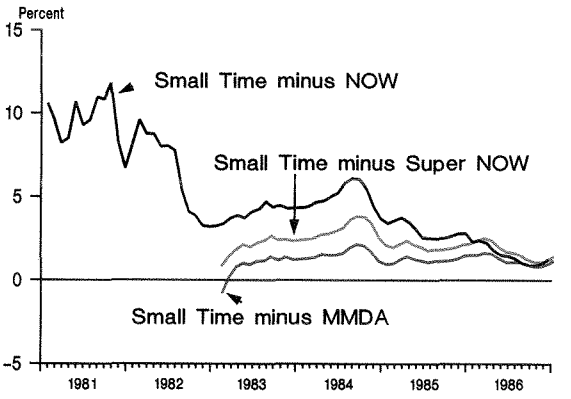


TABLE 5

M2 Variance Decomposition

(Percentage Points)

Pre-Deregulation Period

Months Ahead	Forecast Standard Error	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	.156	5	0	0	35	2	33	23
1	.200	10	0	16	28	3	22	21
3	.251	7	7	17	32	3	16	19
6	.277	5	7	22	33	2	13	18
12	.293	5	7	22	32	2	13	18

Post-Deregulation Period

Months Ahead	Forecast Standard Error	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	.170	0	4	9	3	0	66	17
1	.205	4	3	30	2	2	46	13
3	.240	7	2	36	2	6	35	11
6	.252	9	3	35	2	6	34	11
12	.253	9	4	35	2	6	34	11

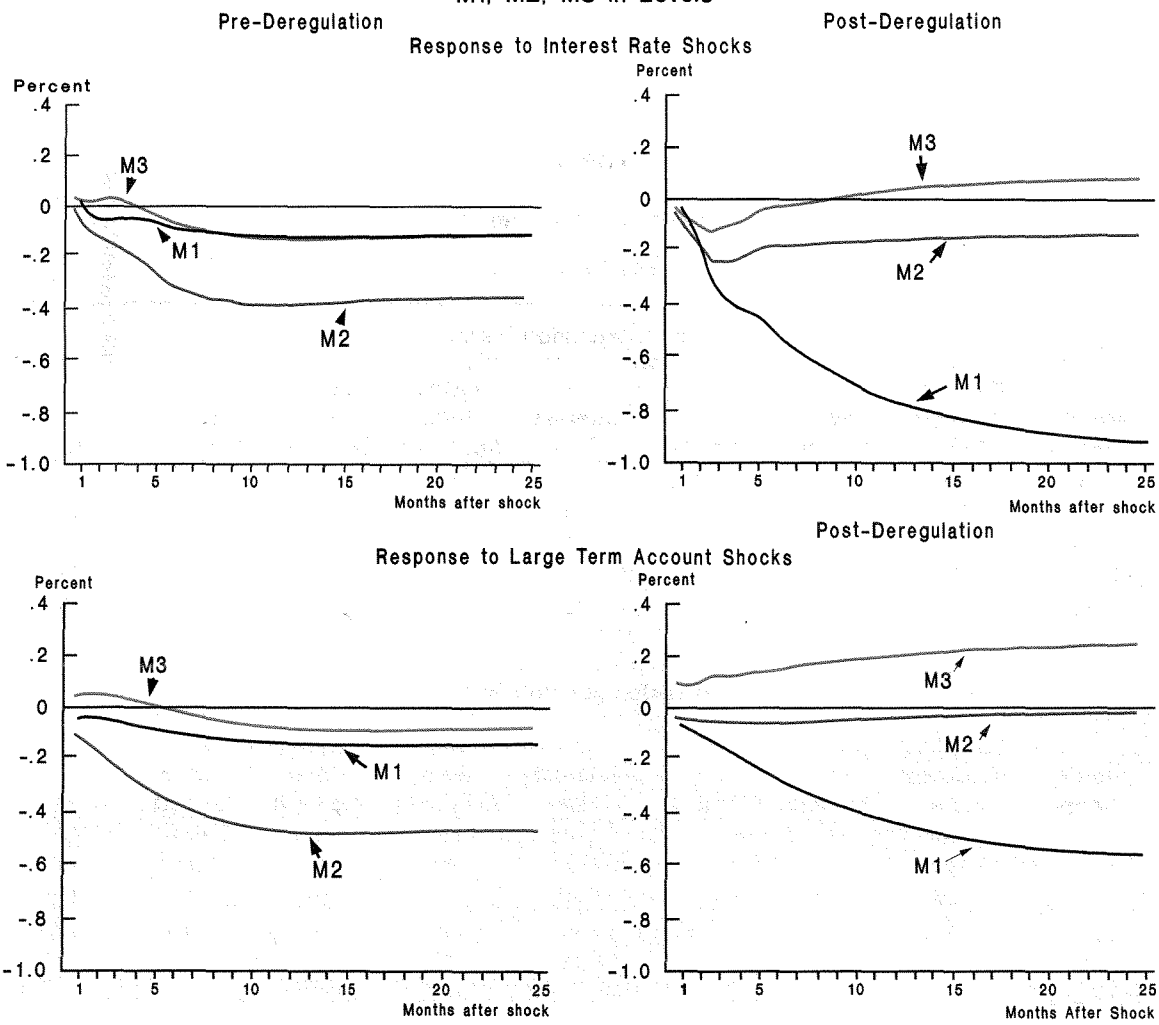
deregulation sample. Thus, M1 was sensitive to innovations in the other monetary aggregates even before 1985.

On the surface, the apparent sensitivity of M1 to changes in the other components of M3 throughout the 1980s contradicts the evidence from the structural M1 demand equations discussed above. If M1 had been contaminated with savings-type balances throughout the 1980s, why is there so little evidence of upward shifts in M1 demand until 1985? An answer is provided by Chart 4. This chart shows successive twelve-month-ahead errors made in predicting the growth rate of the monetary components M1, liquid savings, small time deposits, and large term accounts using the equations from the VAR and assuming actual values for the righthand-side variables. The projections for each year were based on the model estimated over the prior five years.

The panel in the top left corner shows the errors in predicting small time deposits. While the errors made by the equation are relatively large prior to 1985, they tend to be scattered around zero. That is, the errors do not appear to be systematically positive or negative.[10] However, the errors are almost uniformly negative beginning in the second quarter of 1985 (indicated by the dashed vertical line). This is

Chart 6

Impulse Response Functions -
M1, M2, M3 in Levels



also the period when the demand for M1 equation began to underpredict M1 growth by a wide margin. Moreover, the overprediction of small time deposits in 1985-86 is consistent with the underprediction in M1 demand, given the negative response of M1 to an innovation in small time deposits shown earlier in the M1 impulse response functions. The bottom two panels of the chart show that there are no systematic errors in predicting liquid savings or large term accounts.

The results in Chart 4 provide a resolution of the apparent contradiction between the M1 demand results and the VAR results. It appears that M1 demand did not show sustained upward shifts related to deregulation prior to 1985 despite having been contaminated with savings-type balances because there were no large shocks to the monetary components prior to 1985. In other words, although the potential for instability in M1 had been increased by deregulation, actual instability did not show up until sizeable shocks actually occurred.

This evidence leaves open the question of why the large shocks to M1 occurred in 1985-86, after deregulation was largely complete. A plausible hypothesis relates the instability to declines in the spreads between yields on M1 and those on close substitutes. As shown in Chart 5, these spreads have declined sharply since the nationwide introduction of NOWs in 1981; the substantial drop in market rates relative to rates on NOWs and Super-NOWs beginning in the latter half of 1984 brought these spreads to all-time lows. The public may have shifted nontransactions balances from small time deposits into M1 in response to the decline in the yield on less liquid M1 substitutes relative to yields on NOWs.

Some analysts have argued that the very sharp response of M1 to this decline in yield implies that

TABLE 6

M3 Variance Decomposition

(Percentage Points)

Pre-Deregulation Period

Months Ahead	Forecast Standard Error	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	.119	10	0	5	8	3	43	30
1	.131	14	2	4	9	2	39	29
3	.149	14	6	5	9	2	40	23
6	.166	12	7	12	11	2	34	21
12	.175	11	7	14	12	3	31	21

Post-Deregulation Period

Months Ahead	Forecast Standard Error	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	.158	0	1	4	33	0	49	13
1	.176	1	1	11	27	6	41	12
3	.199	2	4	16	25	9	32	12
6	.214	3	6	18	22	9	32	11
12	.218	3	7	19	22	9	31	10

M1's interest elasticity has increased. (See Kretzmer and Porter, 1986.) Although this may be the case, it is too soon to tell. If the public were transferring balances to M1 because the yield differential earned for close cash management has become very small, the rapid growth in M1 may represent a transitional adjustment rather than a permanent change in the interest rate elasticity of M1 demand.[11] Indeed, the long run elasticity of M1 demand may even have declined: for money holders who have made the choice not to manage M1 balances actively, a small change in the yield on NOW accounts versus, say, the yield on small time deposits, would have little effect on their demand for M1.

The fact that two quite different interpretations of the 1985-86 episode are possible illustrates the recent nature of the "problems" with M1 demand, problems that do not allow a reliable estimate of the complex structural M1-demand relationships to test alternative hypotheses. Consequently, it will continue to be difficult to interpret movements in M1 in the foreseeable future.

M2 and M3

The analysis so far has focused on the interactions between M1 and the other components of M3. It also is of interest to examine what these interactions imply for the behavior of the broader monetary aggregates, M2 and M3, since the Fed established target ranges for those aggregates. Our results suggest that portfolio disturbances that disrupt the behavior of M1 do not tend to disrupt M2 and M3 as much because these other aggregates are broad enough to internalize the shocks.

We use the VARs shown in Table 2 to obtain results in terms of M2 and M3. This involved aggregating the impulse response functions for the various components obtained from the VAR and then constructing variance decompositions. The procedure followed is best illustrated by focusing on a specific case, say the response of M2 to an interest rate shock. Since the model is estimated in growth rates and since the various components of M2 are of different sizes in dollar levels, aggregation requires the use of weights for the growth rates of each of the components (M1, small time deposits, and liquid savings). The weight used for each component of M2 was the average ratio of the level of that component to the level of M2 over the sample period. The response of each of the 3 components of M2 to an interest rate shock was then multiplied by the corresponding weight and the resulting terms added to obtain the response of M2 to an interest rate shock. The same procedure was repeated to obtain the response of M2 to the other shocks to the system. The M2 forecast error variance decomposition was obtained from these responses in the usual manner.

Charts 6 and 7 present the effect of unexpected movements in interest rates, large term accounts, small time deposits, and liquid savings on the monetary aggregates M1, M2 and M3. As shown in Chart 6, prior to deregulation, an interest rate shock led to a permanent decrease in the level of all three aggregates. The decrease in the level of M2 was the largest, while M1 and M3 decreased by smaller, and roughly equal amounts. After deregulation, M1 decreases the most, while M3 actually returns to its pre-shock level. M2's post-deregulation response is only slightly smaller than its pre-deregulation response.

Second, the charts show that post-deregulation, M2 and M3 tend to move closely together in response to a shock to any of the monetary components. This is not surprising in view of our earlier demonstration that in the post-deregulation period, the responses of large term accounts to the portfolio innovations are similar to the responses of small time deposits.

The charts also show that the sensitivity of M1 to the other portfolio shocks has increased in the 1980s over the pre-deregulation period more than that of M2 and M3. Moreover, over the post-deregulation period, the response of M1 to any kind of innovation is substantially larger than the response of either M2 or M3.

Tables 5 and 6 present the standard error of the VAR forecasts and the variance decompositions for M2 and M3 respectively.[12] Table 5 shows that the error in predicting M2 more than a month into the future actually has declined after deregulation. However, the standard errors of the M1, liquid savings and small time deposit forecasts are all higher after deregulation. At a 3-month forecast horizon, for example, the standard error of the M1

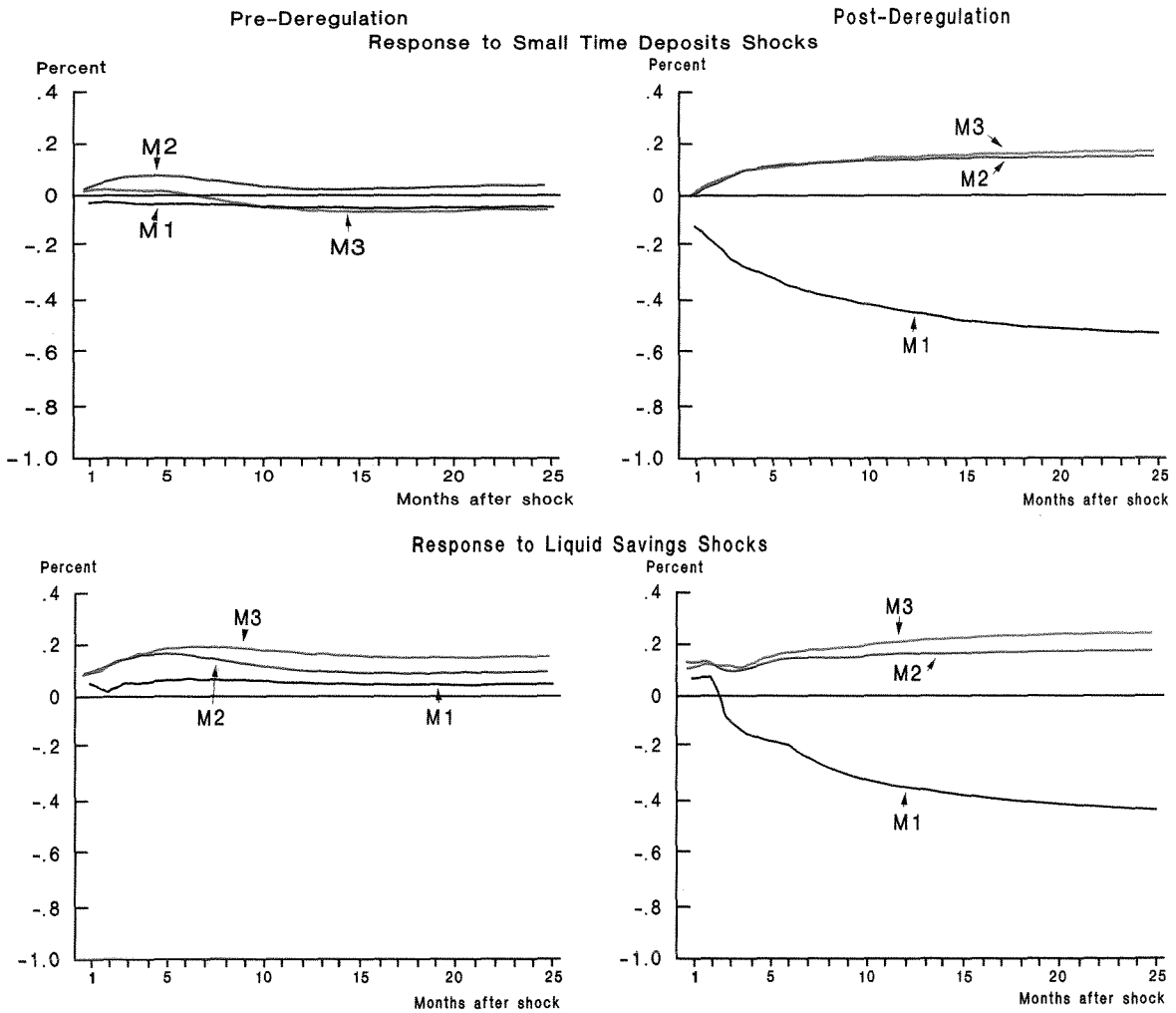
forecast was 0.33 prior to deregulation and 0.48 in the 1980s (see Table 3). The corresponding numbers for liquid savings are 0.48 and 0.78 and for small time deposits, 0.42 and 0.59. Thus, M2 has become easier to predict after deregulation not because its components are more "well-behaved", but because the unpredictable changes in its components tend to offset each other more than they did prior to deregulation.

By contrast, Table 6 shows that the forecast error variance of M3 has increased after deregulation. At the 3-month forecast horizon, for example, this variance has increased from 0.15 to 0.20. Underlying this is a substantial increase in the forecast error variance of large term accounts, which (at the 3-month horizon) has increased from 0.75 in the pre-deregulation period to 1.14 in the post-deregulation period. Notice also that the variance of the errors in predicting M3 is close to the variance of the errors in predicting M2 after deregulation, whereas earlier the former was noticeably smaller.

Our results suggest that M2 and M3 are about equally robust in the face of portfolio shocks. However, M2 traditionally has been preferred over

Chart 7

Impulse Response Functions - M1, M2, M3 in Levels



M3 on the grounds that M3 includes banks' managed liabilities, such as large certificates of deposit. (See, for example, Gramley, 1986.) Because very close substitutes for large term accounts exist in the credit market — such as commercial paper — it is argued that the demand for large term accounts is likely to be relatively unstable. As a result, movements in M3 are not likely to provide any information that is useful for policy purposes. Moreover, it is argued that since the instruments in M2 are not managed liabilities, that aggregate is less likely to be adversely affected by substitutions with credit market instruments.

However, the impulse response functions shown in Charts 2 and 3 contradict the latter assertion. They suggest that there is little difference in the behavior of small denomination time deposits (which are in M2) and large term accounts. This result is confirmed by a survey conducted by the Federal Reserve Bank of New York between November 1986 and January 1987 that concluded that "To banks, consumer CDs (what we have called small time deposits) are an alternative to funding through wholesale deposits" (our large time deposits).[13,14]

To summarize, our analysis of the conventional monetary aggregates suggests that deregulation appears to have had the greatest impact on M1, and that changes in the behavior of M2 and M3 have been relatively small. M1 appears to have become more susceptible to portfolio shifts, but these shocks to M1 generally are represented by portfolio re-allocations within the broader aggregates. In addition, M2 has become easier to predict in the post-deregulation period, even as its components have become more difficult to predict.

III. Policy Implications

Our results support the FOMC's decision to drop M1 from the set of variables being targeted. The increase in the degree of substitutability between M1 and other other components of M3 implies that the behavior of M1 is likely to be dominated by portfolio considerations, at least over the short run. Consequently, movements in M1 are not likely to provide useful information about variables such as prices and income, which are of interest to policymakers. Moreover, our results suggest that M2 and M3 are not as susceptible as M1 to being disturbed by portfolio shifts because they are broad enough to internalize most of those shifts. Thus, our results support the FOMC's decision to continue to establish target ranges for M2 and M3.

If M2 and M3 were the aggregates of choice, is there any evidence that favors greater emphasis on one rather than the other? Some analysts have argued that M2 is clearly superior for monetary policy purposes because M3 includes instruments that are used by banks as managed liabilities. Our results suggest no basis for preferring one over the other since small time deposits, which are in M2, now appear to be used by banks much like the managed liabilities in M3.

Appendix A

Definitions of Variables

Note to Table 1

CPRT	=	three-month commercial paper rate
DDLBL	=	second difference in the log of total loans of commercial banks, including loans sold to affiliates, and adjusted for the introduction of international banking facilities.
LM1	=	log of M1
LM2D1F	=	log of the non-M1 component of M2
LM3D1F	=	log of the non-M1 component of M3
LP	=	log of personal consumption expenditures deflator
LY	=	log of nominal personal income
TIME	=	1, 2, . . . 12 during January 1981 through December 1981.
TIME2	=	the square of TIME
TIME3	=	the cube of TIME
TIMEDR	=	1,2, . . . 13 during December 1982 through December 1983, zero elsewhere.
TIMEDR2	=	the square of TIMEDR

LM1 = A0 + A1*DDLBL + A2*(LY-LP)
+ A3*LP + A4*CPRT
+ A5*TIME + A6*TIME2
+ A7*TIME3 + A8*($LM1_{t-1}$ − LP)

A0	A1	A2	A3	A4	A5	A6	A7	A8
−0.0009	0.23	0.099	1.00	−0.00195	0.0023	−0.0005	0.00002	0.88
(0.008)	(2.96)	(5.31)		(−7.81)	(1.43)	(1.38)	(1.14)	(47.30)

$\bar{R}^2$ = 0.99

SE = 0.0045

DW = 1.77

RESTRICTIONS: A3 = 1.00

Sample Period: August 1976 - December 1984

LM2DIF = C0 + C1*CPRT + C2*LY + C3*TIMEDR + C4*TIMEDR2

C0	C1	C2	C3	C4	C5
−0.76	−0.0076	1.006	0.0075	−0.00028	−.00000529
(−1.90)	−3.122)	(19.31)	(2.05)	(−.418)	(−.154)

$\bar{R}^2$ = 0.999

SE = 0.0032

DW = 1.96

AUTO1 = 1.43 (17.32)

AUTO2 = −0.47 (−5.64)

RESTRICTIONS: Coefficients C1 and C2 estimated with a second order Almon distribution over lags t to t − 14 and t to t − 8, respectively, where the far end-point is tied to zero. Reported coefficients are for the sums of the lag distributions.

Sample Period: August 1976 - December 1984

LM3DIF = D0 + D1*CPRT + D2*LY + D3*TIMEDR + D4*TIMEDR2

D0	D1	D2	D3	D4	D5
−1.71	−0.007	1.19	0.000084	0.000081	−0.0000046
(4.80)	(−2.93)	(24.0)	(0.027)	(0.1333)	(−0.1511)

$\bar{R}^2$ = 0.0999

SE = 0.0026

DW = 1.97

AUTO1 = 1.53 (18.92)

AUTO2 = −0.55 (−6.45)

RESTRICTIONS: Coefficients D1 and D2 estimated with a second order Almon distribution over lags t to t − 14 and t to t − 8, respectively, where the far end-point is tied to zero. Reported coefficients are for the sums of the lag distributions.

Sample Period: August 1976 - December 1984

Appendix B

Table B1

Correlation Matrix of Residuals from VARS in Table 2

Pre-Deregulation Period

	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
Real Income	1.00	−.38	−.10	.07	−.08	.31	.13
Prices		1.00	.01	−.01	.03	−.24	.19
Interest Rate			1.00	.28	−.06	−.12	.03
Large Term Accounts				1.00	−.61	−.30	−.11
Small Time Deposits					1.00	−.12	.01
Liquid Savings						1.00	.19
M1							1.00

Post-Deregulation Period

	Real Income	Prices	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
Real Income	1.00	−.49	−0.12	−.10	.12	−.08	.18
Prices		1.00	.04	−.06	.22	−.01	−.02
Interest Rate			1.00	.10	.22	−.42	−.11
Large Term Accounts				1.00	.01	−.13	−.21
Small Time Deposits					1.00	−.54	−.30
Liquid Savings						1.00	.34
M1							1.00

Table B2
M1 Variance Decomposition

Ordering: M1, Liquid Savings, Small Time Deposits, Large Term Accounts, R, DEF, RPY

Pre-Deregulation

Months Ahead	Real Income	Price	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	-	-	-	-	-	-	100
1	5	0	3	0	0	0	91
3	5	1	3	0	0	2	88
6	5	1	3	1	1	2	86
12	5	1	3	1	1	2	86

Post-Deregulation

Months Ahead	Real Income	Price	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	-	-	-	-	-	-	100
1	3	3	5	1	7	7	73
3	4	2	22	3	17	5	47
6	7	2	21	5	18	5	42
12	9	2	22	6	19	4	39

Table B3
M2 Variance Decomposition

Ordering: M1, Liquid Savings, Small Time Deposits, Large Term Accounts, R, DEF, RPY

Pre-Deregulation

Months Ahead	Real Income	Price	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	-	-	-	0	29	29	42
1	5	0	11	1	27	27	29
3	4	2	9	6	29	26	24
6	4	2	10	13	27	22	22
12	4	2	10	16	26	21	22

Post-Deregulation

Months Ahead	Real Income	Price	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	-	-	-	0	28	35	37
1	5	0	17	1	20	29	27
3	9	1	28	1	15	22	24
6	10	2	29	1	16	20	21
12	10	3	29	1	16	20	21

Table B4

M3 Variance Decomposition

Ordering: M1, Liquid Savings, Small Time Deposits, Large Term Accounts, R, DEF, RPY

Pre-Deregulation

Months Ahead	Real Income	Price	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	-	-	-	49	0	11	39
1	4	2	2	45	0	13	34
3	13	2	3	35	2	18	26
6	12	2	6	34	3	20	24
12	11	2	6	36	3	19	24

Post-Deregulation

Months Ahead	Real Income	Price	Interest Rate	Large Term Accounts	Small Time Deposits	Liquid Savings	M1
0	-	-	-	50	15	21	14
1	3	0	6	41	20	18	12
3	3	3	12	33	18	16	14
6	3	4	16	30	20	14	12
12	4	4	16	30	21	13	12

FOOTNOTES

1. Testimony of Paul A. Volcker, Chairman, Board of Governors of the Federal Reserve System, before the Committee on Banking, Housing and Urban Affairs, United States Senate, February 19, 1987, pg. 26. Also see, Board of Governors of the Federal Reserve System, "Monetary Policy Report to Congress Pursuant to the Full Employment on Balanced Growth Act of 1978," February 19, 1987.

2. See Keran (1983), Judd (1983), Judd and Motley (1984).

3. Disinflation seems to have caused greater problems than did deregulation for using M1 as an intermediate target of monetary policy. Disinflation after 1980 induced declines in nominal interest rates that led to temporary decreases in M1 velocity that contrasted with its steady upward trend in the preceding two decades. In fact, disinflation appears to account for all of the net reduction in M1 velocity in 1981 through 1983. Estimates using the San Francisco Money Market Model implied an M1 velocity growth trend of 0.8 percent per year in steady state, that is, when interest rates and inflation are constant and real GNP is advancing at its long-run potential rate of 3 percent. From the fourth quarter of 1980 to the fourth quarter of 1983, M1 velocity declined at an annual rate of 0.5 percent. Under the assumption that the expected inflation rate in any given month is equal to actual inflation over the previous twelve months, the coefficients in the model suggested that disinflation reduced the annual growth rate of M1 velocity by 1.7 percentage points in 1981 through 1983. Thus, without the disinflation that occurred in those years, M1 velocity would have increased at a 1.2 percent rate — close to its steady state trend.

Of course, these velocity declines would not have caused problems for monetary policy had they been anticipated. Unfortunately, they did seriously complicate the setting of monetary targets because, as often is the case, disinflation proceeded in unpredictable "fits and starts".

4. See Mehra (1986).

5. These simulation results rest on movements in the conventional money demand arguments of real income, an aggregate price index, and a nominal market rate of interest. As shown in Appendix A, the M1 equation also includes the growth in bank loans as an explanatory variable, but this non-traditional argument has little effect on the simulation results presented in the table. See "A Model of the Money and Bank Loan Markets," Federal Reserve

Bank of San Francisco, April 1987.

6. A similar model is estimated in Trehan and Walsh (1987). That model does not include small time deposits and liquid savings, but does include a forward rate of interest.

7. Even though Institution only Money Market Mutual Funds are more liquid than time deposits, we did not remove them from large term deposits to include them in liquid savings. Doing so would mean that we would no longer be able to aggregate the various components in a straightforward manner to obtain M2 and M3. The other alternative, including these accounts as a separate variable in the VAR, was rejected because it would increase the number of variables in the system without yielding any further insights.

8. The results were calculated under the following "ordering" of the model's variables: RPY, DEF, R, large term accounts, small time deposits, liquid savings, and M1. The ordering imposed upon the variables is a way of transforming the residuals from the VAR so that they can be interpreted as disturbances to specific variables in the system. This transformation is necessary because the residuals from the VAR tend to be correlated with each other. Consequently, the data can only be interpreted after the researcher has chosen some method of determining which variable is the causal factor behind the observed correlations.

By placing income first in our ordering, we are assuming that the entire contemporaneous correlation between unpredicted movements in income and other variables in the system is due to shocks to income. In other words, we assume that a shock to any of the other variables has no contemporaneous impact on income. Next, the entire contemporaneous correlation between DEF and the remaining variables in the system is assumed to be due to shocks to DEF. Similarly, while shocks to the interest rate have a contemporaneous impact on the monetary components in the VAR, shocks to the latter have no contemporaneous impact on the former, and so on.

The ordering we chose is equivalent to that imposed in studies of the money demand function, that is, contemporaneous shocks to income, prices, and interest rates are allowed to have an effect on money, but money is not allowed to affect the others. In principle, the results could be sensitive to the precise ordering imposed upon the system. Therefore, in Appendix B we present some results for the case where the ordering is the reverse of what we impose here. In general, our results are not very sensitive to this change.

9. In Table 3, the variables are ordered in the way they were for the impulse response functions, specifically, the ordering is RPY, DEF, R, large term accounts, small time deposits, liquid savings and M1. Table B2 in Appendix B reverses this ordering. While the reversal increases the share of M1 forecast variance explained by M1 innovations (or shocks) as expected, the change in the variance decomposition is not startling when compared to the original ordering. In the pre-deregulation period, interest rate innovations account for a maximum of 3 percent, while the other 3 components of M3 taken together account for a maximum of 4 percent of the M1 forecast error variance. Reversing the ordering leaves the share of interest rate innovations more or less unchanged in the post deregulation period as well. The share of the other components of M3 taken together is also approximately the same as under the original ordering. However, the share of small time deposits goes up somewhat and the share of liquid savings innovations is correspondingly smaller.

10. The equation does not, of course, predict the movements associated with the introduction of Super-NOWs and MMDAs. The errors in these months have been set to zero.

11. In terms of the Baumol-Tobin model of the demand for transactions balances, a larger proportion of cash holders may have reached cash-management "corner solutions".

12. The ordering is the same as before, that is, the variables are ordered RPY, DEF, R, large term deposits, small time deposits, liquid savings and M1. Results from the reverse ordering are shown in Tables B3 and B4 in Appendix B.

13. See Davis, Korobow and Wenninger.

14. More direct evidence on the extent of the potential problem with M3 is provided by a VAR we estimated that contained, in addition to the variables in the previous VAR (Table 2), assets included in the Fed's liquid asset measure, L, but not in M3 (for example, short-term treasury securities and commercial paper). We call these credit market instruments NetL. Under the hypothesized problem of M3, variations in large term deposits should be closely correlated to movements in NetL. For example, when banks raise interest rates on large time deposits to obtain more funds, individuals would respond by selling off short-term Treasury securities and commercial paper to acquire large time deposits. Further, since NetM2 is hypothesized to be less sensitive to these influences, it should be much less closely correlated with NetL. (NetM2 is the difference between M2 and M1 and equals the sum of our liquid savings and small time deposits components. See the box on "Monetary Aggregates." Note also that our large term accounts component is the same as the conventional NetM3).

An examination of the contemporaneous correlations between the residuals from the VAR estimated over the post-deregulation period does not support these hypotheses. The correlation between NetL and large term deposits is .01, between NetL and small time deposits is .1, and between NetL and liquid savings, $-.25$. The associated variance decompositions also do not suggest that there is a marked difference between NetM2 and NetM3. In particular, with NetL ordered before both NetM2 and NetM3, innovations to NetL account for approximately 3 percent of the forecast error variance of NetM2 and 5 percent of the forecast error variance of NetM3 for forecast horizons up to 2 years. Consequently, the evidence does not justify a preference for M2 over M3.

The result that innovations in NetL explain very little of the forecast error variance decomposition of NetM2 and large term deposits has another important implication, namely, that there appears to be little gain in going from M3 to a still broader aggregate. In other words, while the recent portfolio disturbances have not been internalized within M1, they do appear to have been internalized within M3 and, to a lesser extent, within M2.

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