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The Case of the Missing M2

For more than a year, the M2 monetary aggregate has been unusually weak. For example, the Federal Reserve Board staff model of M2, referred to as the *FRB M2 model*, overpredicted M2 growth by an average of 1.8 percentage points over 1990:3–91:4, and an M2 model developed at the Federal Reserve Bank of San Francisco overpredicted M2 growth in late 1990 (Furlong and Trehan 1990). Figure 1 presents results from estimating M2 growth with the FRB M2 model, where the estimated shortfall in M2 growth is the gap between estimated M2 growth and actual M2 growth.

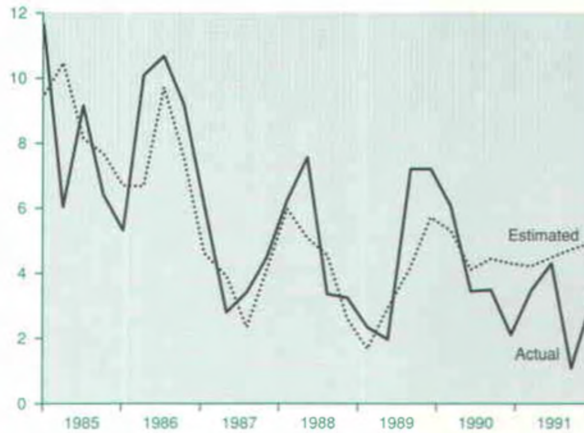
This study assesses two competing explanations for this phenomenon. One is that the missing M2 merely reflects substitution by households into bond and equity mutual funds, which are very liquid (Farrell and McNamee 1991). Indeed, coincident with the missing M2 have been runoffs in small time deposits, unusual weakness in money market mutual funds and large inflows into bond and equity mutual funds. The other explanation is that the missing M2 reflects households' reaction to the activities of the Resolution Trust Corporation (RTC). Indeed, the missing M2 has coincided with the efforts of the RTC to resolve failed thrifts.

The shortfall in estimated M2, or missing M2, has policy implications because monetary aggregates are often used as indicators of economic activity. From the equation of exchange,

$$M \times V = P \times Y, \tag{1}$$

where M = money, V = velocity (gross national product /M), Y = transactions (usually measured by inflation-adjusted GNP), and P = the price level. People typically reduce their money holdings as the spread between the rates that they can earn on nondeposit assets (for example, U.S. Treasury securities) rises over rates paid on deposits. As a result, when this spread, or *opportunity cost*,

Figure 1
Estimated Shortfall in M2 Growth



of money rises, the velocity of money rises because people hold lower average money balances to conduct their transactions.

If velocity is very predictable, then nominal GNP ($P \times Y$) can be inferred from money and interest rates. This inference is important for policy-making because estimates of prices and inflation-adjusted GNP typically are available after a considerable lag, whereas interest rate and money supply data are available more quickly. If *money demand*—the relationship between

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money, interest rates, and nominal GNP—is stable, then policymakers can use current money supply and interest rate data to roughly estimate current nominal GNP.

At one time, the demand for the M1 monetary aggregate was stable, and for this reason, M1 was used as an indicator of economic activity. However, there was a "missing money" period during the mid-1970s when M1 was unusually weak and suggested that nominal income was much lower than it actually was. Moreover, the link between M1, interest rates, and nominal GNP has become looser since the deregulation of deposits in the early 1980s. In particular, substantial shifts of deposits between those classified within M1 and those classified within the broader M2 monetary aggregate have resulted from deposit deregulation.[1] For these reasons, M1 has been used less and less as an indicator of nominal GNP.

Evidence that the demand for M2 is more predictable than the demand for M1 is mounting (Hetzel and Mehra 1989, and Moore, Porter, and Small 1990). Not surprisingly, economists and policymakers increasingly are turning to M2 as an indicator of economic activity and as a guide to long-run price developments (Hallman, Porter, and Small 1991). However, in recent quarters M2 growth has been unusually weak.

Using the FRB M2 model, this study documents the missing M2 evident since 1990 and finds that RTC activity, rather than inflows into bond and equity funds, appears to account for much of M2's recent weakness. In essence, the RTC's method of resolving failed institutions has lowered the perceived return on thrift deposits in ways not typically explained by models of M2. In response, investors have shifted from M2 deposits to other assets, including but not limited to bond and equity mutual funds.

This study is organized as follows. I first describe what bond funds are, explain how they may theoretically affect M2, and show that bond fund effects cannot account for the missing M2. Then I describe the activities of the RTC, explain how RTC activity may theoretically affect M2, and show how these activities appear to account for most of the missing M2. I conclude by summarizing the findings and discussing their policy implications.

Bond funds and the missing M2

This section begins with a review of the characteristics of bond and equity funds and then presents several theories on how bond and equity funds could be depressing M2 by becoming more attractive relative to M2 deposits. Next, I describe how bond fund adjustments to M2 were made and use the FRB M2 model to show that the missing M2 does not mainly owe to bond and equity fund effects.

Characteristics of bond and equity funds. Developed in the mid-1970s, bond funds are mutual shares of bond portfolios. Bond funds are a good substitute for direct bond holdings because bond funds typically are more liquid and more diversified than are direct bond holdings. Bond funds also substitute for M2 deposits. One reason is that many bond funds are in mutual fund families that allow investors to shift their assets among bond, equity, and checkable money market mutual funds (MMMFs) at little or no cost. Indeed, some market analysts have suspected that the 1991 slowdown in MMMF growth owes to shifts into bond and equity funds (*Figures 2 and 3*). Bond funds also provide investors with credit lines and credit cards. Thus, rather than putting one's savings into a small time deposit, an investor might choose to use a bond fund that permits one to either tap a credit line or shift funds into a MMMF when the need to write a check arises.

Similarly, equity mutual funds potentially substitute for both direct holdings of equity and for other assets, such as M2 balances. However, equity funds differ from M2 balances in one important way that bond funds do not. Specifically, equity funds carry a substantial degree of investment risk, which makes them much less substitutable for M2 deposits than bond funds. Moreover, in contrast to bond funds, available data do not allow one to easily measure shifts from directly held equities to equity funds. For these reasons, this study focuses more on bond

[1] *M1 includes currency, demand deposits, and other checkable deposits (NOW accounts). M2 includes M1, passbook savings deposits, small time deposits, MMMFs, money market deposits accounts, overnight Eurodollars, and overnight repurchase agreements.*

Figure 2
Bond and Equity Fund Net Changes

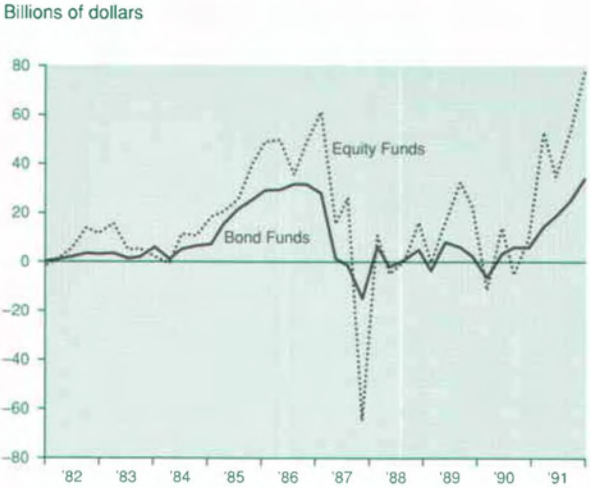
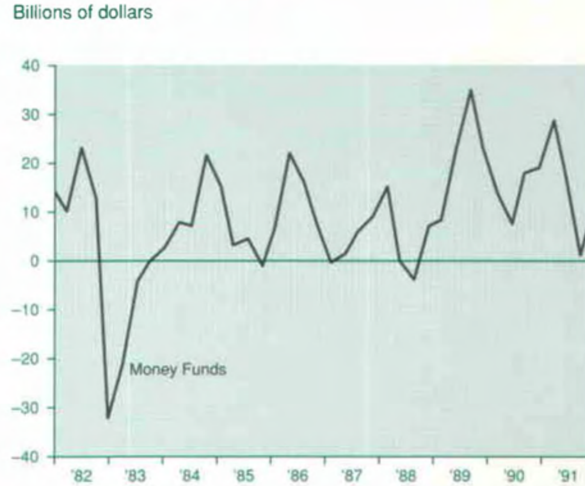


Figure 3
Money Fund Net Changes



SOURCES: Investment Company Institute and Federal Reserve Board.

fund rather than equity fund effects.

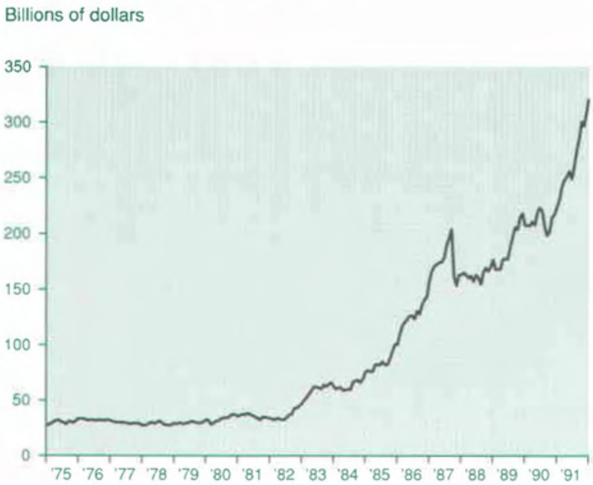
Bond and equity mutual funds since the mid-1970s. At this point, it is useful to review the history of bond and equity funds. As shown in Figure 4, equity funds grew moderately over the late 1970s and early 1980s. During the stock market boom of the mid-1980s, equity funds surged, reflecting higher prices of existing shares and inflows spurred by substantial price appreciation. Equity funds fell sharply during the stock market crash of 1987 and then recovered to pre-crash levels by late 1989. More recently, equity funds have grown rapidly as investors have reacted to declining yields on short-term debt securities and small time deposits.

As illustrated in Figure 5, bond funds grew modestly over the late 1970s and early 1980s. These funds then grew rapidly during 1985–86, were almost flat over 1987–89, and then grew rapidly in early 1991. Over 1985:1–86:4, household bond funds (seasonally adjusted—SA, Investment Company Institute data) rose by $143.4 billion, which is much greater than the $80.4 billion increase in overall holdings of government securities (less savings bonds), tax exempt securities, and corporate bonds (Flow of Funds data, NSA). These data suggest that much of the mid-1980s surge in bond funds reflected shifts from directly held bonds to bond mutual funds. This hypothesis is consistent with tax incentives that encouraged households to shift funds from long-term financial assets to individual retirement accounts (IRAs), for which mutual funds are more suitable.

Beginning in 1987 when the Tax Reform Act of 1986 severely restricted the eligibility requirements for IRAs, bond fund holdings changed little for the remainder of the decade. Although bond fund inflows have recently accelerated, the current spurt differs from that of the mid-1980s. Over 1990:3–91:2, bond funds (SA) held by households rose $32.5 billion, while household holdings of government securities (less savings bonds), tax exempt securities, and corporate bonds increased by $100.5 billion. Thus, the surge in bond funds during the early 1990s mainly reflected shifts away from nonbond assets (that is, M2 deposits), rather than shifts away from direct bond holdings.

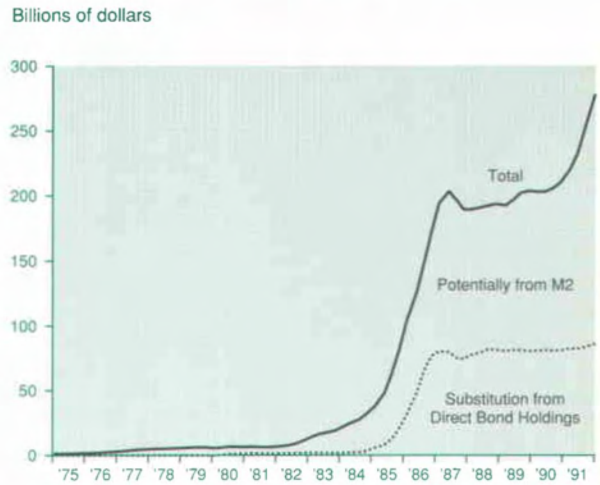
Indeed, the most recent surge in bond funds appears to reflect shifts from M2 deposits, particularly small time deposits, which fell sharply in 1991. In addition, because the costs of transferring assets between bonds and MMMFs within an asset management account are small, one would expect that some substitution between M2 and bonds would occur more specifically between bond and money market funds. Consistent with this view,

Figure 4
Household Equity Funds



SOURCES: Investment Company Institute and Federal Reserve Board.

Figure 5
Household Bond Mutual Funds



SOURCES: Investment Company Institute and Federal Reserve Board.

bond inflows over 1990–91 have coincided with some weakness in MMMFs outflows, as shown earlier in Figure 3. Although bond funds are still small relative to the stock of M2, their rapid growth in 1990 and 1991 may account for some of the recent unusual weakness in M2 growth as suggested by press reports (Clements 1991).

Why bond funds may affect M2: a theoretical framework

This discussion of why bond funds may theoretically affect M2 relies on the model of money demand developed by William Baumol (1952) and James Tobin (1956). This framework stresses that households and firms must choose between holding their assets in money or bonds. Bonds are attractive because their yield exceeds that on money. This yield differential is called the *opportunity cost of money.* On the other hand, if the need to purchase a good arises, a household or business must pay the cost of transferring assets from bonds to money. In the Baumol–Tobin model, people balance these considerations by holding some money and some bonds. Not surprisingly, the demand for money in this model is lower if the opportunity cost of money rises, if spending falls, or if the cost of converting bonds into money falls.

Within this framework, the recent popularity of bond funds can be attributed to two main factors. First, there has been a reduction in the costs of transferring assets from bonds (now bond funds) into transactions accounts, on which households can write checks.[2] A second factor is the recent large spread of long-term interest rates over short-term rates, often referred to as a *steep yield curve.* The expected return on bond funds reflects long-term interest rates, rather than short-term interest rates as with small time deposits. As a result, the recent decline in short-term interest rates relative to long-term interest rates has been accompanied by a fall in M2 deposit rates relative to yields on bond funds.[3]

[2] *Ross Milbourne (1986) developed a model to analyze the impact of certain financial innovations on the demand for different monetary aggregates. His model gives a more complete treatment of how a decline in the costs of transferring assets from bonds to money can decrease the demand for money.*

[3] *The maturities of most small time deposits are less than 1 year and typically range up to 2-1/2 and 5 years. The effective maturities of bond funds primarily fall into the range from 3 to 10 years.*

Theoretical aspects of the empirical analysis of bond fund effects

Shifts from M2 to bond funds, however, likely require high spreads of long-term over short-term rates because such shifts entail fixed costs to households. These costs include commission (load) fees, time needed to gain information on mutual funds, and fixed annual fees (typically $75 to $100). In addition, mutual fund family accounts that allow shifts among bond, equity, and checkable money market mutual funds have minimum required investments (typically $10,000) that usually are much higher than those of simple bond fund accounts.[4] As a result, M2 may not be affected much over the short term by a modest decline in the cost of shifting from bond to money market funds or by a modest rise in the spread between bond and small time deposit yields. It is thus plausible that M2 will be substantially affected only by large or persistent changes in transfer costs or the slope of the yield curve.

The data are generally consistent with this view. Although the cost of shifting assets between bond and money market funds generally fell in the late 1980s and early 1990s, bond funds have only risen noticeably during two periods since 1982—periods when the yield curve has been very steep. As shown in Figures 6 and 7, the growth rate of bond funds adjusted for inflation has only been substantial during the periods 1985–86 and 1990–91.[5] However, of these two periods, the mid-1980s surge was much larger relative to the slope of the yield curve, and partly reflected shifts from direct bond holdings to IRAs/401Ks invested in bond funds when tax requirements were more generous. Further evidence that bond fund growth has not consistently reflected spreads between short-term and long-term rates is that bond fund growth was weak in 1987 despite a fairly large yield spread. This weakness likely reflected the enactment of the Tax Reform Act of 1986, which greatly curtailed the number of households eligible to contribute to IRAs and which imposed much more restrictive limits on the amounts of 401K contributions.

Thus, including the spread between rates on long-term and short-term Treasury securities in M2 regressions is unlikely to detect surges in bond funds that result from changes in the tax code and the unusually fast growth of new instruments during periods of innovation.[6] In the past, these sorts of empirical difficulties have been handled by expanding the definition of M2 (such as adding MMMFs and money market deposit accounts [MMDAs] to M2), rather than by solely relying on adjusting the opportunity cost terms in money demand models. Indeed, Figure 8 illustrates the importance of including past innovations, such as MMMFs and MMDAs, in M2.[7] Taking this approach, I compare the behavior of M2 with that of M2 plus adjustments for bond and equity mutual funds.

Theoretical aspects of measuring bond fund effects

The institutional characteristics of bond funds suggest that they are substitutes for directly holding bonds and for M2 balances.

Substitution between bond funds and direct bond fund holdings. Bond funds offer three main advantages over directly held bonds. First, bond funds enable an investor to acquire shares in a well-diversified portfolio with only a modest investment. Portfolio diversification partially protects investors by enabling them to not be overly exposed to the risk that the value of a particular firm's bonds will fall greatly. A second advantage is that bond funds in mutual fund families are more liquid than directly held bonds. That is, bond funds can be converted into checkable assets such as MMMFs more quickly and with less expense than can directly held bonds.

A third incentive to hold bond funds rather than bonds relates to taxes. During the mid-1980s, U.S. tax laws created incentives for households to open individual retirement (IRA) and Keogh

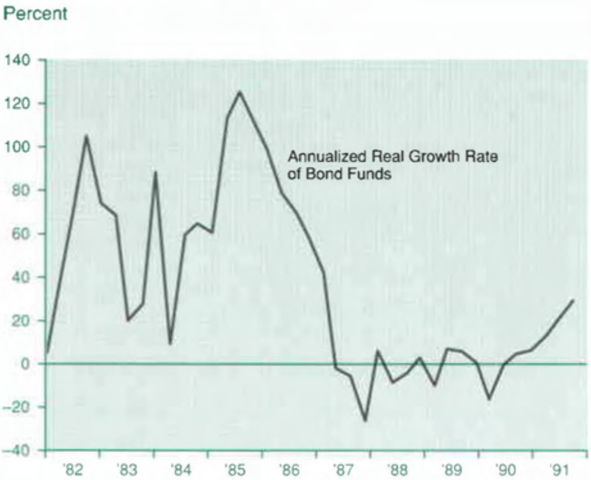
[4] *Minimum balances to open just a bond mutual fund account are as low as $500–$1,000, but do not allow shifting into money market mutual funds.*

[5] *The GNP deflator was used to adjust bond funds for inflation.*

[6] *Indeed, the spread between yields on 10- and 1-year Treasury securities was insignificant when added to the M2 models used in this study.*

[7] *For a discussion of how and why the definition of M2 has evolved over time, see the study by W. Michael Cox and Harvey Rosenblum (1989).*

Figure 6
Growth in Real Bond Funds



SOURCES: Investment Company Institute and Federal Reserve Board.

Figure 7
Yield Spreads

accounts for which bond and equity funds were better savings instruments than directly held bonds. Mutual funds can be more attractive tax shelters because many funds complete and provide all of the tax-related accounting information for investors and bond funds allow investors to make the maximum annual IRA contribution, \$2,000–\$4,000, which is less than the \$10,000 minimum denomination of most bonds.[8]

The major drawback of bond funds is that for rich investors, the costs of directly investing in bonds may be less than bond fund fees. Nevertheless, bond funds are a more attractive means of holding bonds for many investors.

Substitution between bond funds and M2. Several characteristics of bond funds suggest that they are also substitutes for M2. To evaluate the "moneyness" of bond funds, however, it is helpful first to review the salient features of M2 deposits.

M2 deposits generally share three important characteristics. First, because they are federally insured, investors need not worry about the risk that their M2 deposits may fall in nominal value. By contrast, many corporate bonds (especially noninvestment grade or junk bonds) pose default risk to investors because the firms may not be able to pay back investors. A second characteristic of M2 deposits is that they generally have smaller minimum denominations than many bonds and commercial paper issues, which typically come in \$10,000 increments. As a result, many more households are able to invest in M2 deposits than in bonds. Another important feature of M2 deposits is that households can either write checks on many M2 deposits or shift noncheckable M2 deposits into checkable accounts.[9]

How do bond funds compare with M2 deposits? First, many bond funds typically have little or no credit risk because they are heavily invested in U.S. government-guaranteed, mortgage-backed securities and high-grade corporate bonds.[10] As a result, bond funds are relatively safe and can substi-

[8] *The maximum contribution is \$2,000 for most eligible individuals and \$4,000 for most eligible families.*

[9] *In practice, many institutions do not penalize households significantly if they must prematurely withdraw small time deposits in an emergency.*

[10] *Of \$354 billion in bond funds in September 1991, \$146 billion was invested in municipal bonds, \$123 billion in U.S. government securities (including U.S. government-guaranteed, mortgage-backed securities), \$25 billion in junk bonds, and \$50 billion in mixed bond funds (primarily, Treasury, municipal, collateralized mortgage obligations, and high grade corporate bonds).*

tute for small time deposits. Second, many bond funds have minimum investment sizes less than $10,000 and do not require households to invest in $10,000 increments. Third, many bond funds enhance the liquidity of investors by offering check-writing privileges, credit lines, and credit cards. Fourth, many bond fund holdings are in mutual fund families, which allow investors to readily shift assets across bond, equity, and checkable money market mutual funds at very low transactions costs.[11] This last feature heightens the extent to which investors shift funds between bond or equity funds and MMMFs when relative rates of return between these assets change. Indeed, the missing M2 has been accompanied by weakness in MMMFs, as well as in small time deposits.

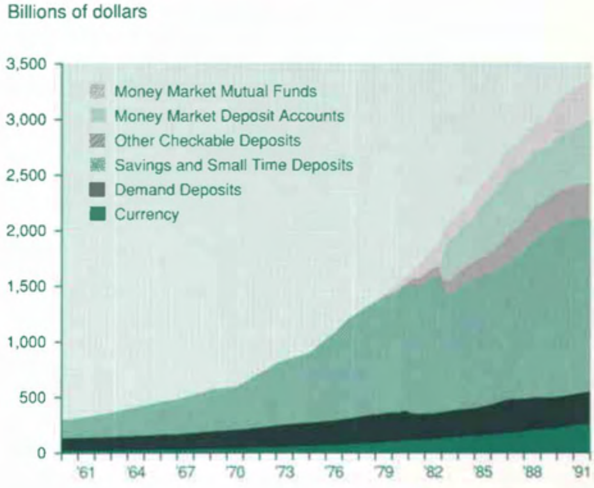
Bond funds differ from M2 deposits in several ways. First, unlike M2 accounts bond funds are *marked-to-market*, meaning that a change in interest rates affects an investor's balances by altering market price of these assets. Bonds bear a fixed coupon and, thus, indirectly so do bond funds. When long-term interest rates rise, therefore, the prices of existing bonds fall, allowing the yield to rise. Thus, the market value of bond funds falls as long-term rates rise. For this reason, bond funds pose interest rate (price) risk.

A second way that bond funds differ from M2 deposits concerns taxes. Because of the marked-to-market feature of bond funds, investors must consider the capital gains tax consequences of shifting out of bond funds into money market funds. These tax considerations entail costs that may hamper substitution between bond funds and money market funds.

A third difference is that bond funds include many IRA and Keogh accounts, which are excluded from M2 because their tax-deferred status reduces their liquidity. Finally, annual fixed fees and minimum balance requirements for bond funds effectively limit the relevance of these instruments to more affluent households. (One reason is that many less well-off households may find that these fixed fees are large relative to the interest income on the amounts that they can invest.)

Overall, the characteristics and recent behavior of bond funds imply that while they are not perfect substitutes for M2 deposits, their degree of substitutability may be substantial. Expanding M2 to include bond funds would internalize such substitution effects, and thus, at least theoretically, might make M2 more stable. However, including bond funds in M2 could create several complications. First, many bond fund assets have substituted for direct bond holdings. Second, the marked-to-market valuation of bond funds would introduce an interest rate sensitivity that is not a direct "money demand" effect. For example, a rise in bond yields would cause bond fund balances to fall through marked-to-market valuation. It is unclear to what extent households would replenish their bond-fund holdings following such a change in bond prices. Finally because they are long-term investments, the degree of substitution between bond funds and equity may exceed that between M2 deposits and equity. This implies that putting bond funds in M2 may make M2 less stable as investors shift between stocks and bond funds.

Figure 8
Selected M2 Components



[11] *Mutual fund families usually allow investors a limited number of free transfers among money market, bond, and equity funds within the same family (* Donoghue's Mutual Funds Almanac, 1987–1988, *16–17). Recently, Citibank has enabled households to easily shift funds among MMDA, checking, MMMF, bond mutual funds, and equity mutual funds, thereby increasing the substitutability of bond (and equity) funds with liquid M2 deposits.*

Empirical analysis of bond and equity fund effects on M2

This section creates bond and equity fund series that are used to adjust M2 for bond and equity fund effects. First, estimates of total household bond and equity fund holding are presented. Then, these data are adjusted for substitution between bond funds and direct bond holdings.

Data and variables. Bond and equity fund data since 1975 are available from the Investment Company Institute (ICI). Federal Reserve Board staff has classified mutual fund holdings into several asset groupings that can be categorized into bond, equity, and mixed bond and equity funds (Duca 1992a). In general, the mixed funds tend to hold more equity than bonds, and for this reason, mixed funds are treated as equity funds.[12]

One difficulty with the ICI data is that they aggregate holdings by households and institutions, whereas MMMFs held by institutions are not in M2, but in M3. It was assumed that 75 percent of all bond funds were owned by individuals on grounds that the share of bond and equity funds held by households has remained around 75 percent according to available year-end data for 1983–90. These monthly bond and total mutual fund outstandings were then seasonally adjusted with an X'11 procedure.

Because bond funds are substitutes for direct bond holdings and M2 deposits, we must distinguish between these substitution possibilities to assess the impact of bond funds on M2. For example, to the extent that the mid-1980s surge in bond funds likely reflected shifts away from directly held bonds, M2 is unaffected. For this reason, a bond fund series was added to M2 that adjusts bond funds for shifts with direct bond holdings ("SBFM2", see Appendix A for details). In addition, two other adjusted M2 series were created. One adds total household bond funds to M2 (BFM2), and the other adds equity and substitution adjusted bond funds to M2 (BEFM2).[13] Each of these three expanded M2 aggregates have grown faster than M2 since 1990:2. However, it important to note that the estimated growth rates of the three expanded M2 aggregates would likely be higher than that of M2 because the opportunity cost of the bond and equity funds added is lower than that of M2 deposits.

Estimating whether bond and equity funds account for the missing M2. Using the FRB M2 model as a benchmark, this subsection estimates M2 and M2 adjusted for bond and equity mutual funds. Three adjusted M2 series were evaluated: these used total household bond funds (BFM2), substitution adjusted bond funds (SBFM2), and equity plus substitution adjusted bond funds (BEFM2). This approach was taken because the riskiness of equity returns may make equity funds less substitutable for M2 deposits than are bond funds. The bond and equity adjustments also enable one to assess the advantage of internalizing any substitution between these two types of funds.

The procedure used in creating these series implicitly makes the strong assumption that any estimated changes in bond or equity funds completely represented substitution effects with M2 deposits. This strong assumption is consistent with results from the Federal Reserve's August 1991 Survey of Senior Financial Officers. Of the large banks in this survey who characterized retail deposit growth as unusually weak between May and July 1991, the most frequently cited reason for this weakness were "returns on nondeposit instruments, such as bond funds or Treasury securities."[14] Nevertheless, because of the strong implicit substitution assumption, the mutual fund adjustments are best viewed as yielding upper

[12] Mixed funds also include Investment Company Institute mutual fund categories whose definitions with respect to bonds and equities have changed over time using data organized by Pat White of the Federal Reserve Board staff.

[13] Adding total household bond and equity funds to M2 produced an aggregate that was even less explainable than BEFM2 and M2. Note that because equity funds and directly held equity rose together during the 1980s, it was impossible to adjust equity funds for substitution away from directly held equities along the lines that adjustments to bond funds were made.

[14] Furthermore, in a survey conducted by National Securities & Research Corp. during the summer of 1991, more than 90 percent of surveyed mutual funds indicated that net inflows from households came partially at the expense of MMMFs and bank deposits, while 50 percent indicated that some of the net inflows came from substitution out of insurance company assets (Clements 1991, C9).

Table 1

Selected Results of Estimating M2 Growth Rates, 1976:1–91:4

		Model		
Selected Variables	**M2**	**Subst.Adj. Bond Fund Adj. M2**	**Bond and Equity Fund Adj. M2**	**Simple Bond Fund Adj. M2**
$\log(M2_{t-1})-\log(GNPAV_{t-1})$	–.19069** (–4.35)	–.18551** (–4.97)	–.18923** (–5.29)	–.14391** (–4.38)
long-run *OC* elasticity	–.048	–.060	–.074	–.068
S.S.E. (Quarterly, not a percentage)	.0008652	.0007768	.0009824	.0008906
R^2 (corrected)	.77969	.79528	.75457	.78427
Durbin–H	–.58816	–.79233	–.11087	–.72293

** Significant at the 99-percent confidence level.
(*t* statistics in parentheses)

Definitions

GNPAV = $(GNP_t + GNP_{t-1})/2$, measure of permanent income used as a long-run proxy for transactions.

OC = Opportunity cost of M2, defined as the spread between the 3-month Treasury bill rate and the average interest rate paid on M2 balances.

NOTE: A negative coefficient on $[\log(M2_{t-1})-\log(GNPAV_{t-1})]$ implies that M2 balances adjust (error correct) toward their desired levels.

bound estimates of the impact of bond and equity funds on M2 growth.

Selected statistics from estimating the FRB's M2 model and mutual fund data are presented in Table 1 (see Duca 1992a for more details). The sample period begins in 1976:1 because mutual fund data start in 1975:1 and because the FRB error-correction model uses a few lags of the dependent variable. The FRB M2 equation contains variables that control for the volume of spending with GNP and personal consumption expenditures, and for the opportunity cost of holding money with the spread between a market interest rate (the six-month Treasury bill rate) and the average rate earned on M2 balances. Changes in the cost of shifting between money and other assets are not in this model because they are not measured across time in practice.

The FRB M2 model is an "error-correction" model which tracks both the long-run and short-run responses of M2 to changes in spending and in its opportunity cost (for further discussion see Moore, Porter, and Small 1990 and the box titled *"The Form of the M2 Regression Model"*). The main advantage of this approach is that it better estimates short-run and long-run movements than other approaches. Owing to its econometric form and the expertise of the Federal Reserve Board staff in modeling M2, the FRB model is considered state of the art. For this reason, it is used to document and is modified to account for the missing M2. Although the four different M2 series are estimated with the same type of model, they differ in the how the opportunity cost of money is measured. Conceptually, the FRB model measures

The Form of the M2 Regression Model

The M2 model developed by the Federal Reserve Board staff has this form:

$$
\begin{aligned}
[\ln(M_t) - \ln(M_{t-1})] = {} & C + EC[\ln(M_{t-1}) - \ln(Y_{t-1})] \\
& + \sum_{i=0}^{i=2} \alpha_i [\ln(Y_{t-i}) - \ln(Y_{t-i-1})] \\
& + \beta_1 \ln(OC_{t-1}) \\
& + \beta_2 [\ln(OC_t) - \ln(OC_{t-1})] \\
& + \alpha_m [\ln(M_{t-1}) - \ln(M_{t-2})] \\
& + \delta_j \text{Regulation dummy}
\end{aligned}
$$

variables, where:

$\ln$ = the natural log of a variable.

M_t = M2 at time t.

$[\ln(M_t) - \ln(M_{t-1})]$ = the growth rate of M2 at time t.

C = a constant.

EC = estimated coefficient on the error correction term.

Y = transactions (often measured by GNP or consumption).

OC = the opportunity cost of M2.

α_i's = estimated short-run effects of transactions.

α_m = estimated short-run effect of previous M2 growth.

β_1 = estimated long-run effect of OC on M2 growth.

β_2 = estimated short-run effect of OC on M2 growth.

δ_j's = estimated effects of changes in regulations.

Also, note that the first difference of the log of a variable is the growth rate of that variable. More detailed variable definitions are provided in the tables.

Before examining regression results, a brief review of key assumptions and each component of the model is helpful. Because of its error-correction specification, this model can estimate the short-run and long-run effects of economic variables on M2 growth and, in particular, how M2 growth responds to previous deviations of the level of M2 from its long-term determinants. Over the long term, it is assumed that the growth rate of M2 matches that of GNP. This assumption is justified on grounds that the long-run velocity of M2 (that is, the ratio of GNP to M2) appears constant. (For evidence, see Hallman, Porter, and Small 1991.)

Of the components, the estimated "error-correction" coefficient, EC, is expected to have a negative sign. The reason is that the difference between the log-level of M2 and that of GNP is expected to converge to the log of the inverse of M2's long-term velocity (adjusted for M2's opportunity cost). For example, suppose that $\ln(M2_{t-1})$ is above the long-term level associated with $\ln(GNP_{t-1})$ and $\ln(OC_{t-1})$. In this case, one would expect M2 to fall until $[\ln(M_{t-1}) - \ln(Y_{t-1})]$ declines to its long-run level holding all other variables constant. As the magnitude of EC rises, this adjustment, or error-correction occurs at a faster speed.

Another variable in the model, $\ln(OC_{t-1})$, measures the long-run effect of a change in M2's opportunity cost. Because M2 holdings are likely to fall as its opportunity cost rises, this term is expected to have a negative sign.

(Continued on the next page)

The Form of the M2 Regression Model—*Continued*

Dividing the coefficient on $\ln(OC_{t-1})$ by EC yields the long-run elasticity of M2 with respect to its opportunity cost. This statistic is very useful. For example, an elasticity of –5 percent indicates that a once-and-for-all (permanent) 100-percent rise in the opportunity cost of M2 will eventually cause M2 to fall 5 percent from its initial level.

Because M2 responds differently in the short run than in the long run, several other types of variables are included. First, lags of the growth rate of transactions are included, which the Board model measures with the growth rate of personal consumption expenditures. These variables are expected to have positive signs, as a rise in transactions would tend to boost the need to hold assets in the form of M2.

Second, the lag of last period's M2 growth rate is included. This variable helps control for momentum in how people adjust their M2 balances and is expected to have a positive sign. Note that because it is assumed that the velocity of M2 is constant over the long-run (controlling for M2's opportunity cost), M2 and transactions (GNP or consumption) will grow at the same long-run rate. To be consistent with this assumption, the sum of the coefficient on lagged M2 growth and the coefficients on the lags of the growth rate of consumption are constrained to equal 1.

Third, the current growth rate of M2's opportunity cost is included to measure the initial effect of a change in M2's opportunity cost. As with the sign of $\ln(OC_{t-1})$, it is expected to have a negative sign.

Finally, several dummy variables are included to control for the impact of changes in bank and thrift regulations that unusually affected M2 holdings. These variables control for the introduction of MMDAs in late 1982, deposit rate deregulation in early 1983, and the imposition of credit controls in 1980:2. (See Table 1 for more details.)

M2's opportunity cost as the difference between a risk-free market interest rate and the average rate on M2 balances. For consistency, the weighted average yields on the adjusted M2 series were calculated to reflect the risk-adjusted return on mutual funds and that on M2 deposits. The risk-adjusted return on mutual funds was set equal to the three-month Treasury bill rate on grounds that these funds likely yield the market rate of return on assets having similar market, credit and prepayment risks.

Looking at the results, the R^2s of the two bond fund adjusted series are somewhat better than those of M2, with the substitution-bond adjusted series yielding the best fit. By contrast, the bond and equity fund adjusted model yields a worse fit than the regular M2 model, likely reflecting that equity funds are much less substitutable for M2 than are bond funds.

Table 2 presents in-sample residuals for the subsample period 1990:3–91:4. The sum of squared errors (*S.S.E.*, a measure of unexplained movements) of the substitution-adjusted and simple bond adjusted M2 series are 26 percent and 29 percent lower over this period than the S.S.E. of the unadjusted M2 series, respectively. The bond and equity adjusted M2 model also produces a lower S.S.E. over this subsample period (9 percent lower) than the FRB M2 model. One measure of the missing M2 is the average growth rate shortfall of an M2 series over 1990:3–91:4. Results indicate that adding substitution-adjusted bond funds accounts for 27 percent of the missing M2; adding total bond funds, for 28 percent of the missing M2; and adding equity and substitution-adjusted bond funds, for 43 percent of the missing M2. Of course, each mutual fund adjustment implicitly makes the strong assumption

Table 2
In-Sample M2 Growth Rate Errors Over 1990:3–91:4, 1976:1–91:4)

(Percent, Seasonally Adjusted Annual Rate, Negative Entries Reflect Weaker-Than-Predicted M2 Growth)

Quarter	M2	Subst.Adj. Bond Fund Adj. M2	Bond and Equity Fund Adj. M2	Simple Bond Fund Adj. M2
1990:3	–.96	–1.06	–1.79	–1.10
1990:4	–2.19	–2.41	–3.17	–2.29
1991:1	–.75	–.93	.65	–.95
1991:2	–.02	–.02	–.56	–.04
1991:3	–3.63	–2.85	–2.32	–2.78
1991:4	–1.64	–.74	.87	–.76

NOTES:

Growth Rate Residuals, 1990:3–91:4:				
Average	–1.83	–1.34	–1.05	–1.32
Percentage of Missing M2 explained	—	27	43	28
S.S.E. over 1990:3–91:4, (Quarterly rate):				
Total	.000139	.000103	.000126	.000099
Relative to FRB S.S.E.	—	26% lower	9% lower	29% lower

that all portfolio substitution involving bond and stock funds are completely internalized within their expanded definitions of M2. For this reason, these estimates are best viewed as upper bounds. Even with this qualification in mind, bond and equity funds can potentially account for only a small part of the missing M2.

This result likely reflects three things. First, the "missing M2" began appearing in 1990:3, whereas bond and equity fund inflows were not substantial until the spring of 1991. Second, if M2 is becoming less attractive to investors because of troubles in the thrift industry, bond and equity mutual funds are not the only alternatives to holding M2. Third, even though simply adding bond and equity funds to M2 may seem to account for much of the missing M2 in 1991, such a calculation is misleading. One reason is that one-fourth of bond and equity funds are held by institutions. Another is that because these assets have lower opportunity costs than M2 deposits, adding them to M2 in a logically consistent manner means that the opportunity cost of this new aggregate is lower than that of M2, and thus the demand for the new aggregate should be somewhat higher. Hence, even though the growth of adjusted M2 may be higher than that of M2, so is the estimated growth of the adjusted series.

RTC activity and the missing M2

In this section, I review the activities of the Resolution Trust Corporation and describe two ways these activities may create a missing M2 phenomenon. I also present RTC variables that are added to the FRB M2 model and estimation results that show that RTC effects appear to account for the missing M2.

The RTC was created in 1989 by Congress under the Financial Institutions Reform, Recovery, and Enforcement Act to close bankrupt thrifts. Through early January 1992, the RTC had resolved 535 thrifts, which entailed handling insured deposits and selling assets seized. The most important RTC activities with respect to M2 are those relating to the resolution of deposits. Between 1989 and early 1992, the RTC had sold or paid off about $183 billion in insured deposits. When the RTC resolves deposits at a bankrupt thrift, it either pays insured depositors directly and closes their accounts or sells the deposits to another institution that has the right to reset deposit rates after providing a two-week notice.

RTC closings of insolvent thrifts can create a missing M2 phenomenon by affecting M2 in two related ways that are not reflected in standard money demand variables.[15] First, when closing a thrift, the RTC's actions force depositors to reassess their M2 balances because the RTC either pays depositors directly and closes their accounts or sells the deposits to another institution that has the right to reset deposit rates after providing a two-week notice. For this reason, the M2 balances of depositors at failed thrifts are likely to more quickly adjust to changes in M2 opportunity costs than they would be in more normal circumstances. According to industry sources, most cases where small time rates are reset involve "brokered" small time deposits.[16]

As a result of actual "calls" of small time accounts, the short-term adjustment of M2 to changes in its opportunity cost may not be adequately estimated using an error-correction model with conventional money demand variables. This effect on the speed of adjustment can, theoretically, either boost or depress M2 growth. However, such an effect could be creating a missing M2 problem in the early 1990s because small time accounts initiated at bankrupt thrifts during the late 1980s are being prematurely "called" in a period of lower interest rates. As a result, the decline in small time deposit rates and the pace of nominal activity (GNP) since the late 1980s can lead to a much quicker adjustment in small time and M2 balances than in the pre-RTC days. Empirically, this "call" effect may be tracked in an M2 model by the volume of deposits at newly resolved institutions as either an independent variable that is implicitly interacted with one or more opportunity cost variables or an extra variable that is directly interacted with M2's opportunity cost.

A second way the resolution process can create a missing M2 phenomenon is by creating uncertainty about deposit yields, which depresses the demand for M2. Depositors, especially those who shop for higher-than-normal yields (often through brokers), face a repricing risk that arises because the high yield earned on deposits (fully covered by deposit insurance) at a troubled thrift either may be lowered (repriced) by a purchasing institutions or will no longer be in effect if the RTC directly reimburses depositors. This risk is similar to the "call" risk posed by many corporate bonds, because in an environment of falling interest rates, many firms would exercise their option of paying off old bonds having high interest rates with new bonds having lower interest costs. For this reason, investors in corporate bonds often do not expect to earn the posted interest rate on a bond for the full period of stated maturity even if they did not expect the corporate bond issuer to default.[17]

As a result of increased uncertainty over nominal deposit yields, conventional measures of

[15] *See Duca (1992a) for why two other RTC-based explanations for the missing M2 are not plausible.*

[16] *These accounts are arranged by brokers for investors who shop for high yields and do not entail much of a relationship between banks and depositors. Industry sources indicate that nonbrokered, small time accounts that are sold by the RTC are much less likely to have their rates reset because the purchasing institutions want to acquire a customer relationship with "nonbrokered" depositors, who are less apt to switch to a competitor.*

[17] *For example, interest rates on mortgage-backed securities that are government guaranteed exceed yields on comparable maturity Treasury bonds. The reason is that investors demand a higher rate on such mortgage-backed securities because some of these bonds would be retired early if households refinance their mortgages at lower interest rates, which would force investors to reinvest funds in an environment of lower rates.*

M2's opportunity cost do not consistently track its true opportunity cost. For example, if a credit-risk free market rate exceeds the *stated* average yield on M2 balances by a given amount in an environment of RTC resolutions, the same spread in a pre-RTC environment would not mean that the true opportunity cost of M2 was identical in both periods. Indeed, in this example, when investors factor in the call risk posed by the RTC, the true opportunity cost of M2 is higher in the RTC environment. Thus, current spreads between the average rate paid on M2 balances have understated M2's opportunity cost since the RTC became very active. By understating the apparent opportunity cost of M2 in this way, most M2 models have overestimated M2 growth, thereby giving rise to a missing M2 phenomenon.

Empirical analysis of RTC effects on M2

Data and variables. This subsection describes how to test for RTC effects and the variables used in such testing. Empirically, the call risk created by thrift resolutions is difficult to measure because people are adapting to a new environment, and markets have had little experience in measuring this call risk. However, the effects may be loosely proxied by the volume of deposits at newly resolved thrifts. Many depositors may not become aware of this new risk until the RTC resolves their deposits or those of people they know because, with deposit insurance, the depositors may falsely assume they only need to know posted deposit rates.

To assess the impact of RTC activity on M2, the FRB M2 model was modified in three ways. The first (model 2) adds a variable measuring the change in the quarterly average running sum of deposits at resolved thrifts (*RTCDEP*). The second and third (models 3 and 4) add terms (*RTCOC* and *RTCDOC*), which respectively interact *RTCDEP* with an M2 opportunity cost term and the first difference of this variable to see if RTC activity affects the long-run or short-run elasticity of M2 with respect to its opportunity cost. See Table 3 for data on *RTCDEP* and Appendix B for details on these three variables.

I should note that since 1989:3, the variable *RTCDEP* has generally been larger than the estimated shortfall in M2 growth produced by the FRB M2 model. This evidence implies that RTC resolution activity may account for the missing M2.

The estimated impact of RTC effects on M2. The impact of RTC activity was assessed by estimating four versions of the FRB model over the period 1976:1–91:4. To compare RTC and mutual fund results, the sample period begins in 1976:1.[18] Because RTC did not begin closing thrifts until 1989:3, the RTC variables (*Table 3*) all take the value zero before 1989:3. As a result, variation in the RTC proxies occurs in only ten quarters, which makes it unfeasible to conduct simulations with RTC variables. Thus, the results should be viewed with caution given that results based on a short-period may not stand the test of time.

Selected statistics from estimating several models are provided in Table 4 (see Duca 1992a for more details). Results from model 2, indicate that *RTCDEP* is negatively and significantly related to M2 growth. The negative but insignificant coefficient on *RTCOC* in model 3 implies that the sensitivity of M2 to its opportunity cost is not significantly heightened by RTC activity. In model 4, *RTCDOC* is statistically significant, but has a positive, rather than the hypothesized negative, sign. Consistent with the significance levels of *RTCDEP*, *RTCOC*, and *RTCDOC*, the full-sample R^2 of model 2 (0.828) is better than that of the FRB model (0.780), while those of models 3 and 4 (0.787 and 0.794) are only slightly better. In addition, M2 adjusts (error-corrects) to desired levels at faster estimated speeds in models 2, 3, and 4 (25 per-cent, 20 percent, and 22 percent per quarter, respectively) than in the FRB model (19 percent per quarter). This is considered a good result because models with higher speeds of adjustment tend to model the desired stock of money better than those having lower speeds.

Although the R^2 of model 2 is somewhat better than that of the FRB model, any improvement in full-sample fit is limited by the short interval during which the RTC has been active. Thus, any RTC effect is likely to be reflected in recent years. This point is borne out by the in-

[18] *The qualitative results with respect to the three RTC variables were similar using a longer sample period (1964:1–91:4).*

Table 3
Changes in Quarterly Average Levels of Cumulated Deposits at Resolved Thrifts

(In Billions)

Quarter	RTCDEP	RTCDEPO	QRTC	Simple Quarterly Total of Newly Resolved Deposits[1]
1964:1–89:2	0	0	0	0
1989:3	.5	.5	.5	1.8
1989:4	9.3	9.8	8.0	8.8
1990:1	4.3	14.1	3.5	7.4
1990:2	15.4	29.5	11.5	38.0
1990:3	33.6	63.1	7.0	30.9
1990:4	29.7	92.8	5.9	14.4
1991:1	17.2	110.0	8.7	17.6
1991:2	14.9	124.9	6.0	12.0
1991:3	25.2	150.1	19.2	42.1
1991:4	26.6	176.6	3.7	5.4

Definitions

RTCDEP change in the quarterly average volume of cumulated deposits at resolved thrift institutions. Main proxy for RTC effects on M2.

RTCDEPO measure of the quarterly average volume of cumulated deposits at resolved thrift institutions (used to create *RTCDEP*).

QRTC quarterly average volume of deposits at newly resolved thrifts that occurred within that quarter.

[1] Note that because resolutions tend to occur in the third month of the quarter,

i) the quarterly average of newly resolved deposits (*QRTC*) is much smaller than the simple sum of newly resolved deposits during an entire quarter (the last column), and

ii) the potential impact of RTC activity during quarter *t* on M2 is mainly felt in quarter *t*+1, owing to quarter-averaging effects. For this reason, the average size of *RTCDEP* tends to be larger than that of *QRTC*, and *RTCDEP* sometimes surges in the quarter following a surge in *QRTC*.

sample errors from the models during the period since the RTC has been active (*Table 5*). Over 1990:3–91:4, the S.S.E.'s of models 2, 3, and 4 are 42 percent lower, 2 percent lower, and 12 percent higher than that of the FRB model, respectively. In addition, if the missing M2 is measured by the average estimated growth rate shortfall over 1990:3–91:4, then the RTC variables in models 2, 3, and 4 account for 83 percent, 37 percent, and 44 percent of the missing M2, respectively.

Tables 4 and 5 suggest several conclusions. First, models 3 and 4 indicate that the neither the long-run nor the short-run responsiveness of M2 to changes in its measured opportunity cost are significantly heightened by RTC activity (the coefficient on *RTCDOC* has the wrong sign). Second, model 2 produces the best full-sample fit, and error-corrects faster than models 3 and 4. Third, model 2 accounts for much more of the missing M2 than either model 3 or model 4. The performance of model 2 is consistent with the hypotheses that RTC actions create a missing M2 phenomenon directly by creating an early "call" on high-yielding small time deposits in a period of

Table 4
Selected Results of Estimating M2 Growth Rates, 1976:1–91:4

Selected Variables	FRB Model	Model 2	Model 3	Model 4
$\log(M2_{t-1})-\log(GNPAV_{t-1})$	–.19069** (–4.35)	–.24819** (–6.00)	–.19502** (–4.52)	–.22164** (–4.96)
RTCDEP		–.00034** (–3.95)		
RTCOC			–.00020 (–1.68)	
RTCDOC				–.00083* (2.16)
long-run *OC* elasticity	–.048	–.051	–.049	–.051
S.S.E. (Quarterly, not a percentage)	.0008652	.0006621	.0008196	.0007925
R^2 (corrected)	.77969	.82808	.78719	.79423

** Significant at the 95-percent confidence level.
** Significant at the 99-percent confidence level.
(*t* statistics in parentheses)

Definitions

GNPAV — $(GNP_t + GNP_{t-1})/2$, measure of permanent income used as a long-run proxy for transactions.

OC — Opportunity cost of M2, defined as the spread between the 3-month Treasury bill rate and the average interest rate paid on M2 balances.

RTCDEP — measure of quarter-to-quarter change in the quarterly average volume of cumulated deposits at resolved thrift institutions.

RTCOC — variable interacting *RTCDEP* and $\log(OC_{t-1})$, controls for whether the long-run opportunity cost elasticity of M2 is sensitive to *RTCDEP*.

RTCDOC — interacts *RTCDEP* and del(log(*OC*)), controls for whether the short-run opportunity cost elasticity of M2 is sensitive to *RTCDEP*.

NOTE: A negative coefficient on $[\log(M2_{t-1})-\log(GNPAV_{t-1})]$ implies that M2 balances adjust (error correct) toward their desired levels.

lower interest rates and indirectly by creating a call risk on other, not-yet-called deposits.

Given that model 2 is preferable to the other RTC-modified M2 models, the variable *RTCDEP* was added as a separate regressor to each of the bond and equity fund adjusted M2 models.[19] Results indicate that *RTCDEP* is significant in all three models. Of these, the substitution-bond adjusted

[19] *Another reassuring aspect of model 2 is that its coefficients on non-RTC variables (not shown) are more similar to those obtained by estimating the FRB model up through 1989:4 than are those obtained by estimating the FRB model through 1991:4. Of these variables, the most noteworthy are the error correction, long-run opportunity cost, and short-run consumption terms.*

Table 5
In-Sample M2 Growth Rate Errors Over 1990:3–91:4, 1976:1–91:4

(Percent, Seasonally Adjusted Annual Rate, Negative Entries Reflect Weaker-Than-Predicted M2 Growth)

Quarter	FRB Model	Model 2	Model 3	Model 4
1990:3	−.96	2.30	.91	−.33
1990:4	−2.19	.02	−.91	−1.12
1991:1	−.75	−.44	−.52	.26
1991:2	−.02	−.34	−.43	−.50
1991:3	−3.63	−2.52	−3.95	−4.80
1991:4	−1.64	−.92	2.02	−.30
NOTES:				
Growth Rate Residuals, 1990:3–91:4:				
Average	−1.83	−.32	−1.15	−1.03
Percentage of Missing M2 explained	—	83	37	44*
S.S.E. over 1990:3–91:4, (Quarterly rate):				
Total	.000139	.000080	.000136	.000155
Relative to FRB S.S.E.	—	42% lower	2% lower	12% higher

*Not particularly meaningful given the "incorrectly" signed coefficient on *RTCDOC* in model 4.

model outperforms all the others in terms of full-sample fit, as shown in Table 6. With respect to the missing M2, the average M2 growth rate shortfall over 1990:3–91:4 is 0.24 percentage points with the substitution-bond adjusted model, 0.26 percentage points with total bond funds, and a somewhat smaller 0.10 percentage points with the equity and substitution-bond adjustments. Similar to the mutual fund regressions that excluded RTC effects, these findings indicate that adding substitution adjusted bond funds yields the most explainable monetary aggregate, but that adding in equity funds seems to account for somewhat more of the missing M2.

Summary and policy implications

The closing of thrifts by the RTC can plausibly depress M2 by actually forcing calls of high-yield small time deposits in an environment of lower interest rates and by creating call risk for other small time deposits. The volume of deposits at newly resolved thrifts can be correlated with unexplained weakness in M2 growth not only because roll-over effects are tracked by this variable, but also because knowledge of the risk to nominal rate returns may move with the level of RTC activity as more households experience these risks first-hand.

Consistent with these possible effects, regression analysis indicates that most of the missing M2 appears to be associated with thrift resolutions. Although some of the missing M2 may be reflected in substitution by households away from retail deposits toward bond and equity mutual funds, it is unclear to what extent these shifts stem from RTC policies that can plausibly reduce the attractiveness of M2 deposits or from a steepening yield curve. Moreover, bond and

Table 6

Selected Results from Combining RTC and Bond and Equity Fund Effects, 1976:1–91:4

(Runs add *RTCDEP* to M2 and bond and equity fund adjusted M2 models in Table 1)

		Model		
Selected Variables	**M2**	**Subst.Adj. Bond Fund Adj. M2**	**Bond and Equity Fund Adj. M2**	**Simple Bond Fund Adj. M2**
$\log(M2_{t-1})-\log(GNPAV_{t-1})$	–.24819** (–6.00)	–.23524** (–6.57)	–.20732** (–5.94)	–.19011** (–5.88)
RTCDEP	–.00034** (–3.95)	–.00031** (–3.77)	–.00023* (–2.46)	–.00033** (–3.59)
Long-run *OC* elasticity	–.051	–.063	–.077	–.072
S.S.E. (Quarterly, not a percentage)	.0006621	.0006075	.0008781	.0007107
R^2 (corrected)	.82808	.83676	.77633	.82447

** Significant at the 95-percent confidence level.
** Significant at the 99-percent confidence level.
(*t* statistics in parentheses)

NOTES:

Growth Rate Residuals, 1990:3–91:4:				
Average (avg. FRB error = –1.83)	–.32	–.24	–.10	–.26
Percentage of Missing M2 explained	83	87	95	86
S.S.E. over 1990:3–91:4, (Quarterly rate):				
Total (FRB S.S.E. = .000139)	.000080	.000047	.000053	.000050
Relative to FRB S.S.E.	42% lower	66% lower	62% lower	64% lower

equity mutual funds do not appear to account for more than a small part of the missing M2.

While the results indicate that equity funds are not good substitutes for M2, I find that bond funds are a good substitute for M2 balances on two grounds. First, the characteristics of bond funds are similar to those of M2 balances. Second, because a bond fund adjusted M2 aggregate is more explainable than M2, it appears that an expanded aggregate internalizes substitution between bond funds and M2. These results suggest that the Federal Reserve may need to monitor an M2 monetary aggregate that is expanded to include some bond funds. Nevertheless, findings indicate that in considering an expanded M2 aggregate, it is empirically important to differentiate bond fund inflows associated with shifts out of direct bond holdings from those out of M2.

This study suggests that the case of the missing M2 is similar to two previous episodes of missing money; all three instances appear to be linked to regulations. The first case of missing money—weak M1 and demand deposit growth in the mid-1970s—was identified by Stephen Goldfeld (1976) and has been linked to two factors. One stemmed from businesses' switching from demand deposits to overnight repurchase agreements spurred by high interest rates and the prohibition on interest on business deposits (Tinsley, Garrett, and Friar, 1981). The other factor stemmed from declines in compensating balances (zero-interest bearing accounts of firms that partially compensate banks for providing services and loans) that owed to shifts away from bank loans to commercial paper. These shifts in business credit sources were induced by banks' rationing credit during a period of Regulation Q-induced disintermediation and passing along the higher cost of reserve requirements during a period of high interest rates (Duca 1992a).

During the late 1970s and early 1980s, a missing M2 phenomenon appeared as high market interest rates, coupled with Regulation Q ceilings on deposit rates, drove households away from deposits toward money market mutual funds. This case of the missing money was solved by later adding MMMFs (and MMDAs) to M2, which internalized any substitution between MMMFs and other M2 components. The current missing money episode can also be interpreted as reflecting the changing impact of regulations. Specifically, the RTC's actions can be viewed as removing the deposit insurance subsidy indirectly paid by taxpayers to investors holding high yielding accounts at troubled thrifts.

Although results link the missing M2 to RTC activity, the short subsample period of RTC activity makes this study's findings subject to qualification. The reason is that without a long track record, it is possible that some other development that happened at the same time as RTC resolutions could be the real cause of M2 weakness. Nevertheless, the results suggest that until its completion, the thrift resolution process could continue to create a missing M2 phenomenon. These findings do not imply that the RTC is incorrectly resolving bankrupt thrifts. Rather, the results simply suggest that RTC activity is affecting M2 growth in ways not captured in conventional econometric models of M2. An important implication of this study is that if economists are to infer the general pace of economic activity from M2, M2 may need to be viewed in conjunction not only with spreads between deposit and market interest rates, but also with the pace at which the RTC resolves troubled thrifts.

Appendix A

Constructing a Substitution Adjusted Bond Fund Series

This appendix describes how a bond fund series was adjusted for inflows from directly held bonds. This series, *BF*, was then added to M2 to construct one of the two bond fund adjusted M2 series that are assessed. As described at the end of this appendix, all three bond and equity fund adjusted series were converted into quarter average equivalents (using the same procedure) because M2 growth is typically measured on a quarter average basis.

BF was calculated as the difference between bond fund outstandings and cumulative bond fund inflows attributable to shifts away from direct bond holdings (*BFS*). *BFS* was calculated in two steps. First, direct bond fund holdings are estimated. Using the Federal Reserve Board's flow of funds data, total household bond holdings (*BT*) were defined to equal the sum of the household sector's corporate bonds, government securities (excluding savings bonds), and tax-exempt securities. Note that household assets in commercial paper or in money market mutual funds were not counted as bond holdings, but that owing to data limitations, this figure includes Treasury bill holdings. Direct holdings of bonds ("*BD*," i.e., nonmutual funds) were estimated as the difference between total household bond holdings (*BT*) less total estimated bond fund holdings (*TBF*).

The second step entailed estimating the extent to which direct bond holdings fell as a result of substitution toward bond funds. This was done as follows. If bond fund holdings rose while direct bond holdings fell, then bond fund holdings attributable to substitution between bond assets equaled the minimum of the size of the decline in direct bond holdings and the increase in bond funds. Given data limitations, bond fund holdings attributable to substitution between bond assets were conservatively calculated as equaling the cumulative sum of such measured substitutions:

(1a) $$BFS_t = \sum_{i=0}^{t} SUB_{t-i},$$

where $SUB_t \equiv \min([BD_{t-1} - BD_t], [TBF_t - TBF_{t-1}])$,

if $(TBF_t - TBF_{t-1}) > 0$ and $(BD_t - BD_{t-1}) < 0$, and

(2a) $$= 0, \text{ otherwise.}$$

This measure likely understates substitution from directly held bonds to bond funds because it does not account for the extent to which direct bond holdings would have *grown* in the absence of bond funds. However, the relatively sluggish growth of total bond holdings in the mid-1980s implies that the degree to which *BFS* underestimates these shifts is minor.

Next, bond funds substituting for M2 (*BFU*) were calculated as the difference between total household bond funds (*TBF*) and *BFS* (see Figure 4):

(3a) $$BFU_t \equiv TBF_t - BFS_t.$$

Finally, this bond fund component was converted from an end-day-of-quarter number to

(Continued on the next page)

Appendix A

Constructing a Substitution Adjusted Bond Fund Series—*Continued*

a quarterly average number to create an adjustment (*BF*) that was comparable to quarterly average M2 data. This was done by defining

(4a) $BF_t \equiv [BFU_t + BFU_{t-1}]/2$, and

$SBFM2_t \equiv BF_t + M2_t$.

In creating the two other mutual fund adjusted M2 series, total household bond funds were added to M2 (*BFM2*), and equity and substitution adjusted bond funds were added to M2 (*BEFM2*). As with *BFM2*, these adjustments were converted into quarter average equivalents following equation 4a.[1] Note that although bond fund data are available on a monthly (end-day-of-month) basis, the adjustments in equation 4a had to be calculated on an end-month-of-quarter basis because the flow of funds data used are end-month-of-quarter data. To compare the M2 series adjusted with substitution adjusted bond fund data (*SBFM2*) with the other two bond and equity fund series, the two other series were converted into quarter averages using the method in equation 4a even though monthly data are available. The qualitative nature of the results was unchanged when *BFM2* and *BEFM2* were constructed by averaging monthly data instead of using just end-month-of-quarter data points.

[1] These quarterly adjustments are averages of constructed month average data. Monthly averages for each month *t* were created by averaging end-day-of-month outstandings for months *t* and *t*–1.

Appendix B

Formulas Used in Measuring the Impact on M2 of Deposits at Resolved Thrifts

RTCDEP was calculated in several steps to create a variable comparable to the way M2 growth rates are typically calculated. Two specific considerations were taken into account. First, the growth rate of M2 usually is measured based on quarterly averages of month average balances. For this reason, a once-and-for-all deposit runoff in the first month of a quarter depresses M2 growth that quarter by a greater magnitude than does a comparable decline in the third month. Second, due to quarter-averaging, inflows occurring in quarter t–1 are likely to have a greater impact on the quarterly M2 growth rate in the following quarter (t). Thus, resolutions of deposits that occur in one quarter can affect the growth rate of the following quarter. For this reason, the impact of deposit resolutions on quarterly M2 growth is best measured if the variable *RTCDEP* is defined as the *change* in the quarterly average level of current and prior RTC resolutions rather than by the contemporaneous volume of deposits at newly resolved thrifts.

Reflecting these considerations, *RTCDEP* and *RTCOC* were constructed in several steps using available monthly data on total deposits at thrifts resolved by RTC.[1] First, the monthly volume of deposits at newly closed thrifts (*RTC*) was converted into a contemporaneous month-average effect by dividing it by 2 (*MRTC*). Next, these monthly data were converted into quarterly average flows (*QRTC*). This was done by weighting each contemporaneous month-average flow by one-third, and then adding the weighted monthly averages to two-thirds of RTC from the first month and one-third of RTC from the second month of each quarter. In the third step, a quarterly average cumulated stock of resolved deposits (*RTCDEPO*) was created by adding the cumulated sum of resolved deposits in prior quarters (*CUMRTC*) with the quarterly average level of newly resolved deposits (*QRTC*). Next, *RTCDEP* was calculated as the first difference in *RTCDEPO*. Fifth, *RTCOC* was created by multiplying *RTCDEP* with the lagged opportunity cost of M2 deposits (*OC*) defined as the difference between the three-month Treasury bill rate and the weighted-average return on M2 balances.[2] Finally, *RTCDOC* was created by multiplying *RTCDEP* with the contemporaneous first difference of M2's opportunity cost (*OC*).

Definitions

RTC	deposits at thrifts newly resolved during a month.
MRTC	month average of newly resolved deposits.
QRTC	quarterly average of newly resolved deposits.
CUMRTC	cumulated sum of deposits resolved in prior quarters.
RTCDEPO	quarterly average cumulated stock of resolved deposits.
RTCDEP	change in quarterly average cumulated stock of resolved deposits.
RTCOC	*RTCDEP* interacted with the opportunity cost of M2.
M2OC	spread between 3-month T-bill rate and average yield on M2 balances.

Subscript m denotes month m.
Subscript q denotes quarter q.
Subscript g denotes first, second, or third month of quarter.

(Continued on the next page)

Appendix B

Formulas Used in Measuring the Impact on M2 of Deposits at Resolved Thrifts—*Continued*

Formulas

$$MRTC_m \equiv RTC_m/2$$

$$QRTC_q \equiv (1/3)MRTC_{g=1} + (1/3)MRTC_{g=2} + (1/3)MRTC_{g=3} + (2/3)RTC_{g=1} + (1/3)RTC_{g=2}$$

$$= (5/6)RTC_{g=1} + (1/2)RTC_{g=2} + (1/6)RTC_{g=3}$$

$$CUMRTC_{q=j} \equiv \sum_{t=0}^{t=j-1}[RTC_{g=1,q=t} + RTC_{g=2,q=t} + RTC_{g=3,q=t}]$$

$$RTCDEPO_q \equiv CUMRTC_q + QRTC_q$$

$$RTCDEP_q \equiv RTCDEPO_q - RTCDEPO_{q-1}$$

$$RTCOC_q \equiv RTCDEP_q \times M2OC_q$$

[1] The author owes a special debt to Richard Anderson of the Federal Reserve Board staff, who compiled these monthly data.

[2] This was done in order to compare results with the Fed's error correction model of M2, which lags the log-level *OC* term by one quarter.

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