# Sources of Money Instability

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*Recent studies generally conclude that the link between nominal output, interest rates, and conventional definitions of broad money has weakened or shifted. By reviewing the recent literature in the context of a microtheoretic model of money, this article attempts to shed light on why these relationships have changed.*

During the early post–World War II era, the relationship between money and nominal output was stable, which encouraged many analysts to use money as an economic indicator. This reliance can be discussed using the equation of exchange:

$$(1) \qquad M \times V = P \times T,$$

where $M$ = money, $V$ = velocity [nominal gross domestic product (GDP)/$M$], $P$ = the price level, and $T$ = transactions (usually measured by inflation-adjusted GDP). Money holdings typically fall as the spread between a riskless short-term market interest rate and the average yield on monetary assets rises. As a result, the velocity of money rises as this spread, or opportunity cost of money, increases. If velocity is predictable, then money and its predicted velocity can be used to infer nominal GDP ($P \times Y$). Under these conditions, money is a useful indicator because data on GDP are available after a long lag, whereas information on money and interest rates is more timely.

Among active researchers, confidence in the M1 monetary aggregate (currency plus checking deposits) peaked with the publication of a money demand study by Goldfeld (1973). This study found that M1 reflected movements in nominal GDP and, to a smaller extent, changes in the three-month Treasury bill rate. These results implied that nominal GDP growth roughly equaled M1 growth, with a small adjustment for interest rates. Shortly after that study was published, M1 grew unusually slowly relative to nominal GDP, giving rise to Goldfeld's (1976) "case of the missing money."

In the early 1980s, the interest sensitivity of M1 jumped as financial innovations and deregulation created new deposits that combined savings and transactions features (see Hetzel and Mehra 1989) and helped firms avoid holding non-interest-bearing demand deposits (see Tinsley, Garrett, and Friar 1981). Partly as a result, attention shifted to M2, a less interest-sensitive and broader aggregate that was created in 1980 (see Simpson 1980). M2 was defined to include money market mutual funds (MMMFs) and overnight instruments, which became important in the late 1970s, and was redefined in 1982 to include money market deposit accounts (MMDAs). M2 had a reasonably stable relationship with interest rate spreads and nominal GDP during the 1980s (see Moore, Porter, and Small 1990 and Small and Porter 1989). However, this relationship broke down in the 1990s as M2 became more sensitive to long-term interest rates (see Duca 1995, Feinman and Porter 1992, and Koenig 1995a) and as households shifted toward bond and stock mutual funds (see Collins and Edwards 1994; Duca 1995, 1994a, 1994b; and Orphanides, Reid, and Small 1994) and toward direct holdings of Treasury securities (see Feinman and Porter 1992).

These breakdowns in the link between money and nominal output have spurred efforts to redefine money (for example, Collins and Edwards 1994, Duca 1995, and Hess and Morris 1995) or revise money models to account for changing behavior (for example, Koenig 1995a). Understanding why the money–income relationship has shifted is critical to finding new ways of deriving useful information from money and is the subject of this article.

The next section presents a simple theoretical model to illustrate three sources of change in the link between money and nominal output, followed by a section presenting evidence on shifts in this relationship. The subsequent three sections then review evidence on each potential source of money instability. The conclusion speculates on how likely changes in financial practices will affect money demand in coming years.

## How the relationship of nominal GDP, interest rate spreads, and money can shift

In the early 1990s, households increasingly viewed nonmonetary assets as more attractive than M2 deposits for a given spread between expected yields on nonmonetary and monetary assets. As a result, conventional econometric models that use income and yield spreads to account for movements in money generally overpredicted M2 growth in that period, giving rise to "the case of missing M2." Theoretical models of money imply that the breakdown of such econometric models likely stems from their failure to control for other factors affecting money holdings. With respect to M2, these factors can be illustrated using a modified version of Milbourne's (1986) model of financial innovation and liquid assets.

Milbourne's framework is a modified Miller–Orr model (Miller and Orr 1966) in which households face uncertain net cash flows in a world with three financial assets: transactions accounts yielding a return of $r_d$, bank savings accounts yielding $r_s$, and bonds—which have virtually no credit risk—yielding $r_b$.[1] Changes in net cash flow are stochastic, with a mean of 0 and a variance of $\sigma^2$. Whenever transactions balances hit zero, funds are transferred at a fixed cost into transactions accounts from either savings accounts or from bonds. Milbourne assumes that $r_d < r_s < r_b$ (or more liquid assets yield lower pecuniary returns) and that the fixed cost of transferring funds from bonds into transactions accounts ($\beta$) is greater than that of shifting funds from savings to transactions accounts ($\alpha$). Owing to the latter assumption, Milbourne's model implies that households will hold a portfolio of all three financial assets and that transactions deposits ($D$), small time deposits ($S$), and total M2 deposits ($M2 \equiv S + D$) equal

$$D = (4/3)^{2/3}\sigma^{2/3}(\alpha/[r_b - r_d])^{1/3}, \tag{2}$$

$$S = (4/3)^{2/3}\sigma^{2/3}(\beta/[r_b - r_s])^{1/3}, \text{ and} \tag{3}$$

$$M2 = (4/3)^{2/3}\sigma^{2/3}[(\alpha/[r_b - r_d])^{1/3} + (\beta/[r_b - r_s])^{1/3}], \tag{4}$$

respectively. Milbourne shows that with $r_b > r_s$, a rise in the cost of transferring funds from bonds to transactions accounts will, by making bonds more costly to hold, cause money balances to rise ($\partial\log(M2)/\partial\log(\beta) > 0$), which implies that a fall in $\beta$ will lead to slower M2 growth.

This model can be modified in two ways to make it more relevant. First, note that, by definition, the standard deviation (volatility) of net cash flow ($\sigma$) rises with the average or expected level of transactions:

$$\sigma = \gamma T, \tag{5}$$

where $\gamma$ is the coefficient of variation. Equation 5 reflects that as the average levels of cash inflow and outflow rise with transactions in magnitude, so will the magnitude of the expected volatility (standard deviation) of net cash flow. To show a link with output ($Y$), assume that transactions are typically proportionate to output with some temporary deviations:

$$T = Y(1 + \epsilon), \tag{6}$$

where $\epsilon$ has a mean of zero and a variance of $var_\epsilon$.

The second major change is to treat bonds and equity as the alternative asset to $D$ and $S$. Because bonds and equity carry price risk, replace $r_b$ with a risk-adjusted expected return on bonds and equity ($r_q$):

$$r_q = E(r_b) - bvar_{rb}, \tag{7}$$

where the parameter $b$ is the risk adjustment factor and $var_{rb}$ is the variance of returns on stocks and bonds. The additive adjustment in equation 7 is consistent not only with the quadratic utility function used by Tobin (1958), which exhibits increasing risk aversion in wealth, but also with utility functions that are characterized by constant relative risk aversion, which is more consistent with empirical research (for example, Friend and Blume 1975) and with the common perception that risk aversion tends not to increase as wealth levels rise. As households become more risk averse, $b$ rises in magnitude.

Substituting equations 5–7 into equation 4 yields

$$(8)\qquad M2 = (4/3)^{2/3}[\gamma Y + \gamma\epsilon Y]^{2/3} \\ [(\alpha/[E(r_b) - bvar_{rb} - r_d])^{1/3} \\ + (\beta/[E(r_b) - bvar_{rb} - r_s])^{1/3}].$$

Rearranging equation 8 produces

$$(9)\qquad Y^{2/3}/M2 = (4/3)^{-2/3}[\gamma(1 + \epsilon)]^{-2/3} \\ \{(\alpha/[E(r_b) - bvar_{rb} - r_d])^{1/3} \\ + (\beta/[E(r_b) - bvar_{rb} - r_s])^{1/3}\}^{-1},$$

which has several empirical implications about velocity ($Y/M$).

Most econometric models implicitly treat interest rate spreads as having a constant effect on velocity over time. Equation 9 implies that velocity may deviate from what these models predict for three reasons:

1. Deviations of output from transactions ($\epsilon$) will introduce noise into the relationship between money and output.
2. Declines in the costs of transferring funds from nonmonetary assets to transactable assets ($\beta$) and from nonmonetary assets to nontransactions M2 accounts ($\alpha$) will raise the velocity of M2.[2]
3. An increase in household tolerance for risk (that is, a decline in $b$) will lead to a rise in the velocity of money.[3]

In addition to these effects, another empirical implication arises.

4. Because econometric models do not have good time series measures of $\alpha$, $\beta$, and $b$, a decline in any one of these parameters will (a) likely boost the estimated sensitivity of M2 to opportunity cost spreads as samples are extended into the 1990s and (b) affect the estimated sensitivity of M2 plus bond and/or equity mutual funds to a smaller extent because these expanded aggregates internalize most of the shifts between M2 and non-M2 that arise from changes in these parameters. (See the box entitled “Omitted Variable Bias.”)

## Omitted Variable Bias

According to the model presented in the article, the elasticity of transactions deposits with respect to their opportunity cost is constant (–1/3), as is the elasticity of small time deposits with respect to their opportunity costs.[1] However, the elasticity of M2 with respect to the opportunity cost of transactions deposits should be smaller in magnitude as the cost of transferring funds from small time deposits to transactions deposits ($\alpha$) falls. In addition, a decline in the cost of transferring funds from nonmonetary assets to transactions deposits ($\beta$) will lead to a decline in the size of the elasticity of M2 with respect to the opportunity cost of small time deposits.[2]

The intuition for the first result is that as the cost of transferring funds between small time and transactions deposits falls, the transactions share of M2 falls. As a result, a given percentage increase in the opportunity cost of transactions accounts has a smaller impact on overall M2, even though it has the same percentage effect on transactions accounts. The same logic extends to the impact of a decline in $\beta$ on the elasticity of M2 with respect to the opportunity cost of small time deposits. If both costs fall, the net effect on both elasticities is, a priori, ambiguous. Only if technological change is balanced, in the sense that the percentage changes in $\alpha$ and $\beta$ are equal (that is, $\Delta\alpha/\alpha = \Delta\beta/\beta$), will the net change in each elasticity be zero.[3]

However, because econometric models do not, as of yet, have good time series measures of $\alpha$, $\beta$, and $b$, a decline in one of these parameters will, over time, boost the estimated sensitivity of M2 to the spread between returns on nonmonetary assets and money.[4] Since most conventional models constrain the income elasticity of money to be constant when the models are estimated, the models will try to account for the negative impact of recent declines in transfer costs and risk aversion by boosting the size of the estimated negative coefficients on interest rate spreads. As a result of constraining the income coefficients to be constant over time, M2 will likely appear more sensitive to opportunity cost spreads in these models as samples are extended into the early 1990s, while this omitted variable bias is less of a problem for an aggregate that adds bond and equity funds to M2. In addition, because the yield curve was steep in the early 1990s, a wide spread between long-term interest rates and the average rate on M2 deposits (which tend to have short-term maturities) will be correlated with omitted data on declining transfer costs (and/or declining risk aversion). As a result, omitted variable bias will likely result in a rise in the observed sensitivity of M2 to long-term opportunity cost measures as samples are extended into the early 1990s.

1 The opportunity cost of transactions deposits in this model is the risk-adjusted spread between the expected return on securities (stocks and bonds) and the transactions deposit rate, while the opportunity cost of small time deposits is the risk-adjusted spread between the expected return on securities and the small time deposit rate.

2 Denoting the opportunity costs of transactions and small time accounts by $c^d$ and $c^s$, respectively, the opportunity cost elasticities of M2 simplify to

$$\Delta\left[\partial M2/\partial c^d\right]\left[c^d/M2\right] = \left\{\frac{(1/9)\alpha^{1/3}\beta^{1/3}[c^s]^{1/3}[c^d]^{1/3}}{\{\alpha^{1/3}(c^s)^{1/3} + \beta^{1/3}(c^d)^{1/3}\}^2}\right\}\left\{\frac{-\Delta\alpha}{\alpha} + \frac{\Delta\beta}{\beta}\right\}, \text{ and}$$

$$\Delta\left[\partial M2/\partial c^s\right]\left[c^s/M2\right] = \left\{\frac{(1/9)\alpha^{1/3}\beta^{1/3}[c^s]^{1/3}[c^d]^{1/3}}{\{\alpha^{1/3}(c^s)^{1/3} + \beta^{1/3}(c^d)^{1/3}\}^2}\right\}\left\{\frac{\Delta\alpha}{\alpha} + \frac{\Delta\beta}{\beta}\right\}.$$

3 Balanced technological change does not affect the transactions and nontransactions shares of M2. Since the opportunity cost elasticities of transactions and nontransactions deposits are constants, the constant shares imply that the opportunity cost elasticities of M2 are also unchanged.

4 The same is true for estimates of the elasticity of transactions deposits with respect to the opportunity cost of transactions deposits and of the elasticity of small time deposits with respect to their opportunity cost.

The impact of financial churning, or volatility, falls under the first category. The second implication covers technological advances that lower $\alpha$ or $\beta$, such as declines in the costs of using mutual funds, the spread of automatic teller machines, improvements in services offered by mutual funds, and greater ease in purchasing Treasury securities. The third empirical implication reflects not only changes in risk aversion stemming from demographic and preference shifts, but also improvements in nonmonetary assets that make it easier for households to obtain a well-diversified portfolio and a greater awareness of alternative investments that makes households more willing to hold non-M2 assets. In practice, the fourth implication appears as omitted variable bias that leads to parameter instability in conventional money-demand functions.

Evidence on this instability is presented in the next section, partly as a means of showing why monetary economists are concerned about issues regarding financial technology, preferences, and volatility. Then, the subsequent sections review evidence on how technological changes, shifts in preferences and demographics, and volatility in financial transactions have affected the demand for money in ways not captured by conventional models.

## Evidence suggestive of omitted variable bias

If substantial shifts in monetary technology and preferences have occurred, then we can observe two types of results from econometric models that do not contain good time series measures of transfer costs and risk adjustments to nonmonetary asset returns. First, expanding M2 to include some of these nonmonetary assets could yield an aggregate that would better predict inflation and nominal output in the 1990s and would have a more stable long-run relationship to those variables in money models than would the current definition of M2.[4] For this to occur, the advantage of internalizing time-varying substitution between M2 and such assets needs to outweigh any extra volatility that arises because the value of the added non-M2 assets fluctuates (that is, most of these non-M2 assets have price risk, unlike M2 components). If this condition holds, then a second type of result arises: the impact of asset returns in models of M2-like aggregates, inflation, and nominal output should vary less over time when a broader version of M2 replaces the current definition of M2 either as a dependent or independent variable.

Three types of evidence are consistent with these implications. First, econometric studies have found that adding bond and/or stock mutual fund assets to M2 yields an aggregate that has outperformed M2 in predicting either inflation (for example, Becsi and Duca 1994, Duca 1994a, and Koenig 1995b) or nominal GDP (for example, Darin and Hetzel 1994 and Duca 1994b) in the 1990s.[5] Furthermore, these studies find that coefficients on the long-run relationships between an M2-type aggregate and either prices or nominal output change relatively less for the expanded M2 aggregates as samples are extended into the 1990s. From a monetarist perspective, this is an important finding because if velocity is stable in the long run, then monetary aggregates should provide information about medium- to long-run inflationary pressures.[6]

The second type of evidence is that as samples are extended into the 1990s, the impact of asset yields (especially long-term interest rates) varies less in models of money (see Duca 1995 and Koenig 1995a), inflation (see Becsi and Duca 1994, Duca 1994a, and Koenig 1995b), and nominal output (see Duca 1994b) when an expanded M2-type aggregate replaces M2.[7] These findings are consistent with the view that adding bond and stock funds to M2 reduces the omitted variable bias that arises from a lack of data on financial technology and preferences.

The third kind of evidence is cross-section data that confirm a recent shift away from certificates of deposit (CDs) toward bond and equity fund assets (see Kennickell and Starr-McCluer 1994). In particular, during the period 1989–92, when M2 growth was unusually weak, the share of households having nonmoney (mainly bond and equity) mutual fund assets rose from 7.1 to 11.2 percent, whereas the share owning CDs (small and large time deposits) fell from 19.4 to 16.6 percent. Furthermore, over this period, the median value of nonmoney mutual fund assets rose from \$11,200 to \$18,000 among households having such assets, while the median value of CDs rose by a much smaller magnitude—from \$12,600 to \$13,500—among households owning CDs.

While all three types of findings are consistent with the view that models using M2 suffer from omitted variable bias, they do not provide evidence on the actual sources of that bias. The next three sections provide some evidence on these sources.

## Technology and shifts toward nonmonetary assets

Since the early 1980s, the attractiveness of nonmonetary assets has likely increased because of two types of technological change: declining costs of transferring funds from nonmonetary assets to transactions deposits and the rising use of financial services from nonasset products.

**Lower asset transfer costs.** As shown above, a decrease in the cost of shifting funds from savings deposits to transactions accounts ($\alpha$) and from nonmonetary assets to transactions accounts ($\beta$) should reduce the transactions and precautionary demands for money. There are several indications that such costs have fallen. With respect to mutual funds, Orphanides, Reid, and Small (1994) cite evidence that load (commission) fees have fallen sharply over the past two decades. Furthermore, many mutual funds provide customers with a number of free transfers among funds in asset management accounts (see Donoghue Organization 1987) that offer a host of investments, including bonds, equities, and commodities, and allow low- or no-cost shifts among investments within mutual fund families that typically include a checkable money market fund. In addition, many banks now offer mutual funds and have introduced integrated customer management of their mutual fund and bank deposit balances. Additionally, the Federal Reserve has made it easier for households to purchase Treasury securities directly, a change that, coupled with interest rate movements, may have spurred shifts from M2 into Treasury securities, as documented by Feinman and Porter (1992).

More generally, the spread of better information technology is lowering transfer costs, with respect to both domestic and foreign assets (see the box entitled "Globalization"). In particular, the rise of electronic banking (especially using personal computers at home or in the office) poses potentially large reductions in the pecuniary and convenience costs of making such transfers. (For recent evidence, see Holland and Cortese 1995 and Lewis 1995.) Unfortunately, there is no continuous time series of data on asset transfer costs. Nevertheless, the limited evidence is consistent with the fact that most of the unusual weakness in M2 during the 1990s has been concentrated in small time deposits (which compete with stocks and bonds) and money market mutual funds (which experienced outflows when stock and bond yields rose relative to short-term money market rates in the early 1990s).

**Financial services from nonassets.** Since the 1960s, firms and households have increasingly used new nonasset instruments and cash management techniques to reduce the average level of liquid funds held to meet unexpected cash outflows. In practice, these instruments enable firms and households to better coordinate cash inflow with cash outflow and to reduce check usage by consolidating many purchases into fewer check payments. Within the context of the Milbourne model, these instruments can be interpreted as reducing the volatility of net cash flow ($\gamma$) and thereby lowering the demand for money.

In the 1970s and 1980s, technological advances and high interest rates induced firms to seek alternatives to using non-interest-bearing demand deposits to meet their transactions needs.[8] Sophisticated cash management techniques enabled firms to better forecast cash needs and to more readily tap nonmonetary liquid assets to meet unexpected shortfalls in cash flow. (For evidence, see Mahoney 1988 and Porter, Simpson, and Mauskopf 1980, and for more references, Judd and Scadding 1982.) In particular, technological advances spurred many firms to use wire or electronic transfers to minimize transactions balances (see Dotsey 1984 and Flannery and Jaffee 1973).

Although there has been much research on how off-balance-sheet innovations affect the money balances of firms, their effects on household balances have been relatively ignored, even though household transactions balances are larger than those of firms. This lack of research partly reflects that financial innovations spread to households a bit later (in the 1980s and 1990s), after enhancements to computer software whittled down the economies of scale that had made innovations more cost-effective for firms. By providing off-balance-sheet liquidity, the rapid spread of credit cards and credit lines may have enabled households to shift their portfolios away from liquid assets to other assets[9] and may have encouraged households to shift toward risky assets by enabling them to tolerate more price volatility among the assets they hold.

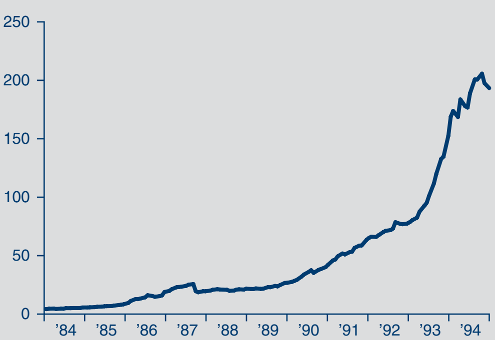
Using cross-section data from 1983, Duca and Whitesell (1995) find that for every 10-percentage-point rise in the probability of owning a credit card, checking accounts are 9 percent smaller, while MMMF plus MMDA balances are 11 percent lower. Although their findings indicate that credit cards significantly affected transactions account levels, they found no statistically significant effect on overall M2 account balances, implying that credit cards primarily affected the composition of M2 in the early 1980s. The impact of credit cards on transactions balances may be even larger today because the share of households owning credit cards is higher, credit cards are more widely accepted, credit card purchases are more quickly processed, and consumers are now offered greater cash rebate/airline mile incentives to use credit cards.[10]

## Globalization

Shifts between nonmonetary and monetary assets also involve foreign assets. In terms of the theoretical model, the costs of transferring from foreign to M2 transactions assets (the $\beta$ for foreign assets) and the risk premium for holding risky foreign assets ($b$) have arguably fallen. Recent studies generally conclude that financial markets across countries have become increasingly integrated (see Obstfeld 1994, 1995 and Feldstein and Bacchetta 1991).[1]

This has manifested itself during the 1990s in at least three ways. First, global bond and equity mutual fund assets have recently grown rapidly (*Figure A*), which may have depressed domestic money holdings and funded overseas activity.[2] Second, financial planners typically recommend that household portfolios contain some foreign assets to improve diversification and to expand the menu of investments having higher expected yields. Third, an enhanced ability to shift funding sources has enabled banks to pull in foreign funds to fund domestic credit growth or use domestic deposits to fund overseas credit growth. In 1993 and 1994, banks pulled in funds from overseas offices—by increasing their net liabilities to foreign offices (*Figure B*)—to fund strong credit growth amid weak M3 growth.[3,4] However, because this funding enables banks to avoid raising deposit rates, it likely restrained M2 and M3 growth in ways captured by the opportunity cost terms in money models.

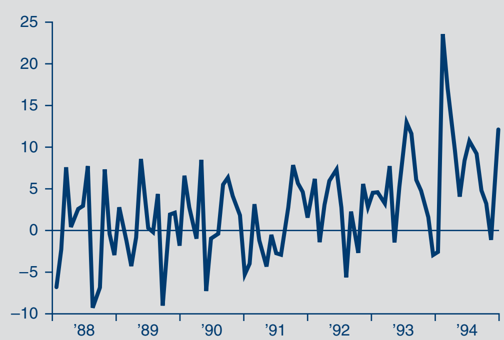
Figure A
**International Bond and Equity Mutual Fund Assets***




* Household and institutional assets in mutual funds classified by the Investment Companies Institute as having investment objectives falling under global bond fund, international, or global equity.

SOURCE: Investment Companies Institute.

Figure B
**Change in U.S. Banks' Net Liability Position with Related Foreign Offices**




[1] Obstfeld (1994) finds that marginal rates of substitution in consumption are converging across countries. Feldstein and Bacchetta (1991) find a decline over time in the positive correlation of domestic savings and investment. Both studies find evidence consistent with the view that capital is flowing across borders to areas characterized by relatively higher credit demand.

[2] While much, but not necessarily all, of this rise reflects substitution between domestic bonds and equity and foreign bonds and equity, some likely reflects shifts between domestic transactions deposits and foreign securities, consistent with a decline in transfer costs and an apparent decline in the risk premium demanded by U.S. residents to hold these foreign assets.

[3] This is measured by the net extent to which commercial banks in the United States are borrowing funds from related foreign offices. The data plotted are from the liability category, "net due to related foreign offices," in the Federal Reserve's H.8 data release.

[4] A related, earlier phenomenon was the rise of Eurodollars (offshore dollar-denominated bank deposits) in the late 1970s and early 1980s (Tinsley, Garrett, and Friar 1981), which prompted the inclusion of overnight Eurodollars in M2 and of term Eurodollars in M3.

Another important innovation is the spread of automatic teller machines (ATMs), which reduce the need to carry precautionary currency balances by enabling households to shift nontransactions M2 deposits into cash or transactions accounts. In terms of the theoretical model, ATMs plausibly lower $\alpha$, the cost of transferring assets within M2, and should thereby lower holdings of transactions deposits and total M2 deposits, with a larger effect on transactions deposits in percentage terms.[11] Using cross-section data from the 1984 and 1986 Surveys of Currency and Transaction Account Usage, Daniels and Murphy (1994a) find that a 100-percentage-point rise in the probability of ATM use increased the velocity of currency (the dollar volume of transactions divided by currency) by 40–45 percent for transactions account holders, while Daniels and Murphy (1994b) estimate that a 5-percent rise in the proportion of ATM users (from 41.7 to 43.8 percent) would boost average transactions account balances by 4.5 percent. Together, these studies imply that ATMs induced households to shift from holding cash to holding transactions account balances in the mid-1980s. Unfortunately, Daniels and Murphy (1994a, 1994b) do not estimate the effect of ATMs on currency plus transactions balances, which corresponds to transactable funds (*D*) in the Milbourne model.

Evidence shows that household payments innovations affected the composition of M2 in the early to mid-1980s. However, the costs of shifting from nonmonetary to transactions assets has fallen since then. Together, lower transfer costs and greater use of nonmoney payments media could now be lowering M2, in addition to altering its composition.[12] For example, many mutual funds offer credit lines and cards with asset management accounts.

## The possible roles of demographics, preferences, and learning

Consumer demand theory implies that changes in attitudes toward risk can affect the asset allocations of households. Some of these changes can arise from shifting demographics and economic factors that lead to increased financial sophistication or greater tolerance for investment risk.

**Demographics.** According to the life-cycle theory of consumption, households save more in their peak earning years before retirement. This theory implies that as the baby-boom generation reaches middle age, the overall savings rate and the portfolio share of higher earning nontransactions assets should rise.

In terms of the Milbourne model, these effects can be accounted for in two possible ways. First, demographic trends may, by increasing the average need to provide for retirement, plausibly raise the willingness of households to invest in risky assets with higher expected long-term yields. In terms of the theoretical framework presented earlier in this article, a lower average degree of risk aversion is reflected in a smaller value of the parameter *b*. This, in turn, raises the risk-adjusted opportunity cost of money for a given spread between the return on nonmonetary assets and money[13] and thereby reduces the demand for money. Alternatively, as people reach their peak earning years, their ratio of income to transactions falls. In terms of the Milbourne model, M2 holdings decline because of a permanent negative shock to $\epsilon$ that reduces the demand for money at each combination of income, asset transfer costs, net cash flow volatility, and opportunity cost spreads (see equation 8).

While the post-1980 decline in the U.S. savings rate may contradict the life-cycle theory,[14] recent evidence supports its implications for asset portfolios. With respect to M2, Duca and Whitesell (1995) find, using cross-section data from 1983, that M2 holdings—and in particular, small time deposit and savings balances—are higher for older age brackets after controlling for other variables (for example, income and wealth). Finally, Morgan (1994) finds that the share of household assets held in the form of stocks and bonds is positively correlated with the population share of 35- to 54-year-olds.[15]

**Changing preferences and financial sophistication.** One factor that could be making monetary assets less attractive is households' increased awareness of investment opportunities in nonmonetary assets and an associated rise in their willingness to tolerate risk in the assets they control (that is, *b* is smaller in the theoretical model presented earlier in this article).[16] Aside from the technological reasons for this trend already mentioned, increased uncertainty in labor markets, changing employment patterns, and the liberalization of IRA/401K accounts have resulted in more households having a hand in managing their retirement assets.[17] This, in turn, has induced households to incur large, predominantly one-time costs to learn more about bond and equity investments for retirement. In addition, because IRA/Keogh balances count toward the minimum balance requirements for opening asset management accounts with many mutual funds, these retirement funds reduce the effective minimum balance requirement on non-IRA/Keogh mutual fund assets. Consistent with this, both IRA/Keogh and non-IRA/Keogh assets with bond and equity mutual funds rose in the mid-1980s, after IRA/Keogh tax laws were eased, and in the early 1990s (see Duca 1995). Additionally, cross-section data indicate a general shift in household portfolios toward bond and equity mutual funds regardless of tax status (see Kennickell and Starr-McCluer 1994).

These factors are consistent with a recent study by Blanchard (1993), who found that the extra return that investors demand from equities over bonds (the "equity premium" of Mehra and Prescott 1985) has been trending downward since the 1940s and abruptly fell in the early 1980s. Five factors likely contributed to the decline in the equity premium: (1) the waning effects of the 1929 stock market crash on risk aversion to stock price movements; (2) investors' realization, following the bond market debacle of the 1970s, that bonds also pose price risk; (3) the rising ownership share of equities held by institutional investors, who are less risk averse and more long-term oriented than households; (4) lower costs for equity diversification, as evidenced by the proliferation of diversified, no-load equity funds; and (5) declining risk aversion among individual investors as they accumulated wealth, gained experience in managing their IRA/Keogh assets, and saw the stock market recover from temporary price corrections in October 1987 and October 1989. As a result of a possible decline in risk aversion, investors may have shifted away from low-risk money assets toward nonmonetary assets that pose higher risk. Nevertheless, because the econometric money results presented earlier could arise for other reasons (for example, technological advances), it is difficult to verify whether and to what extent a systematic shift in risk preferences has noticeably affected money holdings.

## Volatility in financial transactions

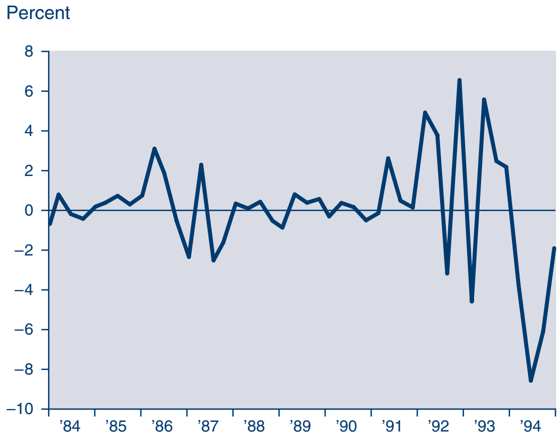
The impact of financial churning on money holdings is more transparent when one recalls that the quantity theory of money implies a relationship between money and transactions, rather than between money and output:

$$(10) \quad V = (P \times T)/M = [P \times Y \times (1 + \epsilon)]/M.$$

In practice, many analysts implicitly or explicitly replace $T$ with the level of production or consumption of goods and services and redefine velocity accordingly. If the ratio of output to total transactions is stable or predictable,[18] then this substitution does not result in any significant errors in predicting near-term nominal GDP. However, if a monetary aggregate is unusually affected by volatility in non-output transactions, then that aggregate may give a false signal about nominal output. Two recent sources of such volatility have been mortgage refinancings and overseas use of currency.

**Mortgage refinancings.** In practice, volatility in commercial financial transactions has not affected the average monthly levels of monetary aggregates much in the recent past. One major reason is that economies of scale allow many firms to use wire or electronic transfers to shift funds from nonmonetary assets to settlement funds without having to hold large money balances for a noticeable period of time. While many well-off households similarly manage their mutual fund balances, the way funds are transferred when households prepay mortgages underlying mortgage-backed securities (MBSs) has had large effects on demand deposits, which constitute a large share of M1 and a smaller share of M2.

Figure 1
**Estimated Effect of MBS Refinancings On Demand Deposit Growth (Seasonally Adjusted Annual Rate)**




SOURCES: Federal Reserve Board; Federal National Mortgage Association; Government National Mortgage Association.

These prepayment effects arise because the Government National Mortgage Association effectively requires MBS servicers to place funds from unscheduled repayments into demand deposit accounts until the fifteenth of the following month before they make principal payments to MBS holders. The Federal National Mortgage Association (FNMA) requires that prepayments be put into custodial accounts until the nineteenth of the following month. While FNMA servicers are not required to put such funds in demand deposit accounts, many do. Because the MBS market was relatively undeveloped until the early to mid-1980s, these effects have only occurred during the mortgage refinancing booms of the mid-1980s and early 1990s. Duca (1990) estimates that swings in MBS prepayments coupled with other, less important effects accounted for one-third of the demand deposit errors from a Federal Reserve econometric model over 1986:1–88:2. Using his methodology, these effects on demand deposits were larger in the early 1990s (*Figure 1*), with estimated effects ranging from adding 6 percentage points to the annualized growth rate in fourth-quarter 1992 to subtracting nearly 9 percentage points in second-quarter 1994. Unless practices change, waves of refinancing activity will likely distort monthly growth patterns of demand deposits and other transactions deposits (see Anderson 1993).

**Foreign use of U.S. currency.** Fluctuations in the share of currency that is held abroad also distorts growth in narrow measures of money, such as M1 and the monetary base (currency plus reserves). According to reports, use of the dollar has surged in countries suffering from high inflation and political uncertainty. If true, then much of the recent movement in the currency component of U.S. money measures may reflect foreign, rather than domestic, nominal economic activity.

## Conclusion

Recent studies generally conclude that the link between nominal output, interest rates, and conventional definitions of broad money has weakened or shifted. By reviewing the recent literature in the context of a microtheoretic model of money, this article attempts to shed light on why these relationships have changed. Three basic factors that may have caused this instability are identified: volatility in financial transactions, technological changes affecting expected transfer costs, and shifts in preferences or demographics that have altered household risk tolerance. In general, while volatility in financial transactions has had substantial effects on narrow monetary aggregates (M1 or the monetary base), it has not been a major source of instability for the broader aggregates. Most of the recent instability in M2's link to nominal GDP does not stem from temporary financial churning or excessive short-term volatility but, rather, reflects an underlying shift in longer term relationships.

By contrast, there is increasing evidence that technological innovations have allowed households to shift away from narrow money or M2 assets toward other financial assets either by reducing asset transfer costs or by allowing households to obtain liquidity via credit lines or electronic transfers. Changing preferences and demographic factors may also be heightening the extent to which other financial assets substitute for money, as manifested by an apparently greater tolerance for risk-taking and a growing share of households that invest their retirement assets.

Changes in technology, and possibly preferences, may continue to alter the relationships between monetary aggregates and nominal variables in coming years. The information revolution will likely foster the spread of electronic financial management, which will further lower asset transfer costs, reduce the need to hold transactable assets in order to obtain liquidity, and lower information barriers that discourage the holding of non-M2 financial assets. In tandem with information advances, greater job mobility, changing employment patterns, and tax incentives are likely to continue bolstering households' role in managing their retirement assets. This greater investment role may, in turn, continue to make households more willing to consider investment alternatives to conventionally defined "money."

## Notes

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1 Waud's (1975) model synthesizes Tobin's (1958) portfolio approach with the cash management insights of Miller and Orr (1966). Milbourne's (1986) model is used in this article because it is relatively more transparent. Milbourne's model is used rather than that of Baumol (1952) and Tobin (1956) for two reasons. First, the Milbourne framework can be used to analyze shifts between nontransactions M2 deposits and non-M2 assets, whereas the Baumol–Tobin framework is a model of transactions balances. Second, unlike the Baumol–Tobin model, the Milbourne model allows for uncertainty in cash flow that plausibly affects households' precautionary demand for money.

2 This follows from the fact that $\partial M2/\partial\beta$ and $\partial M2/\partial\alpha > 0$.

3 This follows from the fact that $\partial M2/\partial b > 0$.

4 If innovations primarily lower $\beta$ and thereby induce shifts between savings deposits and non-M2 assets, then Milbourne's model implies that one should put more emphasis on more narrowly defined money measures that are not affected by such shifts. Nevertheless, even narrow money measures remain vulnerable to innovations, especially given demand shifts that occurred in the early 1980s.

5 Orphanides, Reid, and Small (1994) come to a different conclusion, but their econometric models omit information from the long-run relationship (cointegrating vector) between money and output, in contrast to Duca's model (1994b).

6 This was one of the main motivations for the development of the P* model of Hallman, Porter, and Small (1991).

7 Feinman and Porter (1992) also find evidence that M2's sensitivity to long-term interest rates has risen since the late 1980s.

8 The innovations induced by high interest rates are an example of Lucas's (1976) argument that behavior is not invariant to policy (the Lucas Critique). For a theoretical model of endogenous monetary innovation, see Ireland (1995).

9 Many credit cards enable a household to consolidate

the settlement of many transactions into one monthly payment that has an interest-free grace period. A household can thus lower its *average* liquid deposit balance by making one monthly transfer or by depositing a paycheck before a credit card bill is due.

[10] See Whitesell (1992) for an analysis of how relative costs of using cash, checks, and credit cards affect the use of different payment media.

[11] A decline in $\alpha$ reduces a household's need to hold transactions deposits. Since non-M2 assets have higher pecuniary yields than M2 savings deposits, a decline in $\alpha$ does not induce a rise in savings deposits that offsets the decline in transactions balances.

[12] Research on this issue is currently under way.

[13] Recall that the opportunity cost of money is $[E(r_b) - bvar_{rb} - r_m]$ for transactions accounts in M2 and $[E(r_b) - bvar_{rb} - r_s]$ for nontransactions accounts.

[14] There is much controversy over whether savings behavior supports the life-cycle and permanent income hypotheses. Some, such as Carroll (1992) and Carroll and Kimball (1995), argue that labor income uncertainty limits how far ahead households plan, implying that saving for retirement is much lower than the certainty versions of these theories imply. Others, such as Feldstein (1995a, 1995b, 1974), argue that private pensions, Social Security, and college financial aid programs discourage saving; by implication, the depressing impact of social insurance programs on savings may offset any boost from demographic effects.

[15] Other evidence contradicts Morgan's hypothesis that the aging of the baby boomers accounts for the missing money of the early 1990s. First, the decline in the population share of 35- to 54-year-olds during the early 1970s was not accompanied by unusually strong money growth but, rather, by the first case of the missing money. In addition, aging effects alone cannot account for why money models typically find that M2's sensitivity to long-term interest rates has risen since the 1980s. Finally, the stock and bond market busts of the 1970s may account for the low portfolio share of these securities in that decade, while the higher portfolio shares seen since the mid-1980s may reflect other factors, such as the mid-1980s liberalization of IRAs and Keoghs (see Duca 1995), stronger bond and equity markets since the early 1980s, and a fall in the risk premium on equities (see Blanchard 1993).

[16] While Friedman (1995) points out that households are typically more risk averse than traditional pension fund managers in investing retirement assets, the experience of directing the investment of retirement assets has likely made many people more tolerant of risk for the investments they control.

[17] Since the 1970s, there has been a shift away from defined benefit pension plans toward defined contribution pension plans. One advantage of defined contribution plans is that a greater share of the expected benefits is portable if employment at a particular firm ends.

Gustman and Steinmeier (1992) and Ippolito (1995) estimate that half of the rise in the share of defined contribution plans (401K and traditional defined contribution plans as a share of primary pension plans) owes to employment shifts away from firms that historically have favored defined benefit plans—particularly unionized and larger firms. Ippolito (1995) concludes that the other half of this rise stems from tax law changes that made 401K plans more attractive than pre-1980 defined contribution plans.

[18] For example, if the ratio predictably declines with time, then one can include time trends in predicting velocity ($V$) and then back out a forecast of nominal output.

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