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Would the Addition of Bond or Equity Funds Make M2 a Better Indicator of Nominal GDP?

For some time, the Federal Reserve has sought to keep inflation low to foster maximum sustainable growth.[1] Given the costs of reducing inflation, the Federal Reserve has, since the early 1980s, pursued a policy of preventing inflation from rising.[2] Because monetary policy affects the economy with a lag, implementing this forward-looking, low inflation strategy requires that the Federal Reserve accurately forecast and gauge price pressures.

One way to keep inflation low is to keep nominal gross domestic product (GDP) growing at a moderate pace that, at most, only slightly exceeds the long-run growth rate of inflation-adjusted output.[3] To keep nominal spending growth at such a pace, the Federal Reserve looks at economic indicators to track and forecast nominal GDP. One notable indicator is the monetary aggregate M2, whose relationship to nominal GDP may be breaking down in the 1990s, partly because households are shifting assets away from M2 deposits into bond and equity mutual funds. This article assesses whether M2 would be a better indicator of nominal GDP growth if it were expanded to include bond and, possibly, equity mutual fund assets.[4]

The use of money as an indicator of nominal spending can be justified by the equation of exchange:

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

where M = money, V = velocity (GDP/M), T = inflation-adjusted transactions (measured by inflation-adjusted GDP), P = the price level, and Y = nominal GDP. Holding nominal GDP constant, people typically reduce their money holdings as the gap between the yield on nonmonetary assets (for example, U.S. Treasury securities) and deposit rates widens. Consequently, as this spread, or opportunity cost of holding money, increases, the velocity of money rises.

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[1] See Rudebusch and Wilcox (1994) and Wynne (1993). High inflation lowers long-term growth by increasing uncertainty. High uncertainty not only limits long-term contracting and investment but also reduces efficiency by hindering consumers' and firms' search for the lowest prices, which, in turn, hinders market forces from shifting resources to the lowest cost producers. Because the U.S. tax code does not index capital gains and depreciation for inflation, high inflation also lowers long-run growth through raising the real after-tax cost of capital, thereby reducing investment.

[2] Reducing inflation from high levels has often been accompanied by recessions as consumers and firms often need to experience economic slack before reducing their wage and price demands to levels in line with low inflation.

[3] For example, if long-run output growth is 2.5 percent under low inflation, then over the long run, 4.5-percent nominal GDP growth implies 2-percent inflation, using the implicit GDP price deflator.

[4] Brayton and Tinsley (1993) find that using the federal funds rate as an instrument to hit nominal GDP as an intermediate target outperformed trying to hit price level or money intermediate targets in terms of stabilizing the price level. This article assesses the relative performance of M2 variants, not as potential intermediate targets but as information variables that could be used to help forecast short-run nominal GDP growth.

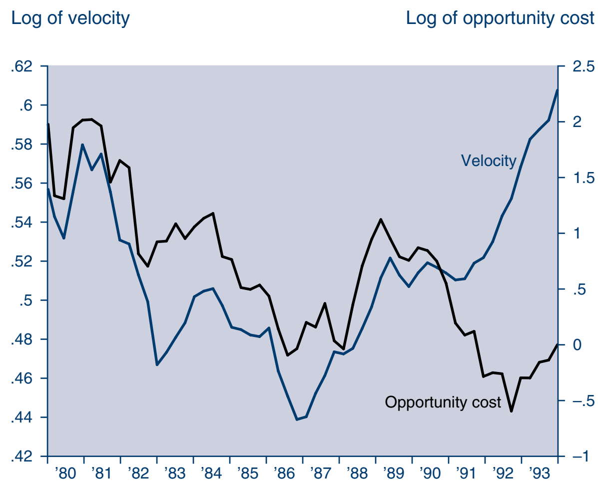
If interest rate variables can reliably predict velocity, then nominal GDP can be inferred from money and interest rates. This is an important implication for policy-making because estimates of nominal GDP are available after a considerable lag and are subject to sizable revisions, whereas good information on interest rates and monetary aggregates is available with very little lag.

When M1's velocity was predictable, M1 was used as an indicator of nominal GDP. However, this relationship began breaking down in the mid-1970s when unusually weak M1 underpredicted nominal GDP. Moreover, the link between M1 and nominal GDP became somewhat looser after the deregulation of deposits in the early 1980s, which made the demand for M1 very interest rate sensitive. Consequently, M1 has been used less and less as an indicator of nominal GDP.

Up through 1990, evidence had mounted that the demand for M2 was more predictable than the demand for M1 (see Hetzel and Mehra 1989 and Moore, Porter, and Small 1990). Partly as a result, M2 became a more popular indicator of nominal GDP and of inflation (see Hallman, Porter, and Small 1991). However, since the early 1990s, M2 growth has been unusually weak and has been underpredicting nominal GDP growth. As shown in Figure 1, this breakdown occurred in the early 1990s when M2's velocity began diverging sharply from a conventional measure of its opportunity cost. This unusual weakness is confirmed in econometric models of M2, as documented by Anderson and Collins (1994), Duca (forthcoming), and Feinman and Porter (1992).

One common explanation for this estimated shortfall, or "missing M2," is that households shifted their assets from M2 deposits into bond and, possibly, stock mutual funds (see Anderson and Collins 1994 and Duca, forthcoming). If such portfolio shifts are too difficult to accurately model, then one option is to redefine M2 to include bond and, possibly, equity funds. Indeed, something similar happened in the early 1980s, when M2 was redefined to include money market mutual funds, or MMMFs (Simpson 1980 and Duca 1993a, 4). More recently, Duca (forthcoming) has found that M2 is less explainable in money models compared with an M2 aggregate that is redefined to include bond funds. In addition, Becsi and Duca (forthcoming) and Duca

Figure 1
M2 Velocity and Its Opportunity Cost



SOURCE: Board of Governors, Federal Reserve System.

(1994) have found that expanded M2 aggregates that include either bond or bond and equity funds easily outperformed M2 in forecasting inflation in recent years using the P-star inflation model of Hallman, Porter, and Small (1991). The current study extends this research by assessing the ability of such expanded aggregates to forecast nominal GDP growth relative to that of M2.

This article is organized as follows. The second section intuitively reviews what occurs when money demand relationships break down and discusses why households may substitute bond and equity mutual funds for M2 deposits. The next two sections assess the relative ability of different versions of M2 to explain future nominal GDP growth. The following section assesses the stability of such models. The article concludes by discussing the policy implications of the findings.

Why money demand breaks down and the recent role of mutual funds

The recent breakdown in the relationship between M2's velocity and conventional measures of its opportunity cost likely reflects that these measures have not tracked the decline in the attractiveness of M2 deposits relative to other financial assets. Possible explanations for this include that other asset yields have become more important, that government regulations have made M2 less attractive, and that the private sector has made bond and equity funds more attractive (Duca 1993b, forthcoming).

In the past, unusual weakness in money growth has been associated with declines in bank competitiveness (see Duca 1993b). One relevant example is the "missing M1" of the mid-1970s, when the interaction of high interest rates and regulations impaired the ability of banks to offer deposit and credit services to firms. In response, many firms substituted repurchase agreements and cash management for non-interest-bearing demand deposits. In addition, many large firms shifted away from bank loans toward commercial paper. This shift reduced compensating demand deposit balances that were held in proportion to firms' bank loans. At the same time, households shifted out of deposits into money market mutual funds, which paid interest rates above the deposit rate ceilings at banks. By expanding the number of households that could directly or indirectly invest in commercial paper, money funds made commercial paper cheaper than bank loans for low risk firms and opened a new channel through which short-term credit could flow from households to firms.

In response to these episodes, the Federal Reserve redefined M2 in 1980 to internalize shifts between bank and non-bank-like deposits so as to create a better economic indicator. Over time, M2 has evolved to include new instruments, most notably, money funds and their bank counterpart, money market deposit accounts (MMDAs).[5] Because of redefinitions, much of M2's apparent value as an indicator before the early 1980s is misleading. In recent years, bond and equity mutual funds have grown rapidly at the expense of money funds and small time deposits, both of which are components of M2.

Bond and equity funds. Bond and equity funds are substitutable for M2 deposits and for direct bond and equity investments. Because they are mutual fund shares, they offer investors lower risk compared with direct holdings of securities because the funds are diversified and professionally managed. Many funds are also in asset management accounts that provide liquidity by giving investors credit lines and by allowing investors to shift assets among equity, bond, and checkable money funds at little or no cost. Bond funds are good substitutes for M2 for two other reasons. First, because most bond fund assets are invested in U.S. government and other high-grade bonds, they generally have low credit risk. Second, bond funds typically offer higher expected returns than M2, owing to the longer maturity of assets that bond funds hold. However, this longer maturity creates a price risk for investors because bond prices fluctuate. Compared with bond funds, equity funds offer higher expected returns and higher risk, which may make them less substitutable for M2 deposits. Thus, it is unclear, a priori, whether M2 plus bond and equity funds (M2+) is a better indicator of nominal GDP than M2 plus bond funds (M2B).

How the recent missing M2 period reflects a bypassing of banks. How can a bypassing of the banking system through bond and equity funds lead to an episode of missing money? Suppose a firm raises $100 by issuing bonds bought by a bond fund. The bond fund pays the firm with $100 from selling mutual fund shares to a household, which obtains the $100 by withdrawing $100 from a small time deposit. Using the $100 raised from issuing a bond, the firm pays down $100 in bank loans. Note that any rise in checking accounts used to make any of these transfers is temporary because the rise in checking accounts runs off after the transfers are completed.

On the firm's balance sheet, total liabilities are unchanged as the $100 decline in loans matches the $100 rise in bonds. Total household assets are also unchanged because the $100 decline in small time deposits matches the $100 rise in bond funds. The bond fund, however, sees a $100 increase in both assets and liabilities, while banks see a $100 decline in loans and deposits. Thus, M2 falls by $100, while the sum of bond funds and M2 (M2B) is unchanged.

In recent years, many firms have shifted from bank loans toward bonds and equity for finance, partly because the spread of the prime rate over

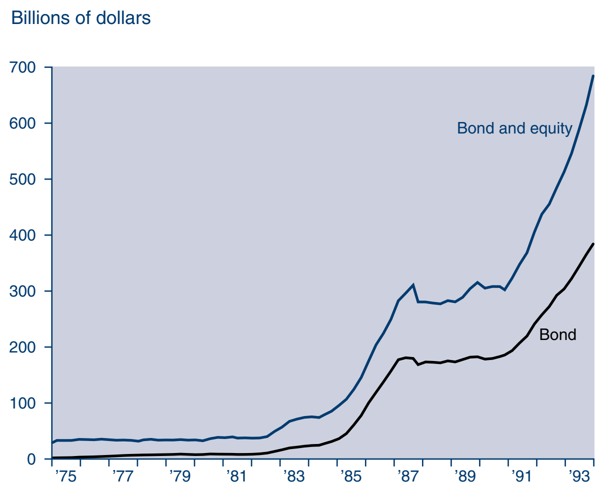
[5] *M2 includes currency, demand deposits, savings deposits (passbook savings plus MMDAs), noninstitutional MMMFs, small time deposits, overnight repurchase agreements, and overnight Eurodollar deposits.*

short-term rates has risen as banks passed on the higher cost of the new risk-based capital standards. At the same time, households have shifted out of M2 to bond and equity funds. Essentially, bond and equity funds provide another channel through which long-term finance can flow from households to firms.

Bond and equity fund growth. Adding either bond funds or both bond and equity funds to M2 may help restore M2 as an economic indicator by internalizing shifts between bank deposits and bond and equity fund assets. Figure 2 plots bond funds and bond plus equity funds held by households. As with M2, both series exclude Individual Retirement Account (IRA) and Keogh assets along with institutional holdings. (For details on M2+ and M2B, see Collins and Edwards 1994 and Duca, forthcoming, respectively.)

In the mid-1980s, households flocked to bond and equity funds as the eligibility restrictions on IRAs and Keogh accounts were loosened. As more households learned about these funds when opening IRAs, many shifted assets into non-IRA/Keogh fund accounts as well. Balance sheet data suggest that more of these fund inflows came from direct holdings of bonds and equities than from M2. After 1986 tax reform tightened IRA and Keogh rules, bond and equity funds were about flat during the late 1980s. More recently, these funds have surged, this time more at the expense of M2 than of directly held securities. Excluding IRA and Keogh assets, adding bond funds or both bond and equity funds to M2 produces an adjusted M2 that has grown faster than M2 in recent years.

Figure 2
Household Bond and Equity Mutual Fund Assets



SOURCE: Investment Company Institute.

Empirical results using lags of only money and nominal GDP

This section simply analyzes the ability of M2, M2B, and M2+ to indicate near-term nominal GDP growth. After the basic empirical model is presented, results from regressions and from out-of-sample forecasts are discussed.

Basic empirical model. Nominal GDP growth (y) is estimated from regressions using four lags of itself, four lags of money growth (m), and the one-quarter lag of the long-run relationship between the logs of nominal GDP and money (EC):

$$(2)\qquad y_t = \beta_o + \sum_{i=1}^{4} \beta_i y_{t-i} + \sum_{i=1}^{4} \gamma_i m_{t-i} + \alpha EC_{t-1},$$

where β_o is a constant, β_i is the estimated effect of nominal GDP growth in quarter $t-i$, γ_i is the estimated effect of money growth in quarter $t-i$, and α reflects the impact of deviations of nominal GDP from its long-run equilibrium relationship to the level of money holdings.[6]

Essentially, the error-correction term accounts for information relating the log levels of output and money and in doing so, prevents the model from letting nominal output levels drift too far away from the level of money (see Hafer and Kutan 1992 for a related discussion). For estimating equation 2, the EC term is based on the equation of exchange (equation 1) and the assumption that the long-run velocities of M2, M2B, and M2+ are stable throughout the sample period. In particular, the average velocity of these aggregates are substituted into the equation of exchange to obtain

$$(3)\qquad EC = \log(\textit{nominal GDP}) - \log(\textit{money}) - \log(\textit{average velocity}).$$

[6] The models used in Orphanides, Reid, and Small (1994) to compare M2 and M2+ do not include error-correction terms as discussed by Duca (1994). Models tested by Feldstein and Stock (1994) also suffer from this criticism.

EC can be thought of as the gap between nominal spending and its equilibrium level as implied by money balances. Thus, for example, a positive value of *EC* implies that nominal GDP growth will decline to restore equilibrium, all else being equal. For this reason, *EC* is expected to have a negative sign.

By contrast, the sum of coefficients on lags of money growth should be positive, as implied by the equation of exchange (equation 1). In theory, the sum of coefficients on lagged nominal GDP growth could be positive or negative. However, in practice, movements in nominal GDP growth tend to persist for some time, reflecting swings in real growth and in inflation.[7]

Regression results. Using data on the levels of M2, M2B, and M2+ that go back to first-quarter 1959, equation 2 is estimated over the in-sample period 1960:2–94:1. For each run, one of the three definitions of M2 is used in defining the error-correction (*EC*) term and lagged money growth variables.

As shown in models 1 through 3 of Table 1, the fit (corrected R^2) of equation 2 is highest for M2, somewhat lower for M2B, and lower yet for M2+. For each aggregate, lags of money growth are jointly significant according to F-statistics. T-statistics indicate that the error-correction terms for M2 and M2B are marginally significant, while that for M2+ is insignificant. Together, all terms involving money (the *EC* and lagged money growth terms) are jointly significant for each aggregate, and, as expected, the sum of coefficients on lagged money growth is positive and the error-correction term is negative. This pattern is also obtained when the error-correction terms are based on estimated cointegrating vectors using the Johansen and Juselius (1990) procedure (models 4 through 6). These findings indicate that each M2 aggregate helps explain future movements in nominal GDP growth over the full sample period.

To help control for short-run velocity movements induced by changes in relative rates of return, models 7 through 12 add four lags of opportunity cost measures to equation 2. To control for substitution with short-term investments, one type of opportunity cost term (*SOC*) is based on the log of the spread between the three-month Treasury bill rate and the average return on money. To account for shifts with longer term investments, a second type of opportunity cost term (*LOC*) is based on the log of the spread between the ten-year Treasury note yield and the average return on money. Federal Reserve Board data on M2 average rates of return are used for M2 and in constructing weighted average rates of return for M2B and M2+. The weighted average rates of return for M2B and M2+ assume that the return on bond funds is approximated by the ten-year Treasury yield and the return on stock funds, by the annualized percentage change in the S&P 500 index of stock prices.[8] The long-term opportunity cost terms are jointly significant, while the short-term cost terms are not. The positive sign on the sum of the *LOC* coefficients could reflect that the velocity of the M2 aggregates rises with *LOC*.[9]

The qualitative results for models 7 through 12 differ slightly from those of models 1 through 6 on two counts. First, the relative R^2s of the M2+ models improve greatly, and the error-correction (*EC*) terms are significant in the M2+ models, perhaps reflecting that the opportunity cost terms partly control for the impact of capital gains and

[7] *The persistence of nominal GDP movements depends partly on monetary policy. As an extreme example, if the Federal Reserve removed all but the most temporary movements in nominal GDP growth around a constant moderate growth rate, then changes in nominal GDP growth would unwind in one quarter, and the one-quarter lag of nominal GDP growth would be negatively correlated with the current growth rate. In practice, temporary shocks to nominal GDP growth often last longer than one quarter, and there have been some persistent swings that make this correlation positive. Nevertheless, the example implies that the Federal Reserve's shift toward stabilizing nominal GDP growth or inflation will make the sum of coefficients on lags of nominal GDP growth less positive. Indeed, this sum declines in size as the sample is extended from 1983 onward, which is consistent with Emery (1994), who finds that changes in the inflation rate became less persistent after the early 1980s; this may reflect that Federal Reserve efforts to keep inflation low after 1983 made any deviation of inflation from this modest pace rather short-lived.*

[8] *While not an ex ante rate, the stock price change may be a reasonable proxy. Whenever the level of a spread was less than 0.5 percent, a Taylor-log approximation of the log of the spread was used.*

[9] *Alternatively,* LOC *is positively correlated with the gap between long-term and short-term interest rates, which is positively related to nominal GDP growth. However, this latter correlation is statistically insignificant.*

Table 1

Predicting Nominal GDP With Money and Opportunity Costs[1] (1960:2–94:1)

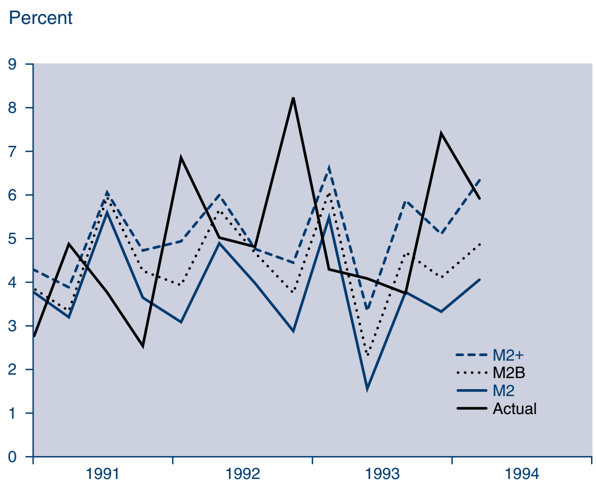
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
GDP	.3616	.4142^{+}	.4642*	.3559	.4142^{+}	.4577*	.0908	.0915	.1105	.0753	.0915	.1019
	(1.71)	(2.22)	(2.70)	(1.77)	(2.22)	(2.64)	(.24	(.25)	(.28)	(.23)	(.25)	(.27)
EC_{t-1}	–.0546^{+}	–.0442^{+}	–.0322				–.0727*	–.0676*	–.0578*			
	(–1.87)	(–1.81)	(–1.56)				(–2.22)	(–2.56)	(–2.37)			
EEC_{t-1}				–.0601*	–.0442^{+}	–.0293				–.0672*	–.0676*	–.0531*
				(–2.23)	(–1.81)	(–1.46)				(–2.41)	(–2.56)	(–2.40)
M2	.3129*			.3368**			.3424**			.4305**		
	(2.83)			(3.56)			(3.22)			(4.48)		
M2B		.4042**			.4042*			.4377**			.4377**	
		(4.49)			(4.49)			(4.76)			(4.76)	
M2+			.4012**			.4072**			.4398**			.4673**
			(4.51)			(4.59)			(4.99)			(5.31)
SOC							–.0120	–.0109	–.0111	–.0100	–.0109	–.0105
							(1.76)	(1.12)	(1.26)	(1.29)	(1.12)	(1.14)
LOC							.0168*	.0143*	.0171**	.0112^{+}	.0143*	.0148**
							(2.52)	(2.76)	(3.05)	(2.06)	(2.76)	(2.98)
F: *M* & *EC*[2]	5.18**	4.83**	4.35**	5.52**	4.83**	4.28**	5.89**	5.10**	4.91**	6.11**	5.10**	4.98**
R^2	.2224	.2135	.2005	.2312	.2135	.1987	.2569	.2590	.2552	.2624	.2590	.2559

[1] Sums of coefficients are provided for lags of GDP, money, and interest rate variables with F-test statistics for the joint exclusion set of lags given in parentheses. Underneath the coefficient on each *EC* term is its t-statistic in parentheses. Estimated constants are omitted to conserve space.

[2] F-statistic on the error-correction term (*EC*) and lagged money growth.

* (**,$^{+}$) denotes significance at the 95-percent (99-percent, 90-percent) confidence level.

Figure 3
Nominal GDP Growth Forecasts Using Money



losses on stock fund assets. Second, the M2B model has a negligibly higher R^2 than that of the M2 model when quantity theory based-EC terms are used (models 7 through 9), whereas M2 has an edge when estimated EC terms are used instead (models 10 through 12).

Forecasts. In-sample results overstate the ability of M2 to forecast nominal GDP growth in the 1990s. This can be shown by forecasting nominal GDP growth starting in first-quarter 1991 using coefficients from models 1 through 3 estimated over 1960:2–90:4 and actual values of all right-hand side variables since then. As shown in Figure 3, M2 underforecasts nominal GDP growth, while M2B and M2+ perform well.[10] Forecasts using M2B and M2+ yielded average errors of –.22 and +.25 percentage points at an annual rate, respectively, compared with –2.64 percent for M2 (*Table 2*). In addition, the sums of squared errors are 74 and 78 percent lower for M2B and M2+, respectively, than for M2. Although not statistically significant, these differences are economically meaningful and suggest that M2 has recently been distorted by portfolio shifts into bond and equity funds that are implicitly taken into account by M2B and M2+.

Regression results using lags of money, interest rates, and nominal GDP

A number of researchers have investigated interest rate variables as alternative indicators of economic activity that contain information beyond that in monetary aggregates (for example, Friedman and Kuttner 1992).[11] Motivated by this research, this section addresses the issue of how the three M2-type aggregates perform in the presence of interest rate indicators.

Empirical model. Several sets of regressions and simulations are run based on adding lags of interest rate variables (x) to equation 2:

$$(4) \qquad y_t = \beta_o + \sum_{i=1}^{4} \beta_i y_{t-i} + \sum_{i=1}^{4} \gamma_i m_{t-i} + \sum_{i=1}^{4} \delta_i x_{t-i} + \alpha EC_{t-1},$$

where δ_i denotes the coefficient reflecting the effect of the ith lag of x.

For each definition of money, four interest rate variables are assessed using equation 4: (1) the federal funds rate (*FF*), (2) the constant maturity yield on ten-year Treasury notes (*10YRT*), (3) the spread between the yield on ten-year Treasury notes and the federal funds rate (*YCURVE*), and (4) the spread between the six-month prime commercial paper rate and the six-month Treasury bill rate (*PAPERBILL*).[12] In addition to running a set of three money regressions for each interest rate variable, an extra set of regressions is run that

[10] *Forecasts (not shown) were also done using models 7 through 9. Once again, M2B and M2+ yielded smaller sums of squared errors than M2, while, on average, M2 tended to underpredict nominal GDP growth to a greater degree than M2B or M2+. However, each of these models yielded worse forecasts than corresponding models without lags of* SOC *and* LOC. *Models adding lags of* SOC *but not of* LOC *yielded forecasts that were similar to those in Figure 3.*

[11] *Another motivation for including interest rates is that they may help control for movements in velocity because they are correlated with M2 opportunity cost movements. However, because deposit deregulation has altered the correlation of opportunity cost and interest rate variables, controlling for velocity movements is better handled by adding terms like* SOC *and* LOC.

[12] *For background on these variables, see Bernanke and Blinder (1992) on the federal funds rate, Stock and Watson (1989) on the yield curve spread, and Bernanke (1990) and Friedman and Kuttner (1992) on the paper-bill spread.*

Table 2
Nominal GDP Forecast Results (Forecasts over 1991:1–94:1 based on a 1960:2–90:4 Insample Period)

***Lagged Money and Nominal GDP with an Error-Correction Term*[1]**

Aggregate	Average annualized error[2] (Percent)	S.S.E.
M2	–2.64	.00159
M2B	–.22	.00042
M2+	+.25	.00035

***Lagged Money, Interest Rates, and Nominal GDP with an Error-Correction Term*[3]**

Aggregate	Average annualized error (Percent)	S.S.E.
M2	–1.16	.00079
M2B	–.53	.00060
M2+	+.16	.00048

[1] The error-correction term is based on a constant velocity and the quantity theory of money.

[2] Annualized, average percentage point error. Negative entries denote underpredictions of nominal GDP growth.

[3] The error-correction terms are based on cointegrating relationships estimated over the 1960:2–90:4 in-sample period.

includes the federal funds rate and the ten-year Treasury yield.

Because *PAPERBILL* and *YCURVE* have no trends, their lags can be added to equation 4 without altering the EC term. However, because the ten-year Treasury yield and the federal funds rate do have trends,[13] it is not valid to simply add lags of these last two interest rate variables without changing the EC term and without first transforming the lagged rate terms into changes. To handle this problem, four lags of the ten-year Treasury yield and the federal funds rate are used ($\Delta 10YRT$ and ΔFF), and the EC term is redefined to control for the long-run relationship between nominal output, money, and interest rates.[14] The EC terms are from estimates of the long-run relationships for the following sets of variables for each definition of M2: (1) log of nominal GDP, log of money, and *FF*; (2) log of nominal GDP, log of money, and *10YRT*; and (3) log of nominal GDP, log of money, *FF*, and *10YRT*.[15]

Regression results. Results for models 13 through 24 (*Table 3*) indicate that the lags of the paper-bill spread (*PAPERBILL*), changes in the federal funds rate (ΔFF), and changes in the ten-year Treasury yield ($\Delta 10YRT$) are each jointly significant at the

[13] Chi-squared statistics from Dickey–Fuller unit root tests rejected that the levels of the federal funds rate (17.7—trend—and 17.8—no trend—at four lags) and ten-year Treasury yield (15.2—trend—and 15.5—no trend) were stationary at the 4-, 6-, 9-, and 11-percent significance levels, respectively.

[14] Qualitative results were similar using the EC term from equation 3.

[15] Using the Johansen and Juselius (1990) procedure, the EC term was based on the estimated cointegrating vector for each combination of interest rates, money, and nominal GDP that had the highest degree of significance according to test results on the rank of the cointegration space. For each combination, only one cointegrating relationship had a significance level of 5 percent.

Table 3

Predicting Nominal GDP With Money and Interest Rates[1] (1960:2–94:1)

Variable	Model 13	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19	Model 20	Model 21	Model 22	Model 23	Model 24
GDP	.4159	.4350^{+}	.5405**	.4037	.4489^{+}	.5612**	.0974	.0989	.4510*	.1718	.1922	.5991**
	(2.02)	(2.29)	(4.16)	(1.74)	(2.22)	(3.55)	(.56)	(.58)	(2.80)	(.53)	(.63)	(3.49)
EC_{t-1}	–.0627*	–.0463^{+}	–.0424*	–.0527	–.0505	–.0335	–.0360**	–.0155*	–.0010	–.0043^{+}	–.0045^{+}	–.116
	(–2.15)	(–1.87)	(–2.02)	(–1.73)	(–1.76)	(–1.43)	(–2.95)	(–2.57)	(–.41)	(–1.97)	(–1.97)	(–1.58)
M2	.2292*			.2893^{+}			.6539*			.6025**		
	(.81)			(2.09)			(6.74)			(3.64)		
M2B		.3649^{+}			.3819*			.7443**			.5887**	
		(2.06)			(3.44)			(6.26)			(3.53)	
M2+			–.00002			–.00002			–.000002			–.000002
			(1.33)			(1.07)			(.86)			(1.22)
Δ*FF*										.0005^{+}	.0004*	–.0036**
										(2.43)	(2.50)	(3.83)
Δ*10YRT*							.0089*	.0111*	–.0003^{+}	.0063^{+}	.0084*	.0047
							(2.76)	(3.09)	(2.05)	(2.07)	(2.47)	(1.55)
PAPERBILL	.0019*	.0034*	.0031**									
	(2.60)	(2.56)	(5.24)									
YCURVE				.0005	–.0004	.0009^{+}						
				(1.25)	(1.13)	(2.02)						
F: *M* & *EC*[2]	3.28**	2.96*	1.99^{+}	4.14**	3.74**	1.41	5.59**	5.01**	.70	2.92*	2.83*	1.01
R^2	.2537	.2450	.2169	.2217	.2105	.1387	.2628	.2482	.1182	.2776	.2750	.2210

[1] Sums of coefficients are provided for lags of GDP, money, and interest rate variables with F-test statistics for the joint exclusion set of lags given in parentheses. Underneath the coefficient on each *EC* term is its t-statistic in parentheses. Estimated constants are omitted to conserve space.

[2] F-statistic on the error-correction term (*EC*) and lagged money growth.

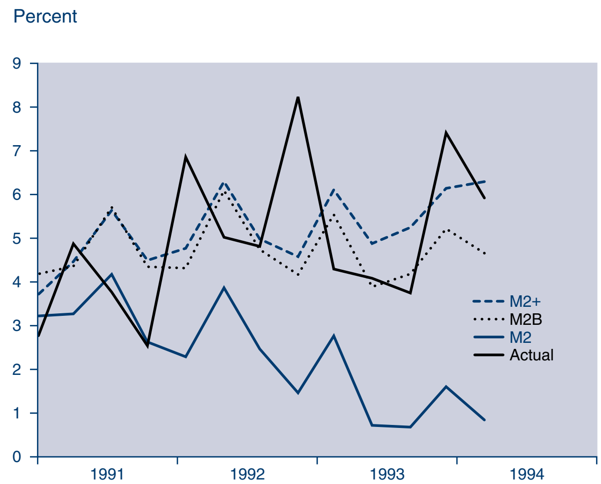
* (**,$^{+}$) denotes significance at the 95-percent (99-percent, 90-percent) confidence level.

10-percent level or better. Thus, these interest rate variables, unlike the yield curve (*YCURVE*), help forecast nominal GDP growth above and beyond the information content in the M2-type aggregates. The models including both the federal funds rate and the ten-year Treasury yield (models 22 through 24) have the best fit (corrected R^2s) among the models for each broad monetary aggregate.

The relative performance of M2, M2B, and M2+ is similar to earlier results, with M2 yielding a slightly higher R^2 than M2B and with M2+ performing the worst among the three. However, in models including both the federal funds rate and the ten-year Treasury yield, the full-sample R^2s of the M2B and M2 models (models 22 and 23) are closer. For all three aggregates, the sum of coefficients on lagged money growth is positive, lags of money growth are jointly significant, the error-correction term is insignificant but correctly signed, and the lags of money and the error-correction term are jointly significant in models 22 through 24. Overall, the results indicate that M2, M2B, and M2+ provide useful information in predicting movements in nominal GDP growth.

Forecast results. Based on in-sample fit, the models containing both the federal funds rate and ten-year Treasury yields are used to evaluate the relative forecast performance of the three M2-type aggregates. As before, the forecasts of nominal GDP growth start in first-quarter 1991 using coefficients from equation 2 estimated over 1960:2–90:4 and actual values of all right-hand side variables since then.[16] Figure 4 illustrates that M2 underpredicts nominal GDP growth, while M2B and M2+ yield somewhat better forecasts. As shown in Table 2, forecasts using M2B and M2+ have average errors of –.53 and +.16 percentage points at an annual rate, respectively, compared with –1.16 percentage points for M2. The sums of squared errors are .00060 and .00048 for M2B and M2+, respectively, or 24 percent and 39 percent lower than that for M2 (.00079), respectively. Together with Figure 3, these findings imply that M2 noticeably underpredicts nominal GDP growth when used alone but to a lesser extent than when used along with interest rates. One explanation for this pattern may stem from a tendency for interest rate models to overpredict nominal GDP in recent years, while M2 growth tends to underpredict it. As a result, these tendencies may be offset when both types of variables are included.

Figure 4
Nominal GDP Growth Forecasts Using Interest Rates and Money



Evidence on stability

This section assesses whether the three M2 aggregates have been relatively stable predictors of nominal GDP growth since the early 1980s.

Rolling regression joint exclusion tests. One way of assessing the stability of the forecasting models is to test whether all the money variables in them can be excluded using different sample periods. The rolling regression approach is used here, where the initial sample used is 1960:2–83:1 and each subsequent sample period adds one further observation. First-quarter 1983 is chosen as the starting point on the grounds that M2 was redefined for a second time in 1983 to include MMDAs and that the last change in monetary operating procedures occurred in late 1982.

Models 1 through 3 were chosen for these F-tests because their error-correction terms do not need to be reestimated for each sample, unlike

[16] *Forecasts using M2B and M2+ that omitted interest rates have better fits than those corresponding runs that include these two interest rates. This may reflect a change in the information content of interest rates over time.*

models 16 through 18, which would require 144 searches for a unique error-correction term. For each model, Figure 5 plots the F-statistic on the joint exclusion of the error-correction term and the four lags of money growth. For all three aggregates, these terms are always jointly significant. However, the joint significance statistics for M2B and M2+ decline in the mid-1980s while that for M2 declines in the early 1990s.

Chow tests. As a further check, Chow tests are run on models 1 through 3 over 1984:1–93:4 to test if the model residuals become unusually large. The F-statistics from these tests are plotted in Figure 6.[17] Chow tests cannot reject stability for any of the aggregates.

Dummy variable tests. Because Chow and joint exclusion tests do not necessarily rule out minor shifts in the relationship between M2 aggregates and nominal GDP, a series of dummy variable tests are run for the two periods of rapid growth in bond and equity funds: the mid-1980s and early 1990s.

A dummy variable equal to 1 after fourth-quarter 1991 (*DUM92*) is added to models 1 through 3 and 22 through 24 to test for a shift in the constant that persists after fourth-quarter 1991; this definition is consistent with Figure 3, which shows M2 underforecasting nominal GDP growth since early 1992. *DUM92* is significant only in the noninterest rate model using M2 (*Table 4*), with a positive sign on *DUM92* implying that the dummy variable helps offset the tendency of M2 to underpredict nominal output in the early 1990s. This finding is consistent with earlier forecasting results showing that M2 noticeably underpredicts nominal GDP growth when used alone but not when used along with interest rates.[18]

As discussed earlier, M2B and M2+ were likely distorted in the mid-1980s by inflows that reflected shifts away from direct holdings of securities (see Duca 1992). This may explain why models using M2 have slightly better full-sample fits than corresponding models that use M2B even though the models using M2B perform better in recent years.

Figure 6
Chow Tests for Residual Stability

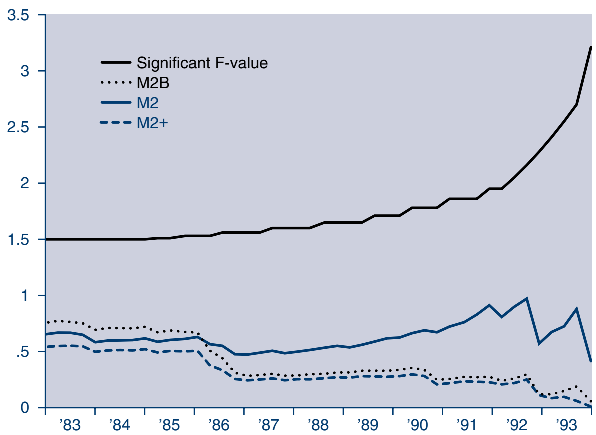
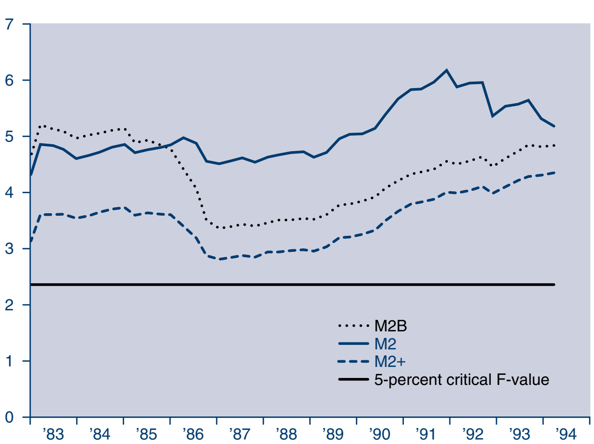


Figure 5
Joint Exclusion Tests for All Money Variables



[17] *Although the critical F-values plotted in Figure 6 are not technically correct, Andrews' (1993) correction would raise the critical values, which would not affect the qualitative results since the lack of stability is rejected using the uncorrected critical F-values.*

[18] *This finding is consistent with other runs (not shown) that added variables interacting* DUM92 *with lagged money growth and the error-correction term. These variables were insignificant, with the exception that the product of* DUM92 *and EC was significant at the 10-percent level in the noninterest rate model using M2 without terms interacting* DUM92 *and lags of money growth.*

Table 4
Dummy Variable Tests

Dummy Variable Tests for an Early-1990s Shift in the Constant

Added variable	Money only			Money and interest rates		
	M2	M2B	M2+	M2	M2B	M2+
DUM92	.0078*	.0022	.0008	.0046	.0027	.0009
	(2.04)	(.63)	(.21)	(1.09)	(.68)	(.25)
$\bar{R}^2$	.2416	.2097	.1944	.2747	.2657	.2576

Dummy Variable Tests for a mid-1980s Shift in the Constant

Added variable	Money only			Money and interest rates		
	M2	M2B	M2+	M2	M2B	M2+
D8587	–.0063*	–.0097**	–.0084*	–.0051	–.0068+	–.0064+
	(–1.98)	(–2.95)	(–2.55)	(–1.46)	(–1.94)	(–1.81)
$\bar{R}^2$	.2401	.2589	.2340	.2805	.2858	.2775

T-statistics are in parentheses.

** (*,+) denotes significance at the 1-percent (5-percent, 10-percent) level.

To test this hypothesis, a dummy variable (*D8587*), equal to 1 over 1985:1–87:1 and 0 otherwise, is added to models 1 through 3 and 22 through 24 to test for a temporary shift in the constant occurring over 1985:1–87:1. In models containing interest rates, *D8587* is significant only in models using M2B or M2+ and with a negative effect that helps control for how portfolio shifts from non-M2 assets bolstered bond and equity funds relative to M2 (*Table 4*). In models without interest rates, *D8587* is significant in models using M2, M2B, and M2+, suggesting that M2 may have also been bolstered by shifts away from direct security holdings. With or without interest rates, the models using M2B have higher R^2s than those of corresponding models using M2 or M2+, with the latter having similar R^2s.[19]

These results imply that the links between nominal GDP and M2B shifted in the mid-1980s, and the shifts are best modeled as a temporary shift in the constant term. Furthermore, the larger estimated impact of *D8587* in the models using M2B and M2+ relative to corresponding models using M2 supports the view that bond and equity fund inflows in the mid-1980s partly reflected shifts away from direct security holdings.

Conclusion

Recent instability in M2 and portfolio shifts into bond and equity funds have raised the issue

[19] *A dummy (*MFCUM*) was added to test for an increasing shift in the constant term during the mid-1980s that then levels out and becomes permanent. Mimicking movements in the shares of bond funds in M2B and bond and equity funds in M2+,* MFCUM *equals 0 before 1985:1, 1 in 1985:1, rises by 1 each quarter through 1987:1, and equals 9 after 1987:1.* MFCUM *was (marginally) significant only in the models using M2B. For models using M2B and M2+, adding* D8587 *increased model fit (*R^2*s) more than adding* MFCUM *instead.*

Alternatively, M2B and M2+ could have had a different relationship to nominal GDP growth in the mid-1980s. To test this, other runs (not shown) added variables to models 1 through 3 and 22 through 24 interacting D8587 *with lags of money growth and the error-correction term. These interactive variables were insignificant, with the exception that they were jointly significant at the 10-percent level in the noninterest rate model using M2B. This finding highlights the importance of including interest rate information.*

of whether M2 should be more broadly defined to include either bond or bond and equity funds. Two criteria for addressing this issue are whether the broader aggregates are more controllable and whether they are better information variables that can be used to forecast nominal variables.

With respect to controllability, adding assets less directly influenced by the Federal Reserve to M2 would likely make M2 less controllable. However, because broader M2 aggregates internalize portfolio shifts that may be induced by Federal Reserve actions affecting interest rates, broader M2 aggregates may be less volatile if the impact of such shifts outweighs the impact of variation in securities prices on the value of bond and stock fund assets. This is an empirical issue that requires further research and more data.

As for judging which M2 aggregates are better information variables, several criteria include whether a more broadly defined M2 aggregate is more explainable in money demand models, yields better inflation forecasts, and is a better near-term indicator of nominal GDP growth. Previous work has shown that the demand for M2B may be more explainable than that of M2 (Duca, forthcoming) and that M2B and M2+ yield more accurate forecasts of inflation in the early 1990s than does M2 within the P-star framework (Becsi and Duca, forthcoming, and Duca 1994).

This article focuses on the relative ability of these aggregates to predict nominal GDP growth and finds that M2B and M2+ have outperformed M2 in recent years. However, when money is used in conjunction with short- and long-term interest rates, this recent advantage is not as large. Interestingly, although M2B yields better in-sample fits than M2+, M2+ has performed better recently, consistent with reports that stock funds are being increasingly used as substitutes for some M2 deposits.

These findings imply that along with M2, M2B and M2+ should be monitored as information variables. Nevertheless, given current changes in asset behavior and that past financial innovations have altered asset portfolios, the link between broad monetary aggregates and economic activity is vulnerable to shifts. Such shifts can stem not only from technological change or new financial products but also from shifts in monetary policy and household preferences that alter time series relationships. This was true not only for M2 in the early 1990s but also for M2B and M2+ in the mid-1980s. These considerations point to the need for further research and to the wisdom of not relying on any single monetary aggregate as the sole guide to setting monetary policy.

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