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Alternative Measures of Money as Indicators of Infla- tion: A Survey and Some New Evidence

IN OCTOBER 1982, the Federal Open Market Committee (FOMC) officially de-emphasized M1 as an intermediate target variable in conducting monetary policy. The FOMC further reduced the emphasis given to M1 in 1987 by not setting target ranges for its rate of growth. The typical explanations given for this de-emphasis have stressed a breakdown in the 1980s in the relationships between M1 growth and both the rate of inflation and the growth rate of nominal GNP that had characterized the post-war period.[1]

The de-emphasis of M1 as a policy guide has prompted many observers to seek a replacement. Some analysts have argued that financial innovations and deregulation have altered the relationship between interest-bearing and non-interest-bearing assets. One group of individuals, for example, has argued that the interest-bearing components of M2 are good substitutes for the narrower set of assets in M1 and, on this basis, concluded that M2 now is the best monetary aggregate for policy actions. Another group, reasoning that interest-bearing accounts act more as savings balances than transaction accounts, has advocated the narrow measure of M1A (currency plus non-interest-bearing checkable deposits).[2] Still others have advocated the use of weighted monetary aggregates, arguing that the individual assets included in M1, M2 and the

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[1]Specifically, in the postwar period through 1981, M1 growth was related closely to nominal GNP growth over a period of one year and to the rate of inflation over a period of three to five years. The breakdown in these relationships also has been discussed as a decline in the growth rate of M1 velocity. See Stone and Thornton (1987), for example, for a survey of explanations that have been offered for this abrupt shift in what had been quite stable relationships. Tatom (1988) and others, in contrast, have disputed

whether historical relationships between M1 and nominal variables were fundamentally different in the 1980s.

[2]For the arguments favoring M2, see Hetzel (1988). For the evidence favoring M1A, see Hafer (1984) and Darby, et al. (1989).

broader aggregates possess different degrees of "moneyness" according to the interest they pay. If these assets have different degrees of moneyness, they should be weighted differently when added together.[3]

This article focuses on research that addresses both the composition and weighting issues in deriving a new monetary aggregate from the first principles of demand analysis.[4] It surveys this work and evaluates the performance of two new money stock measures as indicators of future inflation.

WHY IS THE DEFINITION OF "MONEY" IMPORTANT?

What truly constitutes "money" in the real world is an interesting and important issue because, as economic theory predicts, money has powerful effects on economic activity. Unfortunately, theory alone does not offer explicit guidance in choosing a unique and unambiguous real world counterpart to the abstract theoretical concept of "money." Without clear theoretical guidance, many economists have adopted the conclusion that the appropriate definition of money is the one that serves best in the chosen empirical application.[5]

One theoretical framework that attributes an important causal role to money in determining fluctuations in economic activity is the Quantity Theory of Money. This theory is based on the Equation of Exchange, which typically is written as:

(1) MV = PT,

where M is the quantity of money, V is its velocity of circulation, P is the average price level and T is the volume of transactions. The Quantity Theory derived from this equation predicts that the price level varies directly with the quantity of money. In its strictest form, which has been subjected to empirical testing, the Quantity Theory predicts that the causation runs from changes in money to changes in prices (but not the reverse) and that, accounting

for the short-run influences of other variables, changes in money and prices are proportional.[6]

Obviously, the definition of money is important in testing such propositions. The definition of money is also important for monetary policy purposes. Assume, for example, that a central bank believes the implications of the Quantity Theory. It might then direct its policies to achieve a growth rate of money consistent with zero inflation. This raises the issue of how to measure money in the real world. As Laidler (1989) points out, both critics and advocates of the Quantity Theory frequently disagree about the appropriate definition of money to test its implications. Thus, a central bank committed to achieving a policy goal for "P" still faces considerable uncertainty about which "M" should be targeted and how to do so.

FINANCIAL INNOVATIONS AND THE CONDUCT OF MONETARY POLICY

For more than 30 years after World War II, the trend growth rate of M1 velocity was nearly constant at 3 percent. For many economists, this stability made M1 growth a reliable leading indicator of the effects of current monetary actions on future economic activity. As figure 1 shows, however, this seemingly stable trend was disrupted sharply in 1981, perhaps because of the nationwide introduction of interest-bearing checkable deposits in January of that year. Because these deposits not only paid rates of interest that were close to those on savings deposits but also allowed depositors to write checks directly on these deposits, the hypothesis was that at least some portion of NOW account balances were savings. If so, these new accounts combined "idle" savings balances with "active" transaction balances in traditional demand deposits. The larger quantity of balances in M1 accounts, for the same level of GNP, would be reflected in a fall in the growth rate of M1 velocity.[7] More important, uncertainty about the effects of financial innovations on M1,

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[3]See, for example, Barnett (1983), Barnett et al. (1984) or Spindt (1985).

[4]See Belongia and Chalfant (1989) and Swofford and Whitney (1990a,b).

[5]See Friedman and Schwartz (1970), p. 91.

[6]See Laidler (1989) for a thorough review of the Quantity Theory's history, implications and controversies.

[7]See Gordon (1984), for example, for more discussion of this argument.

Figure 1
Log of M1 Velocity[1]
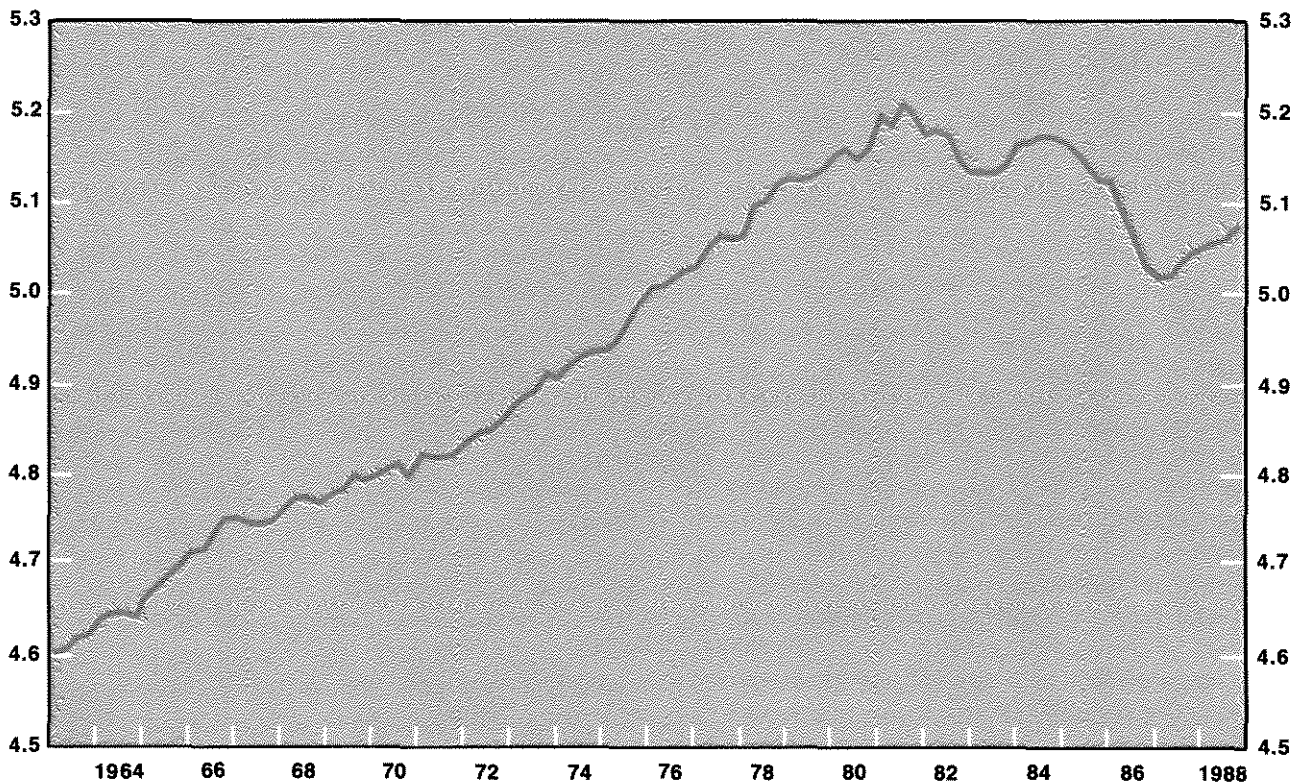
[1]Velocity data are indexed to a base value of 100 in I/1963.

in addition to velocity growth, weakened M1's informational content in predicting future price movements.[8]

This uncertainty has been an important element of monetary policy discussions. The record of the FOMC, for example, shows that, at the meeting of February 8-9, 1983:

> Committee members' views varied considerably on the weight to attach to M1 ... the performance of that aggregate had been subject over the past year or more to substantial uncertainties related to the growing role of NOW accounts and an apparent shift in the behavior of its income velocity ... Only modest allowance was made for the possibility that the new Super NOW accounts would draw funds into M1 from other sources.[9]

Two months later, in a statement to Congress, Federal Reserve Chairman Paul Volcker reported:

> To some extent — but it cannot be measured with any degree of certainty — the decreases in "velocity" may reflect the changing nature of M1; with interest-bearing NOW and Super NOW accounts making up an increasingly large proportion of M1, this aggregate may be influenced by "savings" behavior as well as "transactions" motives. That is a longer-term factor, and the growth in M1 over the shorter-run may have been affected by the reduced level of market rates — particularly relative to interest-bearing NOW accounts — and slowing inflation as well. *The range of uncertainty on these points is substantial* (emphasis added) and has led the Federal Open Market Committee to place less emphasis on M1 in the implementation of policy over the short term.[10]

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[8]Monetary control also will be impaired if shifts of savings-type balances into interest-bearing checkables weakens the link between the monetary base and M1.

[9]*Federal Reserve Bulletin*, April 1983, pp. 288-289.

[10]*Federal Reserve Bulletin*, May 1983, p. 338.

Nonetheless, after being "monitored" but not targeted in 1983, M1 was chosen as an intermediate target of monetary policy from 1984 to 1986. In 1987, the FOMC again declined to set target ranges for M1 growth, instead choosing to emphasize M2 and M3 in policy discussions.[11] These official statements point to considerable uncertainty about how interest-bearing checking accounts were being used and how their use might affect the behavior of the monetary aggregates generally, the behavior of M1 specifically, and the relationship of M1 to important economic variables, such as spending and prices.

APPROACHES TO THE DERIVATION OF ALTERNATIVE MONETARY AGGREGATES

Choosing a monetary aggregate requires at least four steps.[12] First, the group of assets to be included in the aggregate must be selected. Second, individual asset categories must be aggregated appropriately. Third, the aggregate must be analyzed in terms of the central bank's ability to control it. Finally, its performance in some ultimate use must somehow be evaluated.

Before the 1980s, those who were skeptical of using the M1 aggregate for policy analysis generally focused on the fourth point, the methodology used to link M1 either to nominal GNP growth or the inflation rate. Many critics, for example, raised issues about the exogeneity of changes in the money stock, reverse causation running from income or prices to money or technical problems associated with estimation of reduced-form equations.[13] While such methodological criticisms continued throughout the 1980s, much more attention in recent years has been focused on the aggregates themselves rather than their final uses. The official money stock measures particularly have been criticized both for the weighting scheme used to ag-

gregate individual asset categories and for the specific assets used to construct an aggregate. These criticisms are discussed in more detail below.

Composition of Monetary Aggregates

Historically, debates about what is money have focused on the things—coins, bank notes, etc.—that should be included in a monetary aggregate. Before the emergence of interest-bearing checkable deposits, the logic behind the assets included in M1 coincided with Irving Fisher's dictum, "Money never bears interest... ."[14] For economists of this school, the monetary aggregate also was viewed as containing only those assets that could be readily exchanged for goods.[15]

Since the birth of money market mutual funds (MMMFs) and, even more so, the nation-wide introduction of NOW accounts in January 1981, however, the question of which assets are correctly identified as money has become complicated . Many argue that the historical justification for the group of assets in M1 is no longer clear. What, for example, distinguishes the NOW accounts in M1 from MMDAs or MMMFs, which appear to have characteristics similar to NOWs but are excluded from M1? Conversely, because NOW accounts pay interest and can be used as savings accounts, should they be excluded from a monetary aggregate designed to include those assets that can be readily exchanged for goods?

Tests for Weak Separability and Asset Selection

One approach to deciding which financial assets should be considered as a group for ag-

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[11]For more detail on the uncertainty about the behavior of different aggregates, see Hafer and Haslag (1988) or Garfinkel (1990).

[12]Barnett, et al. (forthcoming) argue that this process also involves addressing a fifth step—monitoring how closely the index number tracks the economic aggregator function—that has been overlooked by previous research in this area.

[13]See, for example, de Leeuw and Kalchbrenner (1969), Davis (1969), Gramlich (1971), Goldfeld and Blinder (1972) and B. Friedman (1977), among others.

[14]The full quote is, "Money never bears interest except in the sense of creating convenience in the process of exchange." See Fisher (1963), p. 9.

[15]Ibid., p. 8.

gregation treats financial assets as commodities that are held for the services they provide. In this approach, individuals are assumed to allocate their financial wealth across the spectrum of available assets, according to their preferences for the characteristics of each asset and the relative returns each asset yields. Treating financial assets in this manner leads to inserting them as arguments in the utility function of the representative individual and analyzing the demand for financial assets in much the same way that the demand for other commodities can be studied.[16]

This approach leads to a search for "separable" commodity groups. Separability is related to the notion of multi-stage budgeting in which consumers first allocate their budget across broad expenditure categories such as "shelter," "transportation," "clothing" and "food." Then after allocating, say, 20 percent of their total expenditures to food, further allocations are made within the food group as expenditures are budgeted for "meat," "dairy products," "fruits and vegetables" and so on. The process continues with the gross expenditures for meat allocated across beef, pork and chicken. The result of this process can be pictured as a branching tree diagram in which broad commodity groups are continually divided into smaller, more specific commodity groups.

To decide which financial assets may be grouped under the heading "money," the research task is to find what goods are in the "money" group and what goods are unrelated to utility from the services of monetary assets. This identification can be done formally by testing whether an asset collection is weakly separable from other assets and commodities. Indeed, Barnett (1982, pp. 695-96), has shown that a necessary condition for the existence of a monetary aggregate is that the subset of monetary goods is weakly separable from nonmonetary goods.[17]

Weak separability, a result from demand theory, implies that the consumer's marginal rate of substitution between two assets in a group is unaffected by the quantities of any good not in the group. This ensures that changes in the quantities consumed of goods not in the group will not affect the marginal utilities derived from goods within the group. The practical implication of weak separability is that it permits demand analysis that is concerned only with a specific collection of assets; it does not require that one study all goods in the economy.

To view the problem differently, let some group of assets, A, consist of goods a1, a2 and a3; that is, $A = (a_1, a_2, a_3)$. Assume, however, that this group is not weakly separable from other assets; instead, the separable group also should include asset a4. By arbitrarily cutting off the group to include only a1-a3, changes in the quantity of a4 consumed would affect the marginal rates of substitution within the group of a1-a3 and give rise to seemingly unstable preferences for asset holdings or, from a production function point of view, an unstable transactions technology. In a more concrete sense related to traditional empirical work, the omitted variable a4 would affect an estimated demand function for an aggregate variable constructed from assets a1-a3 by acting as an omitted shift variable. For example, estimating a money demand function based on M1 balances when MMDAs should be part of this group could be the source of instability in such a demand function.[18]

Recent work by Swofford and Whitney (1987, 1988) and by Belongia and Chalfant (1989) has examined the conditions of weak separability for the asset groups that correspond to M1 and M1A (M1 minus interest-bearing checkable deposits), as well as broader collections of assets that include more components of M2. This research checked for the existence of a well-behaved utility function that was consistent with

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[16]There has been a steady controversy about whether money can be modeled as an argument in the utility (or production) function; however, Feenstra (1986) has shown that this approach is equivalent to other standard approaches, including the Clower (transactions) constraint; see Clower (1970).

[17]For more detail on weak separability and other points related to finding an admissible monetary aggregate, see Varian (1982, 1983), Barnett (1987), Ishida (1984), Serletis (1987), Fayyad (1986), Hancock (1987) and Belongia and Chalfant (1989).

[18]In fact, studies of money demand functions often include a dummy variable around 1981-82 to capture the effects of financial innovation. Aggregates based on weakly separable groups, however, should be stable and eliminate the need to account for shifts in functional relationships with dummy variables.

the financial balances held in various forms at existing prices and levels of income. Upon finding that the data were consistent with demand theory, the separability tests were then used to identify the specific financial assets, in combination with currency, that were weakly separable from other financial assets in the utility function. These weakly separable asset groups were then candidates for aggregation.

Weighting of Asset Components

Another criticism of M1 as an indicator of monetary actions—specifically when examining why the financial innovations of the early 1980s might be associated with the sharp slowing in M1 velocity growth—focuses on the potential errors associated with the simple-sum weighting scheme used to derive M1 and other official money stock measures. The simple-sum aggregation scheme, which gives the same weight to currency as it does to dollars deposited in accounts with quite different characteristics, violates fundamental aggregation principles, so the argument goes.

For example, a dollar of currency (which is termed pure money because it pays no explicit rate of return) is weighted equally in M1 with a dollar in a NOW account deposit. This weighting occurs even though the NOW account pays a market rate of return that, in recent years, has approximated the return on savings deposits. Thus, even though some NOW account balances may be held as savings, they are included dollar for dollar in M1 with the other assets that traditionally have been considered to be transactions balances.[19] Such equal weights are justified only if the assets are perfect substitutes for each other; both the raw data as well as much empirical work demonstrate that these conditions do not hold.[20]

The fundamental point here is that each dollar in a NOW account should receive less weight than a dollar of currency, which presumably is held purely for the conduct of transactions. Similarly, if the assets collected in M2 are found to be a weakly separable group, each of its components should be weighted differently with the weights declining as own-rates of interest rise. At this point, it should be noted that, while simple-sum weighting is clearly wrong in principle, it may not in the past have mattered empirically; that is, it may not have produced major distortions in the estimated relationships between "money" and other variables. It also should be noted that the interest in weighted monetary aggregates is not new; the deficiencies of simple-sum aggregates were recognized more than 20 years ago.[21]

By formalizing this intuitive argument, Barnett and others constructed a series of Divisia monetary aggregates.[22] A Divisia index, which is merely one of many statistical index number formulas that have desirable aggregation properties, has an advantage over simple-sum aggregation in that it internalizes pure substitution effects. This means that the measured value of the index will not change unless the utility or production functions underlying the index actually produce a different level of utility or output. In contrast, the failure of simple-sum weighting to internalize substitution effects means it can change even when there has been no change in the flow of transaction services from the group of assets.

Unlike the simple-sum weighting scheme currently used, any good index gives different weights to balances held in different deposit categories. In the case of the Divisia index applied in monetary studies, the weights are based essentially on the difference between the rate of return on a pure store of value (typically, a long-term bond) and each asset's own rate of

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[19]Some analysts, in fact, have attempted to infer the proportion of NOW balances held for that asset's savings characteristics (its interest rate and deposit insurance) on the basis of turnover data relative to demand deposit turnover rates. See Spindt (1985).

[20]See Barnett (1982) for the technical arguments about the shortcomings of simple-sum weighting. Ewis and Fisher (1984, 1985) and references they cite are sources that find low elasticities of substitution between M1 components and near-monies.

[21]See, for example, Friedman and Schwartz (1970), pp. 151-52.

[22]See Barnett (1983, 1984) and Barnett, Offenbacher and Spindt (1981, 1984).

return.[23] The larger this interest rate differential, the higher the opportunity cost of holding a particular financial asset and the greater its "moneyness." The largest interest differential and, therefore, the greatest "moneyness" occurs for currency, whose rate of return is zero.

The research cited above has put the definition and measurement of monetary aggregates on firmer economic and statistical footing; the specific aggregates it has produced, however, have been subject to criticism. One criticism has been that weighting may be, or at least may have been, unimportant empirically. Specifically, the relative performance of simple-sum vs. Divisia measures against various final uses criteria has been disputed.[24] Perhaps the most important criticism, however, is that this research has failed to analyze whether the re-weighted versions of the official monetary aggregates, M1, M2, M3 and L, represent asset groupings that can or should be aggregated. The shaded insert at right illustrates how these issues can affect the behavior of a monetary aggregate.

DIVISIA M1A AND THE MONEY METRIC INDEX

Previous research that has tested for weakly separable asset groups has suggested two weighted monetary aggregates as possible improvements over traditional simple-sum measures. These new aggregates are Divisia M1A and the Money Metric Index (MMI).[25] The former includes only currency and traditional demand deposit balances, which are weighted by their user costs to construct a Divisia aggregate.[26] The latter includes a wider range of assets: currency, demand deposits, other (interest-bearing) checkable deposits, savings deposits and overnight repurchase agreements. The interested reader is directed to the original sources for detail on the testing strategies that led to the choices of these asset groups.

The velocities for these two measures and M1 are shown in figure 2. Perhaps the most interesting aspect of figure 2 is that, in the early 1980s, when M1 velocity began its heralded

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[23]A Divisia monetary aggregate is constructed in the following manner: Let q_{it} and p_{it} represent the quantities and user costs of each asset to be included in the aggregate at time t. The expenditure share on the services of monetary asset i in period t is:

$$s_{it} = \frac{p_{it}q_{it}}{\sum_j p_{jt}q_{jt}}.$$

The user cost of each asset is measured as:

$$p_{it} = \frac{P_t^*(R_t - r_{it})(1 - M)}{1 + R_t(1 - M)},$$

where P_t^* is the geometric mean of the CPI and GNP deflator, R_t is the maximum available expected holding period yield, r_{it} is the observed or imputed nominal own rate of return on asset i and M is the average marginal tax rate [see Barnett (1978)]. The growth rate of a Divisia aggregate then can be written as

$$G(Q_t) = \sum_{i=1}^{n} s_{it}^* G(q_{it}),$$

where $s_{it}^* = 1/2(s_{it} + s_{i,t-1})$, and n is the number of assets in the aggregate. For a more detailed explanation of this weighting procedure and its application to the Divisia aggregates, see Barnett (1978) and Barnett et al. (1984).

[24]Barnett (1984), Serletis (1986), Hancock (1987) and Ishida (1984) find the Divisia aggregates to be superior to simple-sum measures in a variety of final uses (e.g., stability of velocity, relationship with nominal spending or prices). Batten and Thornton (1985), against the standard of performance in nominal spending equations, find little difference between the two.

[25]The more narrow measure, Divisia M1A, is derived in Belongia and Chalfant (1989). The broader measure, the Money Metric Index (MMI), is discussed in Swofford and Whitney (1990b). Both groupings were determined by nonparametric tests for weak separability described in Varian (1982). While parametric tests for weak separability have been reported by Serletis (1986) and Hancock (1987), Swofford and Whitney (1986) have noted that such tests are sensitive to the choice of the functional form for the utility or production function.

[26]The user cost formula is derived in Barnett (1978). We use a simplified formula:

$$\text{user cost} = \frac{P_t^*(R_t - r_{it})}{1 + R_t}$$

Although the return on something completely illiquid, such as the return on human capital, would be the preferred choice to represent R_t, practical measurement issues have led to the use of long bond rates in empirical studies.

The approach used by Swofford and Whitney (1990a) actually calculates upper and lower bounds for the index rather than a unique value for each time period. To avoid any problems associated with choosing an incorrect value of their index, we simply used the Divisia weighting scheme to aggregate the asset collection they identified.

Calculating A Divisia Monetary Aggregate

The example below illustrates the consequences of using a monetary aggregate that is composed of the "incorrect" assets or that employs simple-sum weighting of its constituent assets even if they are the proper ones to use. For simplicity, we assume that only four asset categories exist: currency, traditional (non-interest-bearing) demand deposits, NOW accounts (interest-bearing checkable deposits) and savings deposits. We then define M1 as the sum of C + DD + NOWs and M2 = M1 + Savings. From these definitions, we construct four aggregates: simple-sum M1 and M2 and weighted versions of M1 and M2.

For purposes of these examples, we start with the following initial conditions:

Dollar Balances in Each Asset Category

C = 100   DD = 50   NOWs = 50;   Savings = 50;
M1 = 200   M2 = 200 + 50 = 250

Interest Rates on Each Asset

Benchmark rate (R) = 0.1; r_c = 0; r_{DD} = 0.03; r_{NOW} = 0.05; r_{SAV} = 0.05.

User Costs

A simplified expression for the user cost formula, cited in footnote 26, is:

$p_{it} = \dfrac{R_t - r_{it}}{1 + R_t}$. Thus, the user cost for each asset is:

C: $\dfrac{.1 - 0}{1 + .1} = \dfrac{.1}{1.1} = .0909$

DD: $\dfrac{.1 - .03}{1.1} = 0.0636$

NOWs: $\dfrac{.1 - .05}{1.1} = 0.04545$

SAV: $\dfrac{.1 - .05}{1.1} = 0.04545$

Shares

Expenditure shares are calculated as

$s_{it} = \dfrac{p_{it}q_{it}}{\sum_i p_{it}q_{it}}$. Thus, for M1 assets:

C: .0909(100) ÷ 14.55 = 62.5

DD: .0636(50) ÷ 14.55 = 21.9

NOWs: .04545(50) ÷ 14.55 = 15.6

Similarly, for M2 assets:

C: .0909(100) ÷ 16.82 = 54.1

DD: .0636(50) ÷ 16.82 = 18.9

NOWs: .04545(50) ÷ 16.82 = 13.5

SAV: .04545(50) ÷ 16.82 = 13.5

The divisors in each column, 14.55 and 16.82, are the sums of expenditures on all assets in that group. With this information, we can illustrate how the two issues of concern—weighting and composition—affect the behavior of each aggregate.

An Illustration: Assume, for quarterly data, $10 is shifted from savings to demand deposits. For the simple-sum aggregates, the dollar changes in levels and corresponding growth rates are:

M1:	**Change**	**Growth rate**
100 + (50 + 10) + 50 = 210	+10	21.55%
M2:		
100 + (50 + 10) + 50 + (50 − 10) = 250	0	0%

Weighted M1: The growth rate of a Divisia index is constructed as the growth rate of each asset category weighted by the average shares of the two periods.[1] New budget shares at quarter t + 1 are 59.9 (C), 25.1 (DD) and 15.0 (NOWs). Average shares (S*) for the two periods are 61.2 (C), 23.5 (DD) and 15.3 (NOWs). This yields:

0.612*(0) + 0.235*(growth rate of DDs)

+ 0.153*(0)

= $0.235 \left[\left(\dfrac{60}{50} \right)^4 - 1 \right]$ * 100

= 0.235*(1.0736)* 100 = 25.23%

Weighted M2: For this aggregate, the budget share of DDs rises while that of savings de-

clines. Using the average budget shares across the two periods and recognizing that the changes in C and NOWs both equal zero, we have:

$$0 + .2069* (107.36) + 0 + .1211* (-59.04)$$

$$= 22.22 + (-7.15) = 15.07\%$$

Thus, a simple $10 shift from one category to another produces growth rates ranging from

zero (simple-sum M2) to 25.23 percent (Divisia M1).

The intuition behind these results is that $10 has been shifted from one deposit category (savings) to another with greater "moneyness" because demand deposits have a higher user cost, i.e. their own rate of return is lower. Thus, for example, Divisia M2 will show growth while simple-sum M2 will not because $10, while still in M2, has been shifted into a category that receives a larger weight when its growth rate is calculated.[2]

[1] The weighted measures are indexes set equal to 100 in the same base year as opposed to M1 and M2, which are measured in dollars. Thus, comparisons of changes in levels are uninformative.

[2] Ideally, we would like to isolate the effect of an interest rate change alone, but this is not done for two reasons.

First, economic theory predicts changes in quantities demanded or supplied in response to changes in relative prices. Second, as can be seen from the calculations for the growth rate of a Divisia index, the index will not change unless quantities change.

Figure 2
Logs of Velocity of M1, Divisia M1A, and MMI[1]
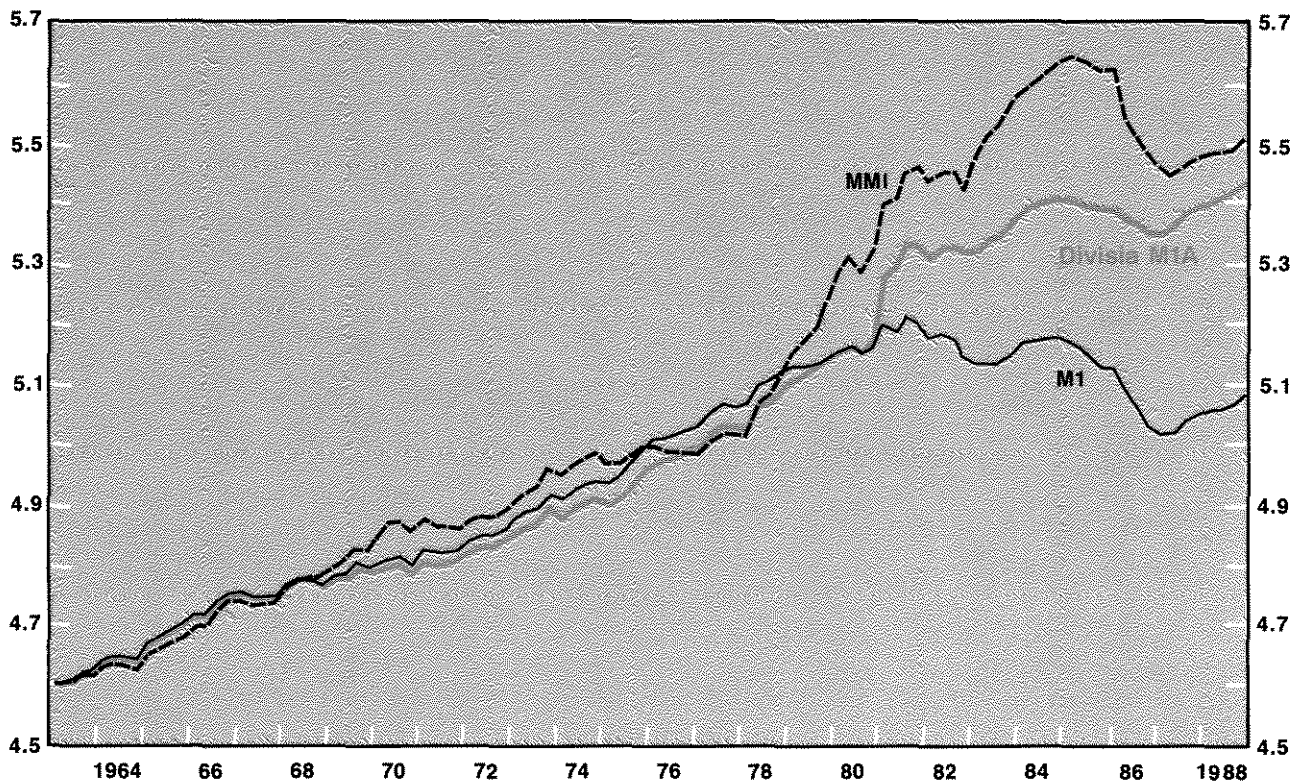
[1] Velocity data are indexed to a base value of 100 in I/1963.

Figure 3
Growth Rates of M1, Divisia M1A, and MMI

Percent   **Percent**
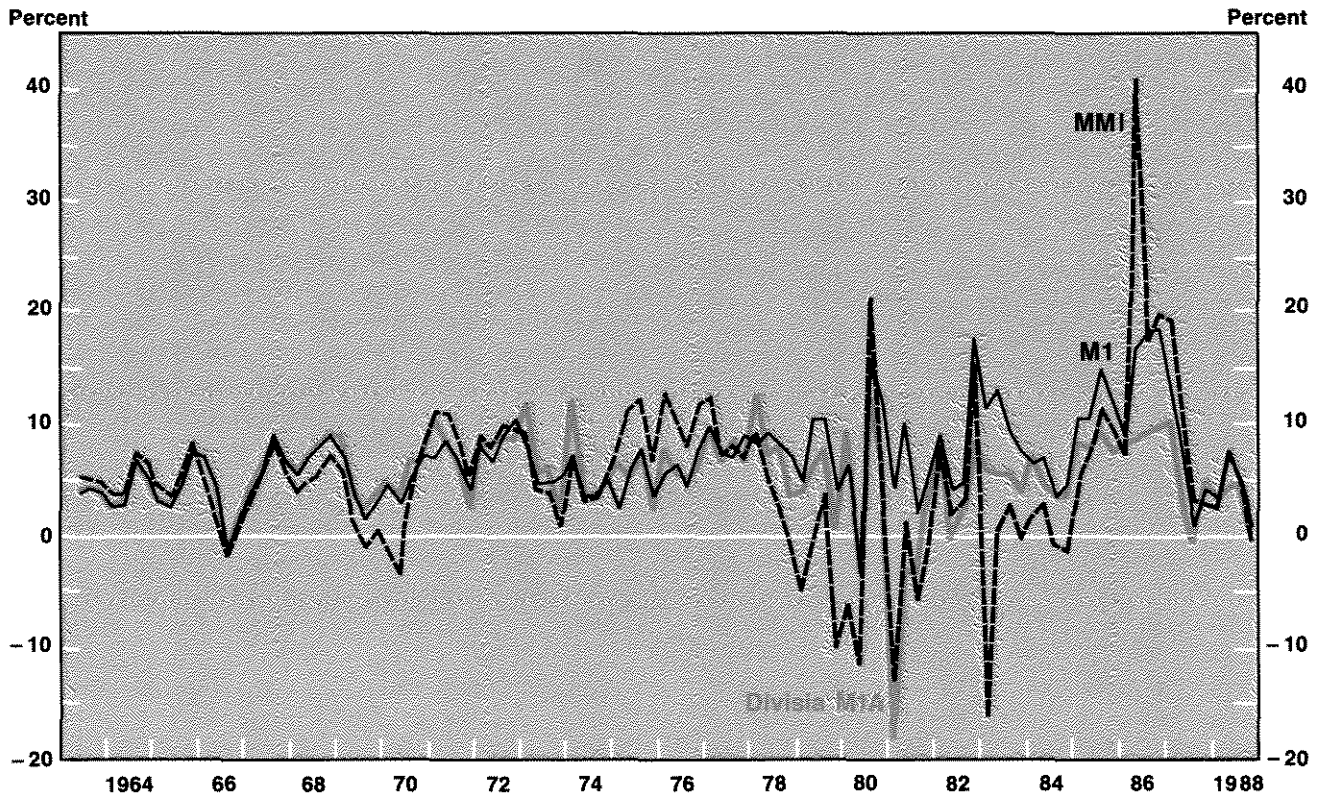
decline, the velocities of both weighted aggregates actually increased. Also interesting is the sharp drop in MMI velocity around 1986, at a time when M1 velocity also fell sharply but Divisia M1A velocity fell only moderately. Since 1986, all three appear to be on similar paths.

These trends are exhibited in different form in figure 3, which depicts the growth rate of each aggregate. Although the three series often track closely, there are notable exceptions. For example, the growth of MMI slows sharply in 1978-79 whereas the other measures continue to grow at rates near 5 percent. In 1980-81, both weighted measures show sharply negative growth rates while M1 growth continues to be positive; this is particularly interesting because the decline in MMI over the same period would refute the idea that this episode merely reflects shifts out of narrow M1A balances into interest-bearing accounts. In general,

figure 3 indicates that the behavior of these aggregates was much more divergent throughout the 1980s than in previous decades.

Long-Run Relationships between Monetary Measures and the Price Level

The empirical performance of alternative monetary aggregates and their usefulness as targets for monetary policy might be evaluated in a variety of ways, for example, the use of St. Louis-type spending equations or short-run money demand functions with tests of coefficient stability over time. Either approach is quite sensitive to specification; for example, the results appear to depend crucially on both the sample period chosen and the lag lengths used

for all explanatory variables.[27] Money demand equations also are sensitive to the specification of such things as the scale and interest rate variables and the equations' short-run dynamics. Such short-run empirical controversies, however, are irrelevant for our purposes in this study. As Laidler (1990) has pointed out, many key discussions of money's effect on economic activity specifically emphasize long-run relationships, testing hypotheses with annual or cycle average data, and never argue that economists should be able to model the short-run dynamics inherent in quarterly data.

Therefore, we want to focus on one desirable characteristic of any aggregate monetary variable: stability in its long-run relationship with a variable of primary importance to monetary policy. If we return to the equation of exchange, $MV = PT$, we can see that long-run inferences about future movements in the price level (P) can be made from the behavior of the appropriate money stock (M) if we have some notion about the long-run behavior of output (expressed as the volume of transactions, T). For this analytical framework to be useful, the velocity of circulation (V), given some long-run forecast of output, must be stable. Indeed, this simple framework for predicting the long-run behavior of inflation is the basis of the widely discussed "P*" analysis of Hallman, Porter and Small (1989).

One way to investigate the stability of velocity is to test whether its time series has a unit root. If a time series has a unit root, it is said to be nonstationary; this means that "shocks" to its path may move the series permanently away from its previous pattern. In this case, it may wander from what appeared to be its trend without any force to push it back again. If velocity were a time series that did not exhibit some stable long-term behavior, the Quantity Theory framework would not provide accurate predictions of long-run inflation on the basis of money stock movements.

Velocity, of course, is calculated as $V = (PT)/M$. The velocity of circulation was calculated for Divisia M1A and MMI, and, for purposes of comparison, for previous (M1) and current (M2) monetary targets as well. The Augmented Dickey-

Fuller (ADF) test for a unit root then was applied to each velocity series by estimating a regression of the form:

(1) $\Delta X_t = a + b\Delta X_{t-1} + c\Delta X_{t-2} + dX_{t-1} + \varepsilon_t,$

where X_t is the natural logarithm of the variable, and Δ is the difference operator.[28] The ADF test examines whether the coefficient, d, on the lagged level of X is significantly different from zero. If it is not, then we cannot reject the null hypothesis that a unit root is present in the data series. Although the estimated t-statistic from this regression can be used in the ADF test, the critical values must be modified from those of the standard t-distribution. Because of the sample sizes in this study and because the null hypothesis is that a unit root is present in the data, the unit root hypothesis will be rejected for calculated t-values that are negative and exceed 2.90 in absolute value.

If the unit root hypothesis is not rejected, equation 1 is re-estimated after including a trend term; in this case the critical value for the coefficient d becomes -3.5 and the null hypothesis of a unit root will be rejected by a test statistic that is a larger negative number. This test is conducted because a time series may be stationary around a deterministic trend. Finally, because it has been alleged that data from the 1960s dominate relationships between money and other variables or that data from the 1980s distort the measurement of M1 and M2, the ADF tests were conducted over three sample periods: I/1963-IV/1980; I/1970-IV/1989; and I/1963-IV/1989.

Table 1A reports the ADF test statistics for the logarithms of each of the four monetary velocities during the three sample periods; the τ_u and τ_T columns refer to the cases without and with trend, respectively. As the results indicate, no velocity measure is stationary in the log levels even after accounting for trend. Thus, we difference the data again and estimate a regression of the form:

(2) $\Delta^2 X_t = a + b\Delta^2 X_{t-1} + c\Delta^2 X_{t-2} + d\Delta X_{t-1} + \varepsilon_t,$

where the test again is whether the coefficient, d, is significantly different from zero. As before,

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27See Friedman and Kuttner (1990) for evidence on the effects of a changing sample period and Thornton and Batten (1985) for a discussion of the sensitivity of such results to lag length selection.

28For more detail on the test, see, for example, Dickey, et al. (1986), especially pages 16-17. An FPE criterion was used to determine the number of lagged values for ΔX_{t-i}.

Table 1A

Augmented Dickey-Fuller Tests on Monetary Velocities

Monetary variable	I/1963 - IV/1980		I/1970 - IV/1989		I/1963 - IV/1989	
	τ_μ	τ_T	τ_μ	τ_T	τ_μ	τ_T
M1	0.49	-1.19	-1.92	-1.26	-1.88	-1.05
M2	-1.25	-1.99	-2.33	-2.33	-2.72	-2.69
Divisia M1A	1.44	-0.32	-0.64	-1.66	-0.34	-1.79
MMI	1.53	-0.23	-0.91	-1.46	-0.73	-1.72

Table 1B

Augmented Dickey-Fuller Tests on Growth Rates of Monetary Velocities

Monetary variable	I/1963 - IV/1980		I/1970 - IV/1989		I/1963 - IV/1989	
	τ_μ	τ_T	τ_μ	τ_T	τ_μ	τ_T
M1	-5.84*	-5.87*	-3.10*	-3.29*	-3.86*	-4.08*
M2	-4.50*	-4.51*	-4.34*	-4.31*	-5.31*	-5.29*
Divisia M1A	-5.59*	-5.96*	-4.55*	-4.52*	-5.38*	-5.36*
MMI	-3.54*	-3.86*	-3.01*	-3.00*	-3.62*	-3.61*

NOTE: An asterisk denotes statistical significance at the 5 percent level.

if the null hypothesis is not rejected, equation 2 is re-estimated with a trend term added.

The results of this estimation are reported in table 1B. In this case, the results again find nothing to distinguish any of the monetary indexes as indicators of long-run trends in inflation as each measure apparently exhibits a stable growth rate of velocity in each sample period. If one raises the significance level of the ADF test statistic to the 0.01 level, however, critical values for the τ_μ and τ_T tests of about -3.6 and -4.15 would indicate that only the velocities of M2 and Divisia M1A show the existence of a single unit root over time. In contrast, doubts would be raised about the stability of the growth rate of MMI velocity in each of the three sample periods and about M1 velocity at least in the 1970-89 interval; the stability of M1 velocity over the entire 1963-89 sample would be a borderline call.

The upshot of these cursory results is that, for the specific final use criterion chosen (stationary velocity), a badly designed monetary aggregate (M2) may perform better than one that is measured in a manner consistent with both economic and statistical theory (MMI). Conversely, some aggregates that have considered the question of asset collection and weighting (Divisia M1A) perform better than some of the official aggregates (M1).[29]

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[29]As was noted in the paper's introduction, a monetary aggregate also must be controllable by the central bank to be useful as an intermediate target variable. Applying a test used by Belongia and Chalfant (1989) to each of the four aggregates used in this article produces the following results:

(1) $\text{Div } \dot{M}1A_t = -2.25 + 1.05 \cdot A\dot{M}B_t; \bar{R}^2 = .34; DW = 1.53$
        (2.16)   (7.49)

(2) $\dot{M}1_t = -3.21 + 1.37 \cdot A\dot{M}B_t; \bar{R}^2 = .56; DW = 1.39$
        (3.69) (11.72)

(3) $\dot{M}2_t = 2.98 + 0.78 \cdot A\dot{M}B_t; \bar{R}^2 = 0.23; DW = 0.86$
        (2.98)   (5.76)

(4) $\text{M}\dot{M}I_t = -4.79 + 1.38 \cdot A\dot{M}B_t; \bar{R}^2 = 0.18; DW = 1.19$
        (2.32)   (4.96)

The intuition of this test is to look for a close, contemporaneous relationship between the instrument of monetary control (the monetary base-AMB) and the target. By this standard, Divisia M1A and simple-sum M1 both appear to be controllable. Although the coefficient for AMB is statistically different from zero for M2 and MMI, the fits ($\bar{R}^2$ = 0.23 and 0.18) are poor and the low DW statistics suggest that other variables may have important influences on this relationship. Overall, these results do not make a strong case for the controllability of either M2 or MMI.

SUMMARY

The breakdown in the 1980s of historical relationships between the growth rates of M1 and both the price level and nominal income has led researchers to look for explanations of these changes. Some have argued that the historical relationships were spurious and that the current experience demonstrates the true relationship. Others have argued that the traditional relationships still hold after minor revisions to the estimating equations. Still others have used indirect evidence to make adjustments to the official measures of various monetary aggregates. None of these efforts has been completely successful in resolving what has been termed "the velocity problem".

This article has reviewed still another approach to this problem: constructing monetary aggregates from first principles, using economic and index number theory to determine which assets should be included in an aggregate as well as how they should be weighted in aggregation. The two measures discussed, Divisia M1A and the Money Metric Index, exhibited quite different velocity behaviors; Divisia M1A velocity is consistent with a stable long-run relationship with the aggregate price level while MMI velocity appears not to be. Similarly, M2 velocity appears to be stable over time whereas M1 velocity does not. If price stability is an important objective of monetary policy, monitoring the growth rates of certain monetary aggregates can be a viable approach to policymaking. At the same time, there is still no definitive answer in terms of all its final uses to the question: What is money?

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