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MONEY, OUTPUT, AND PRICES: EVIDENCE FROM A NEW MONETARY AGGREGATE

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ABSTRACT

This paper develops a new utility-based monetary aggregate which we label the currency-equivalent aggregate. This aggregate equals the stock of currency that would be required for households to obtain the same liquidity services that they get from their entire collection of monetary assets. It equals

$$CE_t = \sum_i \frac{r_{b,t}-r_{i,t}}{r_{b,t}} m_{i,t}$$

where $r_{b,t}$ is the rate of return on a zero liquidity asset, while $r_{i,t}$ and $m_{i,t}$ respectively represent the yield and stock of monetary asset i at time t. We compare the ability of the new aggregate and conventional aggregates, such as M1 and M2, and other indicators of monetary policy to forecast real activity. The CE aggregate has more predictive power for output and prices than standard aggregates, and the time path of the estimated output response is more consistent with broad classes of theoretical models.

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How monetary shocks affect prices and real activity are two of the central questions in macroeconomics. The implications of various theoretical models addressing these issues have been explored in literally hundreds of empirical papers. Despite the substantial interest in what money does, there is little consensus on what money is. Most previous empirical studies use relatively arbitrary rules in deciding which assets are monetary, and which are not. By choosing to study how the monetary base, or M1, or M2, affects prices and real activity, researchers implicitly made judgments about the identity of monetary assets. Narrow definitions of money, such as the base, exclude a variety of assets that provide liquidity services. Broader definitions, such as M2, give equal weight to a variety of assets with arguably quite different liquidities. This is hardly more defensible than constructing a measure of GNP by adding together the physical volume of output in different industries!

A more attractive approach involves weighting different assets by the value of the monetary services they provide. This principle underlies Barnett's (1980) derivation of Divisia monetary aggregates. The continued widespread use of conventional aggregates is particularly surprising, since research has repeatedly shown Divisia aggregates to be at least as good at predicting GNP. In this paper we propose a new monetary aggregate, the currency-equivalent (CE) aggregate, which is related to the Divisia aggregates. The CE aggregate is a time-varying weighted average of the stocks of different monetary assets, with weights which depend on each asset's yield relative to that on a benchmark "zero liquidity" asset.

One attractive feature of the CE aggregate is that it has a straightforward interpretation: it is the stock of currency that yields the same transactions services as the complete constellation of monetary assets. Thus, currency gets a weight of one in our aggregate. Other assets with higher rates of return get a smaller weight because their marginal liquidity services are lower.

After deriving our aggregate and summarizing its relation to both conventional and Divisia aggregates, we use it to develop new evidence on the correlation between money and output. We first test whether, in post-1959 U.S. data, there is any correlation between changes in various monetary aggregates, including CE, and subsequent movements in output. We then study whether these correlations suggest that changes in money cause changes in output.

Most models where exogenous changes in money have an effect on output predict that this effect will be short lived and that, eventually, a one percent increase in money leads to a one percent increase in prices. Thus the impulse response function of output with respect to monetary shocks ought to exhibit pronounced, short lived effects. Indeed, monetary shocks that fail to display this property, so that output responds permanently to them are probably not causal. Rather, money-income correlations of this type can easily be interpreted as being due to monetary endogeneity with respect to either income or other variables which affect income. Our evidence suggests that shocks to the CE aggregate are both more strongly correlated with subsequent changes in output, and have a shorter lived "effect" on output, than shocks to more traditional monetary aggregates.

Several recent papers, for example Bernanke and Blinder (1990) and Friedman and Kuttner (1990) have suggested that interest rates and interest rate spreads are better indicators of monetary policy than the monetary aggregates themselves. We therefore compare the predictive power of these variables to the predictive power of the CE aggregate. This comparison is of particular interest because some changes in interest rates directly affect the CE aggregate. We find that the correlation between interest rates, and interest rate spreads, and subsequent movements in output is stronger than the correlation of these variables and the CE aggregate. On the other hand, the impulse responses of output to these variables do not correspond to the pattern one would expect if the economy were responding to a monetary disturbance.

This paper is divided into five sections. The first derives the currency-equivalent monetary aggregate and compares it with existing Divisia aggregates. Section two describes the data inputs needed to construct our aggregate, and reports summary statistics on its univariate time series properties. The third section tests whether the new aggregate Granger-causes real output, and compares its predictive performance to that of other indicators of monetary policy. It also tests the long run neutrality of money with respect to output. Section four presents a parallel analysis of the effect of monetary shocks on prices, comparing the findings for the currency equivalent aggregate with those for more traditional measures. There is a brief conclusion which sketches the implications of our findings for competing theories of the monetary transmission mechanism.

1. The Currency-Equivalent Monetary Aggregate and Its Properties

1.1 Derivation

Some assets can readily be used for transactions. Individuals pay for the liquidity that these assets offer by foregoing the higher expected returns that are available on other, less liquid assets. Holding one dollar in currency costs more than holding one dollar in a NOW account, and it presumably generates greater liquidity services. We formalize this idea by assuming that individuals derive utility from holding certain assets. Our results could also be obtained by assuming that individuals and firms incur transactions costs which depend negatively on asset-holdings and positively on the volume of transactions.

We consider an individual whose expected lifetime utility in period t is given by

$$V = E_t \sum_{j=0}^{\infty} \beta^j U_{t+j} \tag{1}$$

where E_t takes expectations as of time t, β is an intertemporal discount factor, and U_t gives the level of instantaneous utility at t. This instantaneous utility depends on consumption, C_t, and the levels of n monetary assets, $m_{i,t}$. We let i range from 0 to n-1, and define $m_{0,t}$ as currency holdings at t. We assume that U_t equals $U(C_t,L_t)$, which is concave in both arguments, where

$$L_t = f(m_{0,t}, m_{1,t}, \ldots, m_{n-1,t}). \tag{2}$$

The function f is an aggregator function for liquidity services.

Any desirable monetary aggregate must in some way correspond to L_t. We show that under two assumptions about this aggregator function, L_t equals the currency equivalent (CE) monetary aggregate introduced by Rotemberg (1991). Our first assumption is that the aggregator function is homogeneous of degree one.[1] Second, we assume that f is additively separable in currency and other monetary assets:[2]

$$f(m_{0,t},m_{1,t},m_{2,t},...) = h(m_{0,t}) + k(m_{1,t},m_{2,t},...) \tag{3}$$

This assumption gives a central role to currency, since it is possible to obtain any level of liquidity services by holding sufficient currency. While the inessentiality of other monetary assets might be controversial, it is consistent with the fact that circulating media of exchange appear to predate the introduction of other liquid assets.

Our assumption that the aggregator function f has constant returns to scale implies that

$$L_t = \sum_{i=0}^{n-1} f_{i,t} m_{i,t} \tag{4}$$

where $f_{i,t}$ is the partial derivative of f with respect to the quantity of monetary asset i evaluated in period t. Since (3) implies $f_{0,t}=h_{0,t}$,

[1]The key part of this assumption is that f be homothetic since it can then be converted into a homogeneous function by transforming U. As shown by Samuelson and Swamy(1964), homotheticity considerably simplifies the construction of index numbers. It is required for Divisia aggregates to be path independent as well as to ensure that the true economic index lies between the Paasche and the Laspeyres index.

[2]We would obtain identical results if we treated currency as a collection of disparate assets (denominations) which provide different types of liquidity. Letting $c_{j,t}$ denote the holding of currency of type j at t, f would have to be given by

$$g(c_{0,t},c_{1,t},...) + k(m_{1,t},m_{2,t},...)$$

so that f is additively separahle in a function that depends on the various currency assets and a function that depends on the other monetary assets.

$$h(m_{0,t}) = h_{0,t}m_{0,t} = f_{0,t}m_{0,t} \tag{5}$$

The first equality in (5) implies that the derivatives of h and of $h_{0,t}m_{0,t}$ with respect to $m_{0,t}$ must be equal, so the second and all higher derivatives of h with respect to $m_{0,t}$ must be zero. This implies that h is a linear function, and that the derivatives $h_{0,t}$ and $f_{0,t}$ are constants.[3]

Our assumptions thus imply that currency does not lose its ability to provide liquidity as the quantity of currency rises. This implication is not as disturbing as it might at first appear, because it does not imply that overall utility is linear in currency. Rather, the function U is concave in total liquidity so that, indirectly, it is concave in currency as well.

We also assume that there are assets that do not provide monetary services. For simplicity, we focus on a particular asset of this form whose nominal return between time t and t+1 is known with certainty at time t.[4] We call this the benchmark asset and let its nominal return equal $r_{b,t}$. In our empirical work, we measure $r_{b,t}$ by the return on prime

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[3]Interpreting traditional simple-sum monetary aggregates as equalling total liquidity services also requires linearity assumptions on f but these are much stronger than those implies by our separability and homogeneity assumptions. In particular, the function f must be linear in all its arguments with equal coefficients for each. But this implies that all monetary assets provide the same return.

[4]Even if all actual assets without liquidity services had stochastic returns, the analysis would apply. However, the benchmark return would have to be the return on an imaginary asset with no liquidity services and with a nonstochastic payoff in period t+1.

grade commercial paper.[5]

The benchmark return has the standard property that

$$U_C(C_t,L_t) = (1+r_{b,t})E_t\frac{P_t\beta U_C(C_{t+1},L_{t+1})}{P_{t+1}} \tag{6}$$

where P_t measures the price of a unit of consumption in terms of currency at date t. Equation (4) says that the consumer is indifferent between his current (optimal) consumption profile and a profile in which he increases his holdings of the benchmark asset by reducing current consumption and uses the proceeds to increase future consumption.

Monetary assets do not share this property of the benchmark asset because increasing their stock raises the level of liquidity services received by the consumer. Thus the loss in utility from lowering current consumption is offset by both additional future consumption and by further liquidity services. In particular, for monetary asset i

$$U_C(C_t,L_t) = U_L(C_t,L_t)f_{i,t} + (1+r_{i,t})E_t\frac{P_t\beta U_C(C_{t+1},L_{t+1})}{P_{t+1}}. \tag{7}$$

Substituting the expectational term from (6) into (7), we obtain

[5]We chose the commercial paper rate because the market for prime grade commercial paper is broad and the instrument is fairly safe. We also tried the Federal funds rate, which pertains to an even safer (though less widely held) instrument. The results were identical, so we only report the results for commercial paper. We did not use Treasury bill returns because during much of the 1960-1980 period, these yields were below the interest rates on passbook saving accounts. Since saving accounts would appear to be more useful for transactions purposes than T-bills, this behavior is puzzling. Our own tentative explanation is that Treasury bills provide other types of services. They are well understood throughout the world, they can easily be used as collateral and they can be posted as margin in financial transactions. Because we think these services are different from transactions services we do not include Treasury bills in L. The existence of these services does not invalidate our analysis as long as the utility function is separable in consumption, L, and these services.

$$U_L f_{i,t} = \frac{r_{b,t}-r_{i,t}}{1+r_{b,t}} U_C. \tag{8}$$

This says that the consumer is indifferent between reducing his holdings of monetary asset i by one unit, and increasing his holdings of the benchmark asset by $(1+r_{i,t})/(1+r_{b,t})$. This change leaves the value of the individual's portfolio at the beginning of period t+1 unaffected, so that future consumption can remain unaffected as well. However, this portfolio change allows the individual to raise his current consumption by $(r_{b,t}-r_{i,t})/(1+r_{b,t})$. The gain in utility from this consumption increase must therefore equal the fall in utility from his reduced holdings of monetary asset i.

For currency, the analogue of equation (8) is:

$$U_L f_{0,t} = \frac{r_{b,t}}{1+r_{b,t}} U_C. \tag{9}$$

Since U is an arbitrary concave function, we can normalize f so that $f_{0,t}$ equals one. This normalization ensures that total liquidity, L, is measured in units of currency. Combining equations (8) and (9) now yields

$$f_{i,t} = \frac{r_{b,t} - r_{i,t}}{r_{b,t}}. \tag{10}$$

The level of the liquidity aggregate L_t from equation (4) then satisfies

$$L_t = \sum_i \frac{r_{b,t}-r_{i,t}}{r_{b,t}} m_{i,t} \equiv CE_t. \tag{11}$$

This expression <u>defines</u> the currency-equivalent monetary aggregate.

Actually, our derivation has considered an individual's holding of monetary assets so that L_t in (11) is the level of liquidity held by an individual. However, because (11) is linear in individual asset holdings, the sum of the L's held by all individuals is simply (11) applied to aggregate asset holdings. Thus CE_t provides an accurate measure of the sum of the individual L's even if the aggregator functions f differ for different individuals.

The CE aggregate has the attractive property that assets which do not pay interest, such as currency and travelers' checks, are added together with weights of unity. Other assets are added with weights between zero and one, with higher-yield assets receiving lower weights. This makes intuitive sense since these assets must, given their higher returns, provide smaller liquidity services. The benchmark asset, in particular, provides no liquidity services. Therefore, by the same logic, assets whose returns equal or exceed those of the benchmark asset do not contribute to the currency equivalent aggregate.[6]

The CE aggregate also adapts easily to changes in the financial environment. When new assets, such as interest-bearing NOW accounts, are introduced, they can be added to the aggregate. The problem of deciding whether such accounts are "liquid enough" to be included in the monetary aggregate is resolved by reference to their interest yield.

One interesting interpretation of this aggregate is developed in Barnett (1991). He shows that assuming static expectations, CE_t equals the expected present discounted value of expenditures on liquidity services. These expenditures in period t equal $\Sigma_i\ (r_{b,t} - r_{i,t})m_{i,t}$, which is the total amount of interest foregone by holding monetary assets instead of the

[6]Although many assets promise yields greater than those on the benchmark asset, this is not necessarily evidence that liquidity services are provided by the benchmark asset. Rather, it could simply reflect differential risk across assets.

benchmark asset. Under static expectations, the present value of these expenditures equals their level divided by the rate of return on the benchmark asset, yielding CE.

1.2 Properties of Divisia and CE Aggregates

The currency equivalent aggregate closely resembles the Divisia monetary aggregates proposed by Barnett (1980). Both types of aggregates attempt to measure the sub-utility, L_t, derived from monetary assets. This sub-section compares these two approaches to monetary aggregation.

The principal advantage of Divisia aggregates is that their derivation requires weaker assumptions only that the aggregator function f be homogeneous of degree one. Under this weak assumption and in a continuous time setting without uncertainty, the change in the Divisia aggregate gives the exact value for the change in L_t. Since the CE aggregate equals L only under stronger assumptions, it would appear to be strictly inferior in this case. However, it has five advantages in comparison with divisia aggregates.

First, in discrete time, the Divisia aggregate tends to drift away from the level of L while the CE aggregate does not. The Theil-Tornquist approximation to the Divisia index, D_t, is

$$\log D_t = \log D_{t-1} + \sum_i \frac{1}{2}\left(\frac{(r_{b,t}-r_{i,t})m_{i,t}}{\sum_j (r_{b,t}-r_{j,t})m_{j,t}} + \frac{(r_{b,t-1}-r_{i,t-1})m_{i,t-1}}{\sum_j (r_{b,t-1}-r_{j,t-1})m_{j,t-1}} \right) \log\left(\frac{m_{i,t}}{m_{i,t-1}} \right). \quad (12)$$

Diewert (1976) shows that the change in this index from one period to another is equal to the change in L if f has the translog functional form.[7] Otherwise each change in the index introduces an approximation error. Since this error is a random walk with drift, it eventually becomes unboundedly large. The CE aggregate does not suffer from this problem. If f does not satisfy the linearity restriction that makes the CE aggregate exact, but the derivatives of f with respect to its arguments remain bounded, it will not drift arbitrarily far from L.

A second advantage of the CE aggregate is that its <u>level</u> has a definite meaning. Divisia indices seek to measure the <u>changes</u> in the sub-utility from assets, L_t. They cannot be used in international comparisons of liquidity, or to evaluate the different levels of liquidity held by different individuals.

A third, and perhaps the most important, advantage of the CE aggregate is that it can easily handle situations where the function f changes over time. Such changes constitute one of the most important challenges of monetary aggregation since the set of available monetary assets changes constantly. For example, when NOW accounts eliminate charges on checks, their liquidity properties, and therefore their respective f_i, change. Divisia aggregates assume instead that the utility provided by each asset remains immutable. The CE aggregate deals with changes in asset characteristics by incorporating the idea that, for asset holdings not to change, $(r_{b,t}-r_{i,t})/r_{b,t}$ must rise as much as f_i. The CE aggregate thus correctly interprets increases in $(r_{b,t}-r_{i,t})/r_{b,t}$ with an unchanged asset stock as an increase in the assets' liquidity services.

[7]Because the translog is itself a quadratic approximation to any homogeneous function f, the Divisia aggregate is "superlative" in the terminology of Diewert (1976).

The function f changes most dramatically when new assets are introduced. While these introductions cannot be addressed using Divisia aggregates, they present no difficulty for the CE aggregate. As equation (12) shows, the change in the Divisia index is based on the changes in the logarithms of its components. Because the logarithm of zero is minus infinity, (12) implies that the growth rate of the Divisia aggregate equals infinity when an asset is introduced. Barnett and his collaborators therefore use a different index method to incorporate new assets.

A fourth advantage of the CE aggregate concerns aggregation across different consumers. Equation (12), which defines the change in the Divisia aggregate, is a good approximation to the change in an individual's liquidity. However, the version of (12) that uses the aggregate value of the components does not generally bear any relationship to an individual's L. It does so if each individual's asset holdings are proportional to those of all other individuals. While this is implied by the representative individual paradigm, this paradigm is unattractive in the case of monetary assets because monetary transactions generally involve a payment from one individual to another. Such transactions reduce one individual's money holdings while raising those of someone else. Because the CE aggregate is linear in asset holdings, it remains equal to the sum of individual L's even when individuals engage in transactions with each other.

A final advantage of the CE aggregate, which we hope will provide the basis for future research, is that it simplifies the estimation of money demand equations. With $f_{0,t}$ normalized to one, equation (9) can be viewed as a conventional money demand equation relating an individual's demand for total liquidity, L_t, to the "market" interest rate and a measure of his transactions, in this case consumption. This equation applies directly to the sum of the L's across individuals if either all individuals have identical L's and C's or if each individual's utility function is quadratic with the same parameters. Estimates of money demand equations often use the commercial paper rate, which to some degree justifies our use of commercial paper as our benchmark asset. However, conventional money demand equations often add other interest rates as well. Our restriction on f implies the testable proposition that other interest rates have no role in the estimation of (9).

In contrast to the CE aggregate, which makes a simple prediction about the appropriate interest rate to include in a money demand equation, the foregone interest cost of holding an additional unit of the Divisia aggregate is a complicated function of many interest rates. Moreover, for a given Divisia quantity aggregate, there are two different, equally valid, price indices. The first can be computed using a formula analogous to that for the Divisia quantity index applied to prices, while the second is obtained by dividing expenditure on liquidity by the Divisia quantity index. Serletis (1991) estimates systems of demand equations for Divisia aggregates using the latter approach.

Before closing this sub-section, it is worth remembering that Divisia and CE aggregates have many things in common. Changes in monetary assets affect both aggregates only to the extent that their rate of return is lower than that of a benchmark asset. Thus, changes in broker-dealer money market mutual funds and in time deposits at commercial banks, which are in M2 but essentially yield the commercial paper rate, do not have a significant impact on either aggregate. This contrasts with the conventional wisdom, which holds that money market accounts can be used for making payments and so must be "like" checking accounts.

The conventional view confuses average and marginal liquidity services. The first few dollars invested in broker-dealer money market accounts do provide liquidity services since individuals are likely to write checks on them. Because these accounts pay interest rates equal to those on zero-liquidity assets, however, they also attract additional funds which will not be used to make payments in the near future. So, starting from the equilibrium holdings, changes in these asset stocks do not affect total liquidity services.

One difficulty with this argument is that not all consumers start by holding the optimal portfolio of all assets. Some consumers are very sophisticated and hold their wealth in assets that provide liquidity services with negligible losses in return. For these consumers, further increases in their holdings of money market accounts do not raise their liquidity. Other consumers are only slowly drifting into such assets, thereby gaining the inframarginal liquidity services the optimizing consumers already enjoy. As these consumers convert their "regular" checking accounts into money market accounts, their liquidity does not fall as the CE and Divisia aggregates would imply. This problem is not too severe if the conversion from regular checking to money market accounts is gradual since it then has little effect on money's monthly growth rate, whatever form of aggregation is used.

1.3 Comparison with Other Methods of Monetary Aggregation

There are two alternatives to the sort of aggregation that underlies both the Divisia and the CE aggregates. The first is the estimation of a parametric utility function along the lines of Chetty (1969) or Poterba and Rotemberg (1987). Armed with the utility function's parameters, one can obviously construct a measure of the utility derived from liquidity services. While we are sympathetic to this approach, Spindt (1985) correctly argues that it copes poorly with changes in the liquidity characteristics of the underlying assets.

A second approach, introduced by Spindt (1985), is to measure the liquidity services provided by various monetary assets using data on their turnover. The idea is that assets with large turnover must be more useful in transactions and so have higher liquidity services. The problem is that turnover need not be a good measure of liquidity services. For instance, relatively small denominations of currency turn over more quickly than larger ones. Yet, one would not want to say the money supply changed when the composition of currency outstanding changes. The reason is that one expects all currency to provide the same services at the margin. Large denominations make up for the fact that they are used only rarely by being particularly useful in certain circumstances, such as when one must carry large sums of cash.[8]

1.4 Slow Portfolio Adjustment

The currency-equivalent aggregate does encounter difficulty if individuals are slow to change their portfolios in response to interest rate changes. In this case, equations (6)-(8) will not always hold and the variations in $(r_{b,t}-r_{i,t})/r_{b,t}$ do not necessarily correspond to variations in f_i. This problem is likely to be important, particularly since our benchmark rate is quite volatile while the rates on monetary assets tend to change sluggishly.[9] Because this

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[8]We do not pursue the empirical properties of this index here because Serletis (1988) shows that it is not very useful in predicting output or prices.

[9]Of course, violations of the consumer's first order conditions also degrade the approximation properties of Divisia aggregates. In the case of interest rate changes that do not lead to rebalancing of individual portfolios it is possible that Divisia's errors are smaller than CE's because changes in

sluggish adjustment is due in part to regulatory inertia, it is hard to attribute the resulting changes in $(r_{b,t}-r_{i,t})/r_{b,t}$ to changes in the assets' liquidity services. When individuals rebalance their portfolios only occasionally, they choose a portfolio of monetary assets such that the each f_i is close to the $(r_b-r_i)/r_b$ expected to prevail in current and future periods. The f_i's at any moment therefore depend on the current, past, as well as expected future values of the interest rate differentials.

In implementing the CE aggregate, we address the problem of slow portfolio adjustment by constructing averages of $(r_{b,t}-r_{i,t})/r_{b,t}$ and using them to measure CE. Our benchmark case is constructed using weights corresponding to a 13-month centered moving average. We also consider a 37-month centered moving average, as well a "fixed weight" CE in which the $(r_{b,t}-r_{i,t})/r_{b,t}$'s are replaced by overall sample averages.

2. Data and Summary Statistical Properties

2.1 Data Construction

We include eight component assets in the currency equivalent aggregate. Three -- currency (CU_t), travelers' checks (TC_t), and demand deposits (DD_t) -- do not yield interest. The interest paying assets are other checkable deposits (OCD_t) such as NOW accounts, savings accounts at thrift institutions (SSL_t), savings accounts at commercial banks (SCB_t), money market accounts at commercial banks ($MMCB_t$) and money market accounts at thrift

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interest rates have a bigger effect on the latter.

institutions (MMSL).[10] Using these symbols as subscripts to identify returns, the CE aggregate is given by:

$$CE_t = CU_t + TC_t + DD_t + (1 - \frac{r_{OCD,t}}{r_{CP,t}})OCD_t + (1 - \frac{r_{SSL,t}}{r_{CP,t}})SSL_t + (1 - \frac{r_{SCB,t}}{r_{CP,t}})SCB_t + (1 - \frac{r_{MMCB,t}}{r_{CP,t}})MMCB_t + (1 - \frac{r_{MMSL,t}}{r_{CP,t}})MMSL_t. \quad (13)$$

For the reasons given in the previous section, our benchmark estimates of the currency equivalent aggregate use 13-month centered moving averages of interest rate spreads as weights.[11] Because even this aggregate's short-term fluctuations are sensitive to high frequency interest rate changes, we also consider a second aggregate, labelled the "fixed weights currency equivalent." In this aggregate we replace the 13-month average interest rate spreads with the overall sample average differentials.

Data on the quantities of various monetary assets that enter equation (8), as well as the commercial paper rate, are drawn from Federal Reserve Board Statistical Release H.6. The data are available at a monthly frequency, seasonally adjusted, for the period since January 1959. Data on interest rates corresponding to the monetary assets are not as readily available. Our measure of $r_{OCD,t}$, the interest rate on other checkable deposits, is an average

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[10]M1 equals the sum of currency, travellers checks, demand deposits and other checkable deposits. M2 includes all monetary assets in M1 plus savings deposits, small denomination time deposits, short-term (overnight) repurchase agreements and Eurodollar deposits, and money-market mutual fund shares. We assume that the last two components of this aggregate yield market returns and consequently give them no weight in our CE aggregate. M3, a still broader aggregate, includes large-denomination time deposits and term repurchase agreements and Eurodollar deposits.

[11]We replace, for example, $r_{OCD,t}/r_{CP,t}$ with its 13-month average centered in month t. For each of the first (last) 13 months of the sample, we use the average interest rate ratio for the first (last) 13 months instead of the centered moving average.

across various types of interest-bearing accounts computed by the Federal Reserve Board. The interest rate on savings accounts at commercial banks as well as those on money market accounts, $r_{SCB,t}$, $r_{MMCB,t}$ and $r_{MMSL,t}$, were also provided by the Federal Reserve Board. We constructed the interest rate on savings accounts at thrifts, $r_{SSL,t}$, in two parts. Since mid-1986, when interest rates at thrifts were deregulated, we use the average interest rate paid on these accounts, as reported by the Federal Reserve Board. Before 1986, we impute interest rates for thrifts using rates at commercial banks. Our imputation relies on regulations relating the maximum allowable interest rates at thrifts and commercial banks, as well as occasional FHLBB surveys of average interest rates paid at these institutions.[12] For part of our sample, the interest rate on passbook savings accounts exceeded that on commercial paper. We assume that these interest rates were equal in these cases, thereby setting the weight on the associated asset stock to zero.

Figure 1 plots M1 and the currency-equivalent aggregate defined in (13). The two aggregates are drawn on the same scale so the Figure shows that their size and growth rate are generally similar. While CE includes more assets, many of these are given small weight. In particular, OCD_t is given a smaller weight in CE than in M1. The most striking difference between the two aggregates is that M1's rate of growth is smoother. CE rises much more sharply than M1 in some periods and CE also declines steadily during certain periods. These pronounced changes in CE are associated with changes in interest rates. When the commercial paper rate changes, the rates on regulated monetary assets often

[12]For the 1959-1970 period, we assumed $r_{SSL,t} = r_{SCB,t} + .75$. This additive factor was .50 for 1970-1973. For the 1973-1979 period we assume $r_{SSL,t} = 5.24\%$, and for the 1979-1986 period, we make crude estimates using occasional surveys of interest rates paid.

change less than proportionately. Thus, as an example, declines in the commercial paper rate tend to raise $r_{OCD,t}/r_{CP,t}$ so that the weight on OCD_t falls. The result is that aggregate itself falls as well.

2.2 Stationarity Properties of Alternative Aggregates

The apparently cyclical behavior of CE raises the question of whether CE and traditional aggregates exhibit different stationarity properties. This issue is important because part of our subsequent analysis will focus on the long-run effects of monetary shocks on the level of economic activity.

Table 1 reports standard Dickey-Fuller tests of the null hypothesis that M1, M2, and the two CE aggregates contain unit roots. These tests are equivalent to testing whether in an equation of the form

$$\log M_t = \alpha + \beta t + \sum_{i=1}^{k} \gamma_i \log M_{t-i} + \epsilon_t^M \tag{14}$$

the γ_i's sum to one. The table reports tests constraining ß, the coefficient on the linear trend, to equal to zero and also tests allowing it be unrestricted. The former, which are reported in the first column, suggests that the hypothesis that there is a unit root cannot be rejected for any of the aggregates. By contrast when ß is unrestricted (the second column), the hypothesis that there is a unit root can be rejected for CE, though not for the other aggregates. This rejection reflects the cyclical patterns displayed in Figure 1, and suggests that the dependence of CE on high frequency movements in interest rates accounts for the rejection of nonstationarity.

These results leave us with a choice as to how to treat the stationarity of CE. We wish to compare the properties of CE with those of the traditional aggregates. Conventional specifications, for example Kormendi and Meguire (1984) and Stock and Watson (1989), treat the latter as nonstationary. Our basic specifications will be therefore assume that CE has one unit root as well. However, we will also discuss how the results change when we assume instead that CE is stationary.

3. Testing Methods

Developing a new monetary aggregate is of some intrinsic interest for what it reveals about the evolution of the money supply in the United States. The new aggregate may also differ from previous aggregates in the evidence it presents on whether monetary shocks affect real activity.[13] We follow the tradition of Sims (1972) and perform causality tests to see whether various measures of money and monetary policy have significant predictive power for future output realizations. Under the assumption that the residuals in (14), ϵ^M_t, are exogenous monetary impulses, these tests inform us about the influence of money on output.

We measure real activity by both industrial production and by the unemployment rate for married men. The latter is a particularly useful measure of labor market tightness because, unlike other unemployment rates which are partly contaminated by decisions to leave the labor force, very few married men withdraw from the labor force.

When we use industrial production as our measure of activity y, the estimated equations are of the form

[13]Blanchard (1990) surveys the voluminous prior literature on this issue.

$$\Delta \ln y_t = \alpha + \delta t + \beta(L)\Delta \ln y_{t-1} + \gamma(L)\Delta \ln m_t + \epsilon_t^Y. \tag{15}$$

The polynomials $\beta(L)$ and $\gamma(L)$ are of 12th order which seems natural given that we are analyzing monthly data. Industrial production enters the equation in logarithmic first differences because, following Nelson and Plosser (1982), we assume that the logarithm of industrial production has a unit root. When we study the behavior of the unemployment rate we use its level, not its first difference, in (15) because the unemployment rate is more likely to be stationary. Following the suggestion of Stock and Watson (1989) we have included a deterministic trend in this regression even when we are explaining the behavior of the change in industrial production.[14] Equation (15) assumes that only the logarithmic first difference of money is correlated with output. This is reasonable if money itself has a unit root for, in this case, the monetary shocks of (14) are functions only of current and lagged differences in money. Equation (15) can thus capture the causal effect of the ϵ^M_t's on output.

This brings us to the question of whether it makes sense to judge monetary aggregates by their correlation with output. In practice, there exist three separate kinds of monetary shocks. These are changes in central bank policy, changes in the financial system and changes in the demand for monetary assets. The first two affect the supply of money directly and it would be justifiable to treat the correlations of money and output as causal if exogenous changes of this type were the only influence on the stock of money. We now argue that, if these were the only disturbances, theoretically more appropriate monetary aggregates ought to be more closely linked to output than other aggregates. After making

[14]For our data, the inclusion of this trend has a relatively minor effect, however.

this case, we return to the issues that plague the interpretation of all studies of money-output correlations.

Both changes in central bank policy and changes in financial institutions affect the economy only through their effect on L which, via the money demand equation (9), affects interest rates and economic activity. Therefore, measures of L summarize the effect of all these shocks on economic activity. This means that one should find that monetary aggregates that more closely approximate L ought to be more closely linked to subsequent changes in the economy. In particular, they should be more closely linked to output than arbitrary aggregates or even than variables which are more strongly influenced by the central bank, such as the monetary base. These variables would be particularly poor proxies for exogenous changes in L if the monetary authority chooses its policy to neutralize some of the changes in financial institutions.

Any study of the correlation of money with output faces the problem that the level of money is set endogenously. In particular, when money demand changes exogenously, money supply probably accommodates the change in money demand to some extent. This problem cannot be fully resolved without a structural model of the demand and supply for liquid assets which is well beyond the scope of this paper. While our, and our predecessors', neglect of this endogeneity is mainly a matter of expedience it is important to point out that this may not be a very large problem in practice.

Endogeneity has two components. The first, stressed by King and Plosser (1984), is that money demand rises when economic activity rises exogenously and that the money supply then accommodates the increased money demand.[15] One expects these exogenous increases in economic activity to lower prices so this story would predict that prices would rise less rapidly after positive monetary shocks. We show below that this does not seem to be the case, so this type of endogeneity may not be very important. The second form of endogeneity arises when there are increases in money demand that are unrelated to exogenous changes in output. In the absence of any money supply response, these ought to have the same effect as monetary contractions, reducing output and prices. If the money supply is endogenous and responds partially, the resulting increases in money ought to be associated with subsequent reductions in output and prices. Insofar as monetary increases are associated with both price and output increases, this problem may be minor as well.

With these provisos, we test for the absence of correlation between money and output by testing the null hypothesis that $\gamma(L) = 0$ and we interpret rejections as suggesting that changes in money affect economic activity. There are many factors, such as nominal rigidities and issues pertaining to the distribution of newly supplied monetary assets, that could make monetary shocks non-neutral in the short run. It is much more difficult, however, to explain permanent, long-run, effects of money on output. Insofar as monetary shocks do affect output in the long run, the interpretation that the money-income relationship represents true causation from money to income is called into question. Instead it becomes more likely that the relationship is a statistical fluke or is the result of responses of money to either income itself or to third variables which affect income as well. This endogeneity

[15]We deal with this problem to some extent by excluding the contemporaneous change in money from our regressions although this exclusion has no material effect on our results.

could well be a serious problem for conventional aggregates if non-monetary shocks which affect output also affect the subsequent allocation of assets for a given level of overall liquidity.

In the case where both output and the monetary indicator have a unit root, our test for monetary neutrality corresponds to the one proposed in Kormendi and Meguire (1984). In this case, (15) can be rewritten as

$$\Delta \ln y_t = \frac{\alpha + \delta t + \gamma(L)\Delta \ln m_t + \epsilon_t^y}{1-\beta(L)}. \tag{16}$$

So, a one permanent one percent increase in money raises long-run output by $(1-\beta(1))^{-1}\gamma(1)$ percent. Testing long-run neutrality therefore requires testing whether the estimated value of this quantity is significantly different from zero.[16]

One issue that arises at this point is why our tests of long run neutrality make sense given the criticism levelled by McCallum (1984) at the earlier attempt by Lucas (1980). As McCallum showed, Lucas' (1980) method is equivalent to computing the sum of the coefficients in a regression of output on many lags of money and the same is true of our method. McCallum's (1984) criticism of this method applies only when money is stationary. Then, monetary shocks have no long run effect on money itself. So, as argued by Fisher and Seater (1990), measuring the response to a once and for all increase in money is then impossible because such increases never occur in practice.

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[16]Note that long run neutrality is perfectly possible even if money and output are not cointegrated. They will fail to be cointegrated if monetary impulses have no long run effect on output but other shocks do.

Suppose however that money has a unit root. Then a shock that raises money at t by one percent raises money at t plus infinity by Z percent. The quantity Z can be estimated from univariate regressions of money growth on lagged values of money growth using standard methods. Then the sum of coefficients method works because an event analogous to a once and for all increases in money actually takes place every period.

The quantity Z is generally not equal to one but this does not matter for testing long run neutrality. From (15) and the univariate regressions for money growth we can compute two things: Z, the long run response of money to a unit innovation in money growth and $(1-\beta(1))^{-1}\gamma(1)Z$, the long run response of output to a unit innovation in money. Thus, under the null that Z is nonzero (so that money is nonstationary), long run neutrality prevails only if $(1-\beta(1))^{-1}\gamma(1)$ is zero.

A certain form of long run neutrality, whether monetary shocks can have permanent effects, can be tested even when money is stationary.[17] This is not identical to the question of what would happen if money rose and stayed higher forever but it is closely related. If output is itself stationary, then it is impossible for monetary shocks to have long run effects. If one accepts that industrial production has a unit root, then analysis of the long run effects of monetary shocks becomes interesting. For the reasons stressed in McCallum (1984) this cannot be tested by the sum of the coefficients method we used in the case where both money and output have a unit root. Instead, what is required is a simultaneous analysis of (14) and the equation which is analogous to (15) and relates output growth to the current and

[17]Fisher and Seater (1990) feel instead that long run monetary neutrality means only that once for all changes in money have no real effects. This hypothesis can obviously be tested only if monetary shocks have permanent effects on the level of money.

past levels of money. Using both these equations simultaneously one can compute the impulse response function of output with respect to monetary shocks and analyze the long run response to these shocks.

We carry out these tests for our currency-equivalent aggregate, which may be stationary. We also apply this test to two variables, which may also be stationary, that have recently been proposed as measures of monetary policy: the federal funds rate and the spread between the yield on commercial paper and the yield on Treasury bills. If monetary policy is indeed the predominant force acting upon these variables, then their changes ought not to have any long run effects on output.

We also test whether money has any effect on prices by considering regressions of the form

$$\Delta \ln p_t = \alpha' + \delta' t + \beta'(L)\Delta \ln p_t + \gamma'(L)\Delta \ln m_t + \epsilon_t^p \qquad (17)$$

where we measure the price level (p_t) as the Consumer Price Index. We then test the null hypothesis that money has no effect on prices by testing whether $\gamma'(L) = 0$. Admittedly, there are no plausible theories that imply this null hypothesis. It is thus of more interest to analyze the long run response of prices to monetary shocks. As shown by Fisher and Seater (1990) this can be done using the same method to the one we used for measuring the long run effect on output. In the case where money and prices both have a unit root, the hypothesis that permanent increases in money eventually raise prices one for one implies that $(1-\beta'(1))^{-1}\gamma'(1)$ equals one.

4. Money and Output

4.1 Granger Causality Tests

We first report tests of whether money matters at all in equations such as (15). The first 8 rows of Table 2 reports the rejection p-values for the null hypothesis of no link between current real activity and past money for a range of traditional monetary aggregates. The results do not yield a consistent pattern, except for M2, which always has a statistically significant effect on real activity. When the measure of activity is industrial production, the null of monetary neutrality is rejected at high levels for both ordinary and Divisia M2 and the Divisia M3 aggregate proposed by Barnett and his co-authors, but not by M1 or M3.[18] By contrast, in the case of the unemployment rate, we obtain high rejections for M1 and M2, but neither Divisia M2 nor M3, nor ordinary M3, yield strong rejections of neutrality.

Other conventional monetary aggregates yield even weaker evidence against neutrality. For currency and the money multiplier, we do not reject the null of monetary neutrality for either industrial production or the unemployment rate. For the monetary base, the null is rejected when we focus on the unemployment rate, but not for industrial production.

Our benchmark CE aggregate, which is based on a 13-month moving average of interest rate spreads, yields strong evidence against neutrality regardless of which index of real activity we analyze; this rejection pattern resembles that for M2. Because the current value of this CE aggregate depends on future interest rate spreads, the interpretation of these rejections might be viewed as problematic. In particular, it might be thought that these

[18] The ease with which we can accept that M1 has no effect on industrial production contrasts with Stock and Watson (1989) who show that M1 does affect output in specifications like (13). The reason our results are different is that our sample is longer than theirs. We obtain the same results as them when we restrict attention to the period before 1985.

future spreads simply contain information about future output and that this is the cause of our significant correlations.

We consider three variations which are not subject to this problem. The first is the "fixed weight" CE which uses the overall sample average yield spreads as weights. The second uses a three-year moving average of yield spreads. This too uses future information on interest rates but, leaving aside changes in the component stocks, the change in this CE aggregate from one month to the next is influenced only by the change in yields from 18 months before to 18 months after the current period. As we will see below, changes in money growth from one month to the next affect output growth only for approximately 6 months. Thus it seems implausible that the yield changes in the 3-year CE affect output only through their inclusion of future information on output. The final CE is based only on contemporaneous yield spreads and would be the appropriate aggregate in the absence of costs to portfolio adjustment.

As can be seen in Table 2 the results are fairly robust to these changes in specification. The "fixed weight" CE leads to strong rejections of neutrality for both industrial production and unemployment. The "3-year" CE also leads to rejections at conventional levels though its effect on industrial production is weaker. Finally, the contemporaneous CE, which is very volatile, only affects industrial production.

The remaining rows of Table 2 present Granger causality tests for several recently proposed alternative measures of monetary policy. Bernanke (1990) argues that shifts in policy are captured by the yield spread between commercial paper and Treasury bills. The correlation of this spread with subsequent output was first demonstrated by Friedman and

Kuttner (1990). We too find strong correlations with output. We find similarly strong rejections of $\gamma(L) = 0$ when we use the federal funds rate suggested by Bernanke and Blinder (1990) or the commercial paper rate itself as a measure of monetary policy.

One important limitation of the interest-rate based measures of monetary stance is that the estimated effects of these aggregates are sensitive to the time period in question. Using the CE aggregate, within-sample stability tests for the coefficients in (15) for industrial production, for example, do not reject the null hypothesis that $\gamma(L)$ and $\beta(L)$ are identical for the pre- and post- 1980 period. By contrast, this hypothesis is rejected at the .01 level for the commercial paper-Treasury bill yield spread. The evidence against sub-sample stability for M1 and M2 is also weak, suggesting that these aggregates behave more like the CE aggregate.

The results in Table 2 suggest that the CE aggregate provides stronger and more consistent evidence against the monetary neutrality hypothesis than many, but not all, other measures of the money supply. However, the interest rate variables are actually better predictors of output. Since CE is partially based on interest rates this raises the question of whether CE has any incremental explanatory power once the other measures of money or monetary policy are included in an equation for output.

Table 3 addresses this question by reporting p-values for the F-tests of the hypothesis that all coefficients on the lagged values of CE are zero in equations which already include other indicators of monetary stance. The findings suggest that CE's information content remains even after the other measures of money or monetary policy are controlled for. The most surprising finding in the table is that CE remains a significant explanator of industrial production (though not of the unemployment rate) after controlling for both M1 and the commercial paper rate. This suggests that the variations in interest rates that affect the benchmark CE are not solely responsible for its explanatory power.

4.2 Long Run Neutrality

We now test whether once and for all increases in money change output significantly in the long run. We thus measure $(1-\beta(1))^{-1}\gamma(1)$, the percentage increase in long run output when money increases by one percent, and test whether it equals zero. Table 4 displays this measure and its standard error for conventional, CE and Divisia aggregates.

The results provide strong evidence against long-run neutrality for M1, M2, and both the Divisia aggregates M2 and M3. Not only is the hypothesis that $(1-\beta(1))^{-1}\gamma(1)$ equals zero rejected for all these assets[19] but the point estimates exceed one; they suggest that a one percent increase in the asset raises real output by more than one percent in the long run. Even for M3, where the hypothesis that $(1-\beta(1))^{-1}\gamma(1)$ is zero cannot be rejected, the point estimate exceeds 0.5.

In contrast, the null cannot be rejected for the CE aggregate nor for its 3-year and contemporaneous weights variants. For the benchmark CE, the point estimate of the long-run elasticity of output with respect to money is very small (.05). For the contemporaneous and three year versions the point estimates are somewhat larger but still below 0.15. On the other hand, the long run response of output to a one percent change in the fixed weight CE is similar to that of output to M1. The point estimate of this response is near one and is

[19]Fisher and Seater (1990) also report rejections of long run neutrality for M1 using a much longer time series.

significantly different from zero. So, the utility based aggregates that do let asset characteristics vary over time, such as the fixed weight CE and the Divisia aggregates, fail to be long run neutral.[20] This suggests that changes in the liquidity characteristics of assets are important.

4.3 Impulse Response Functions

In this sub-section we present impulse response functions of output with respect to monetary shocks. We do this first for the monetary indices which are arguably non-stationary. For these we report the effects of a once and for all increase in money using the estimates of (15). From these we learn the time profile of the effects of these monetary impulses. We then study the impulse response functions for the indicators of monetary policy which appear stationary. These impulse response functions, which are based on simulating the analogues to equations (14) and (15) simultaneously, also serve to test the long run neutrality of these shocks.

Figures 2a through 2c display these impulse response functions for the effects on industrial production of a 1% once and for all increases in M1, M2 and CE. The figures also report one standard-error bands on either side of the point estimates. Each figure shows the cumulative effect of a shock to the monetary variable on real output. Long run neutrality therefore implies a zero effect at long horizons.

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[20]The same is true of an aggregate we created by simply adding together all the components of our CE aggregate. We created this aggregate to see whether our results were attributable to the fact that our menu of included assets does not correspond to any conventional aggregate.

The impulse response functions (IRFs) of industrial production with respect to M1 and M2 do not correspond to the predictions of standard models. The cumulative effect of money on output rises for the first fourteen months after a monetary shock. There is virtually no reduction in the cumulative output effect thereafter, which leads to the finding in Table 4 of strong evidence against the long-run neutrality hypothesis.

The IRF pattern is substantially different for the currency equivalent aggregate. A positive innovation in the money stock raises industrial production, and the cumulative IRF continues to increase for seven months after the shock. After this point, however, the lagged monetary shock has a negative effect on output and by fourteen months after the shock, the total increase in real output is estimated to be only one tenth as large as seven months after the shock. By eighteen months after the shock, the point estimate of the cumulative IRF is effectively zero. This suggests not only that the long-run effects of the CE aggregate are consistent with monetary neutrality, but also that any non-neutralities implied by these estimates are resolved in a relatively short time span.

We now turn to the effect of the stationary monetary impulses. The impulse response functions for shocks to the commercial paper-Treasury bill spread and to the federal funds rate are given in Figures 2d and 2e. Figure 2d shows that a 100 basis point increase in the spread between the annualized yield on commercial paper and that on Treasury bills permanently lowers industrial production by 5%. It is hard to interpret this as a response to a monetary shock since the maximal reduction in output (which occurs after about 10 months) is essentially equal to the long run reduction. Figure 2e shows a similar pattern for the response of output to a 100 basis point increase in the annualized Federal funds rate.

Output falls steadily and becomes about 5% lower in the long run. This too seems hard to reconcile with typical analyses of monetary contractions.

We also computed the impulse response of industrial production to shocks in CE assuming that CE is stationary. In other words we considered the system of equations (14) and (15) in which CE enters only in levels and computed the response of both variables to ϵ_t^M. We did this because the results of Table 1 suggest that the CE aggregate might be stationary. The results are very similar to those obtained when CE is assumed to have a unit root. Increases in CE first raise output significantly and then lower output so that they have no significant long run effect.

5. Money and Prices

The new currency equivalent aggregate can also be used to examine the effects of monetary shocks on the price level. In the long run, if output is not affected by monetary shocks and velocity is stable, prices should rise one-for-one with increases in the money stock. This section tests whether monetary impulses Granger-cause changes in the price level, and investigates the long-run price-level effects of monetary shocks.

The first column in Table 5 reports tests of Granger-causality between traditional monetary aggregates, other indicators of monetary policy, and the price level. The entries correspond to p-values for rejecting the null hypothesis that $\gamma'(L) = 0$ in equation (17). All of the CE aggregates except that with time-invariant weights display strong predictive power for future movements in the price level. The Granger causality results are much weaker for traditional monetary aggregates. The monetary base is the only such aggregate for which we can reject the null hypothesis of no effect. The last three rows of the table show that the Federal Funds rate and the commercial paper rate do show strong predictive power for changes in the price level, while the null hypothesis of no causality cannot be rejected for the commercial paper-Treasury bill yield spread.

The second column in Table 5 presents our estimates of the long-run effects of monetary shocks on prices. The results do not permit us to draw sharp conclusions about the relative merits of the various monetary aggregates. For all of the monetary aggregates we consider, the hypothesis that in the long run prices rise proportionately to the rise in money cannot be rejected at conventional significance levels. The standard errors are large, however, and the point estimates for the long-run elasticity of price with respect to money range from .3 to 3.7. Figures 3a and 3b report estimates of the CPI's response to a permanent 1% increase in M1 and CE. In the case of CE half of the long-run effect (.62) is reached three years after the monetary shock. This implies that the process by which prices respond to monetary shocks is relatively slow and gradual.

6. Conclusions

This paper develops a new monetary aggregate based on the amount households spend on liquidity services. We compare the performance of this "currency-equivalent" (CE) monetary aggregate, other traditional monetary aggregates, and various other indicators of monetary policy in forecasting real activity. The CE aggregate has more predictive power than any of the traditional monetary aggregates. While some other indicators of monetary policy based on nominal interest rates can forecast output as well as the CE aggregate, they also suggest long-run non-neutrality of output with respect to money. This suggests that changes in the CE aggregate are a more plausible indicator of changes in the supply of liquid assets. This result in turn supports the idea that the monetary aggregate with which one can best measure monetary shocks is the one which measures the utility (or the services) that people derive from their liquid assets.

Our results also contain some information on the channel through which monetary disturbances affect output. The literature on this topic stresses two issues: whether nominal rigidities are important, and whether "money" or "credit" is important.[21] According to the "money" view, monetary contractions initially reduce money balances and interest rates must rise to make people hold the new constellation of assets. This increase in interest rates then lowers investment. According to the "credit" view, there is a direct reduction in investment which comes about because monetary contractions force banks to curtail the volume of loans.

Our findings provide some support for the "money" view. We have shown that the money stock which has the most plausible effect on output is one that makes sense from the point of view of holders of money. A monetary expansion can thus be thought of as a situation where the level of liquid assets is high, at least for some consumers.

In the "credit" view, the level of consumers' liquid assets does not matter, except insofar as it is correlated with funds available for loans. The latter are presumably more correlated with broad aggregates like M2 than with the CE aggregate. From the point of

[21]The distinction between the "money" and the "credit" view has been stressed mainly by authors working with models of sticky prices, including Bernanke and Blinder (1990), Gertler, Hubbard and Kashyap (1990), Kashyap, Stein and Wilcox (1990) and Romer and Romer (1990). However, this distinction is just as important if nominal rigidities are absent and money matters only because different people carry out financial transactions at different times. This can be seen by comparing Grossman and Weiss (1983) and Rotemberg (1984) and Fuerst (1990).

view of credit availability, whether banks raise their funds through "regular" checking accounts at zero interest, or through expensive CD's is probably irrelevant. Because the data suggest that this distinction is important for the subsequent evolution of output they also suggests that the "credit" view is incomplete.

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Table 1: Unit Root Tests for Various Monetary Aggregates

Aggregate	$\beta=0$	Unrestricted
M1	.999	.429
M2	.994	.750
Divisia M2	.988	.591
Divisia M3	.977	.669
CE	.993	.012

Notes: Each entry reports the confidence level(based on Fuller(1976)) at which the null hypothesis that $\gamma=0$ in the regression

$$\Delta lnM_t=\alpha+\beta t+\gamma lnM_{t-1}+d(L)\Delta \ln M_{t-1}+\epsilon_t^M$$

can be rejected. The regressions are estimated using monthly data for the 1960:2-1989:6 period. d(L) is a twelfth-order lag polynomial.

Table 2: Causality Tests: Monetary Aggregates and Real Activity

Traditional Monetary Aggregates	Industrial Production	Unemployment Rate for Married Men
M1	.205	.019
M2	.003	.005
M3	.160	.068
Monetary Base	.174	.007
Money Multiplier	.223	.179
Currency	.517	.473
Divisia Aggregates		
Divisia M2	.013	.093
Divisia M3	.025	.580
Alternative Indicators of Monetary Policy		
Commercial Paper	<.00001	.0005
Federal Funds Rate	.001	<.00001
Commercial Paper-Treasury Bill Yield Spread	<.00001	<.00001
Currency Equivalent Aggregates		
Currency Equivalent	<.00001	.0002
Fixed Weight Currency Equivalent	.002	<.00001
Three-Year Currency Equivalent	.042	.0003
Contemporaneous Currency Equivalent	.031	.721

Notes: Each entry reports the confidence level at which the null hypothesis that gamma(L) = 0 can be rejected in the specification

$$\Delta \ln y_t = \alpha + \delta t + \beta(L)\Delta \ln y_t + \gamma(L)\Delta \ln m_t + \epsilon_t^y.$$

Both β(L) and γ(L) are 12th order lag polynomials, so the statistics reported above test the joint hypothesis that $\gamma_1 = \gamma_2 = \ldots = \gamma_{12} = 0$. The sample period for all estimates except Divisia M2 and M3 is 1960:2 to 1989:6. For the two Divisia aggregates, the sample is 1961:2-1989:6.

Table 3: Incremental Explanatory Power of Different Monetary Aggregates

Incumbent	Challenger	Industrial Production	Unemployment Rate for Married Men
M1	CE	.002	.011
M2	CE	.003	.005
Divisia M2	CE	.023	.009
Divisia M3	CE	.015	.006
Commercial Paper-Treasury Bill Yield Spread	CE	.002	.003
Federal Funds Rate	CE	.002	.004
Commercial Paper and M1	CE	.009	.097

Note: Each entry reports the p-value for the null hypothesis that $\Theta(L)=0$ in the specification

$$\Delta \ln y_t = \alpha + \delta t + \beta(L)\Delta \ln y_t + \gamma(L)\Delta \ln m_{1,t} + \Theta(L)\Delta \ln m_{2,t} + \epsilon_t^y.$$

where $m_{1,t}$ denotes the incumbent aggregate and $m_{2,t}$ denotes the "challenger" aggregate. All lag polynomials are 12th order, so the statistics reported above test the joint hypothesis that $\Theta_1 = \Theta_2 = \ldots = \Theta_{12} = 0$. The sample period for all estimates except those for the Divisia Aggregates is 1960:2 to 1989:6. For the Divisia aggregates, the sample is 1961:2 to 1989:6.

Table 4: Long-Run Effects of Monetary Shocks on Industrial Production

Traditional Monetary Aggregates	Estimated Long-Run Effect
M1	1.04 (0.44)
M2	1.57 (0.52)
M3	0.53 (0.50)
Monetary Base	1.42 (0.63)
Money Multiplier	0.99 (0.61)
Currency	0.13 (0.61)
Divisia Aggregates	
Divisia M2	1.31 (0.53)
Divisia M3	1.15 (0.44)
Currency Equivalent Aggregates	
Currency Equivalent	0.05 (0.10)
Fixed-Weight Currency Equivalent	1.08 (0.28)
Three-Year Currency Equivalent	0.17 (0.16)
Contemporaneous Currency Equivalent	-0.10 (0.09)

Notes: Each entry reports the long-run effect of a unit shock to the monetary aggregate on the logarithm of industrial production. The estimates are computed as $f(\beta,\gamma) = (1-\beta(L))^{-1}\gamma(L)$ evaluated at $L=1$, where the lag polynomials are estimated in

$$\Delta \ln y_t = \alpha + \delta t + \beta(L)\Delta \ln y_t + \gamma(L)\Delta \ln m_t + \epsilon_t^y.$$

Standard errors, which are shown in parentheses, are calculated as in Poterba, Rotemberg and Summers(1986) as $[\partial f/\partial\beta\ \partial f/\partial\gamma]^* V(\beta,\gamma)^* [\partial f/\partial\beta\ \partial f/\partial\gamma]'$ where $V(\beta,\gamma)$ is the variance-covariance matrix of the estimated parameters.

Table 5: Causality Tests and Long-Run Effects: Monetary Aggregates and Prices

Traditional Aggregates	Causality	Long-Run Effect
M1	.241	2.42 (2.02)
M2	.394	0.86 (0.87)
M3	.693	0.95 (0.70)
Monetary Base	.003	2.49 (1.06)
Money Multiplier	.439	1.75 (2.35)
Currency	.159	1.52 (0.55)
Divisia Aggregates		
Divisia M2	.802	0.94 (1.07)
Divisia M3	.640	1.21 (1.34)
Currency Equivalent Aggregates		
Currency Equivalent	.002	0.62 (0.38)
Fixed-Weight Currency Equivalent	.141	3.71 (7.68)
Three-Year Currency Equivalent	.002	0.81 (0.42)
Contemporaneous Currency Equivalent	.046	0.31 (0.17)
Alternative Indicators of Monetary Policy		
Commercial Paper	.0004	
Federal Funds Rate	<.00001	
Commercial Paper-Treasury Bill Yield Spread	.666	

Notes: Entries in column 2 are p-values for Granger-Causality tests of the sort reported in table 2, while entries in column 3 are long-run responses of the price level to shocks in the growth rate of the monetary aggregates, whose analogue for industrial production was reported in table 3. Standard errors are in parentheses.

Figure 1
THE CURRENCY EQUIVALENT AGGREGATE
and M1

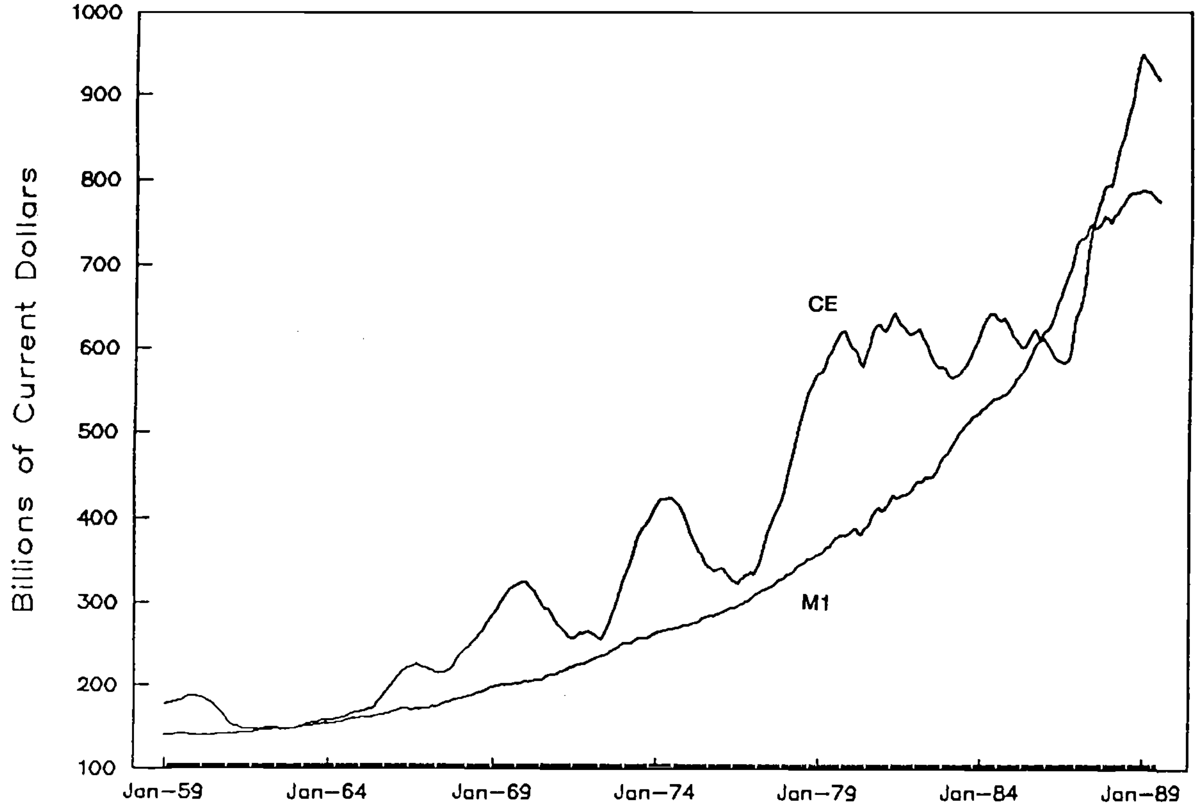

Figure 2a
IMPULSE RESPONSE FUNCTION
OF INDUSTRIAL PRODUCTION
Permanent Increase in M1 by 1 Percent

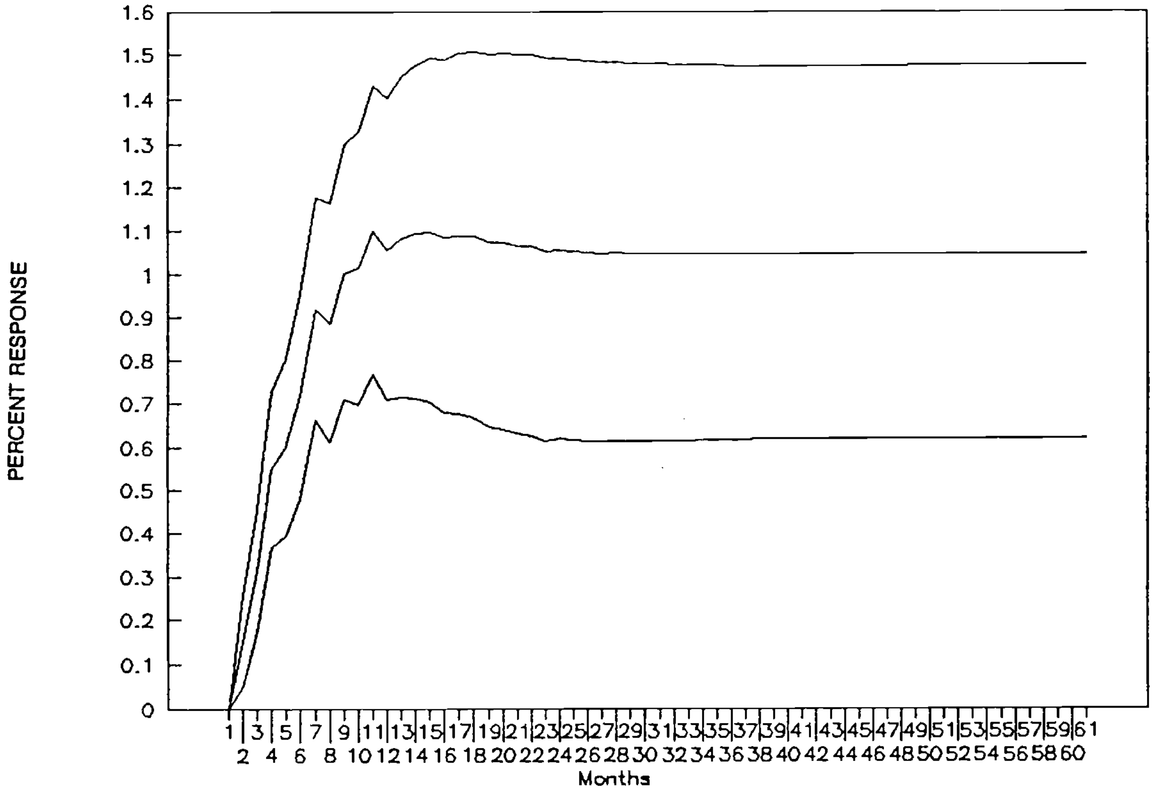

Figure 2b
IMPULSE RESPONSE FUNCTION
OF INDUSTRIAL PRODUCTION
Permanent Increase in M2 by 1 Percent

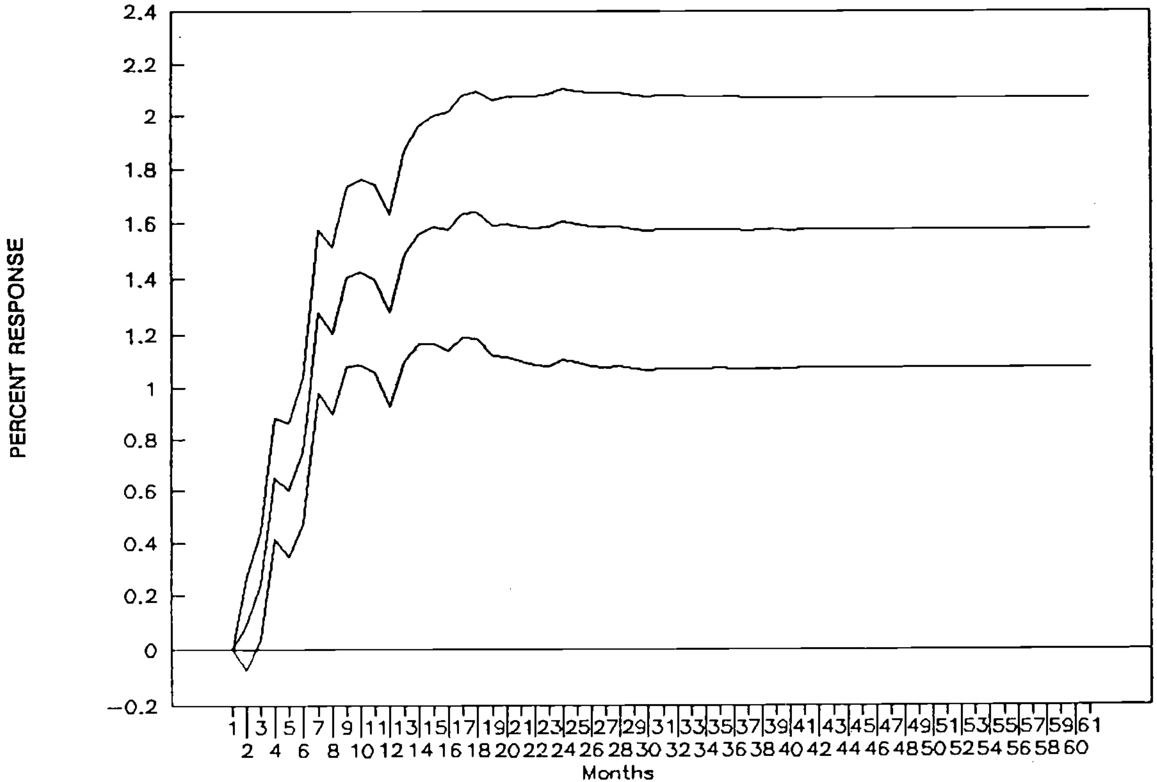

Figure 2c
IMPULSE RESPONSE FUNCTION
OF INDUSTRIAL PRODUCTION
Permanent Increase in CE by 1 Percent

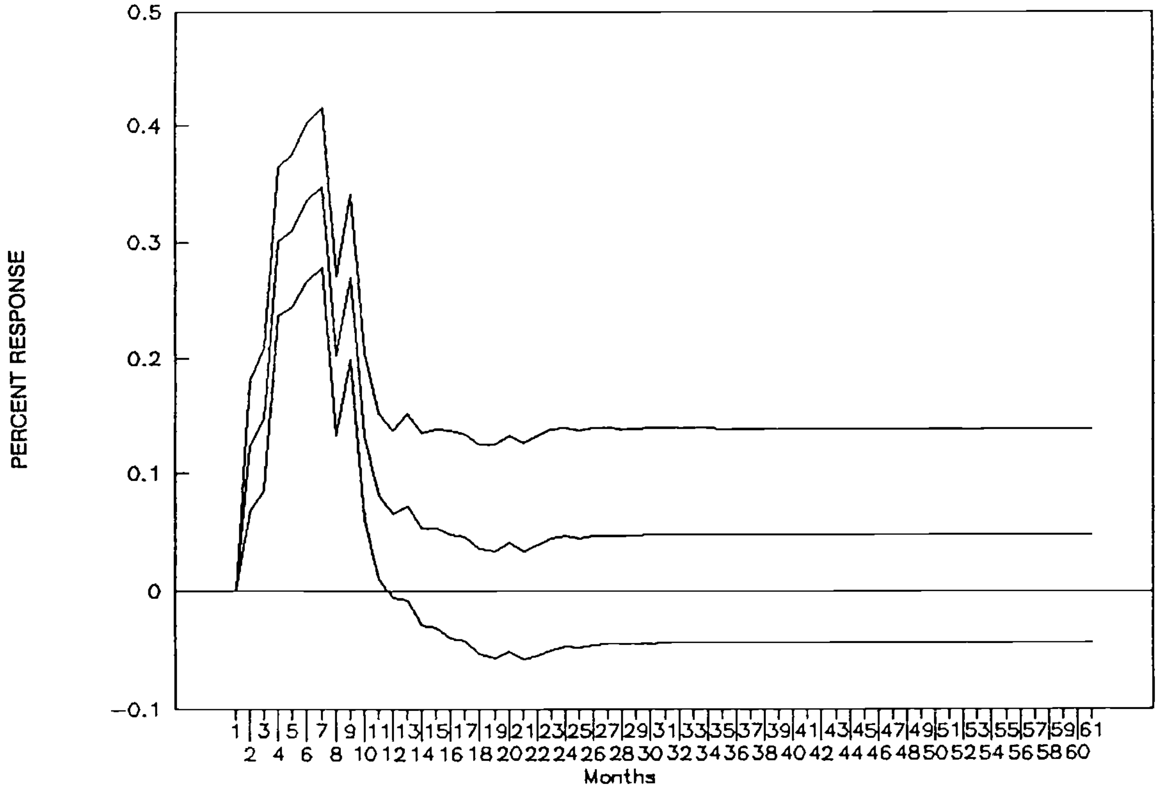

Figure 2d
IMPULSE RESPONSE FUNCTION
OF INDUSTRIAL PRODUCTION
A 100 Basis Point Shock to Spread

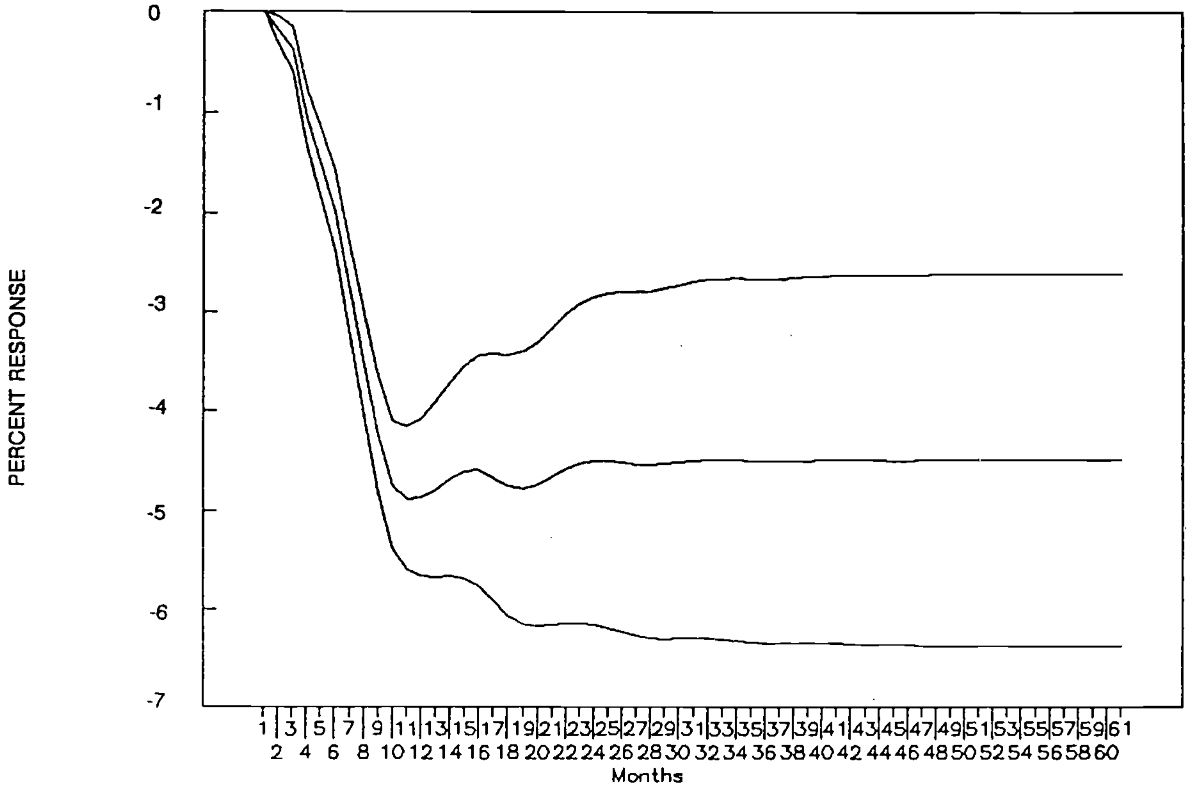

Figure 2e
IMPULSE RESPONSE FUNCTION
OF INDUSTRIAL PRODUCTION
A 100 Basis Point Shock to Federal Funds Rate

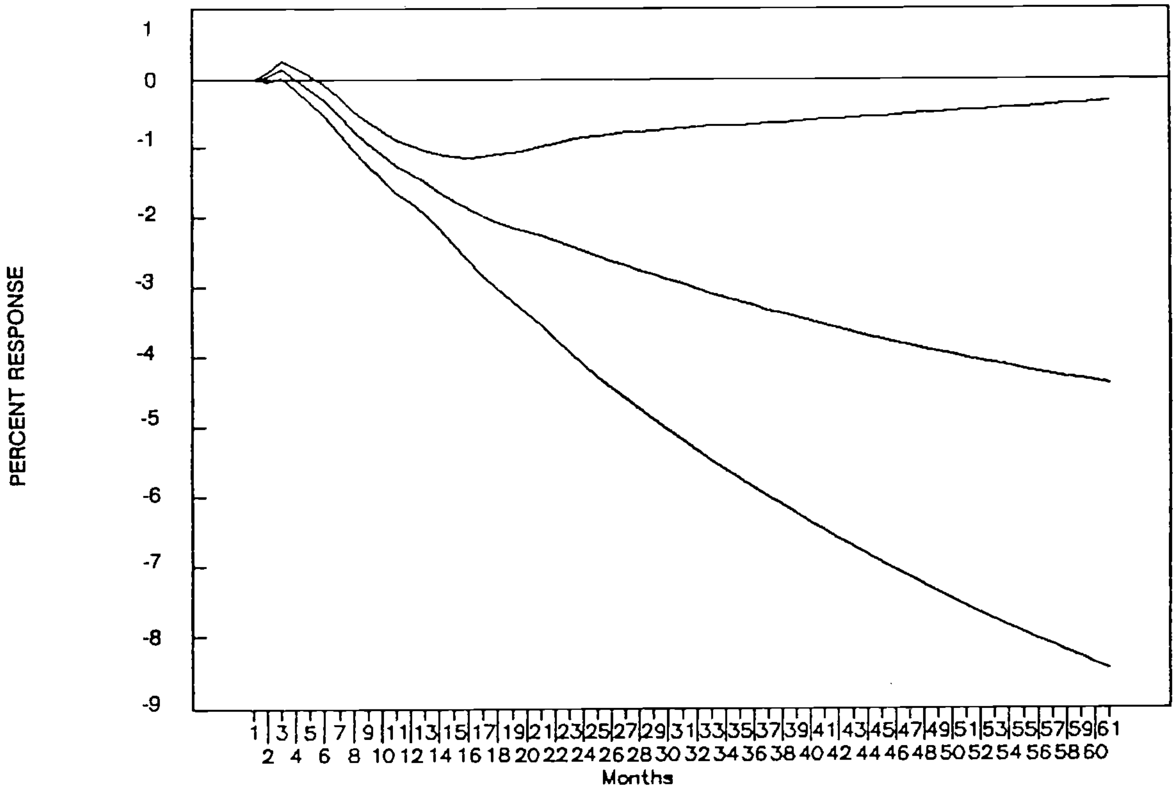

Figure 3a
IMPULSE RESPONSE FUNCTION
OF CPI
Permanent Increase in M1 by 1 Percent

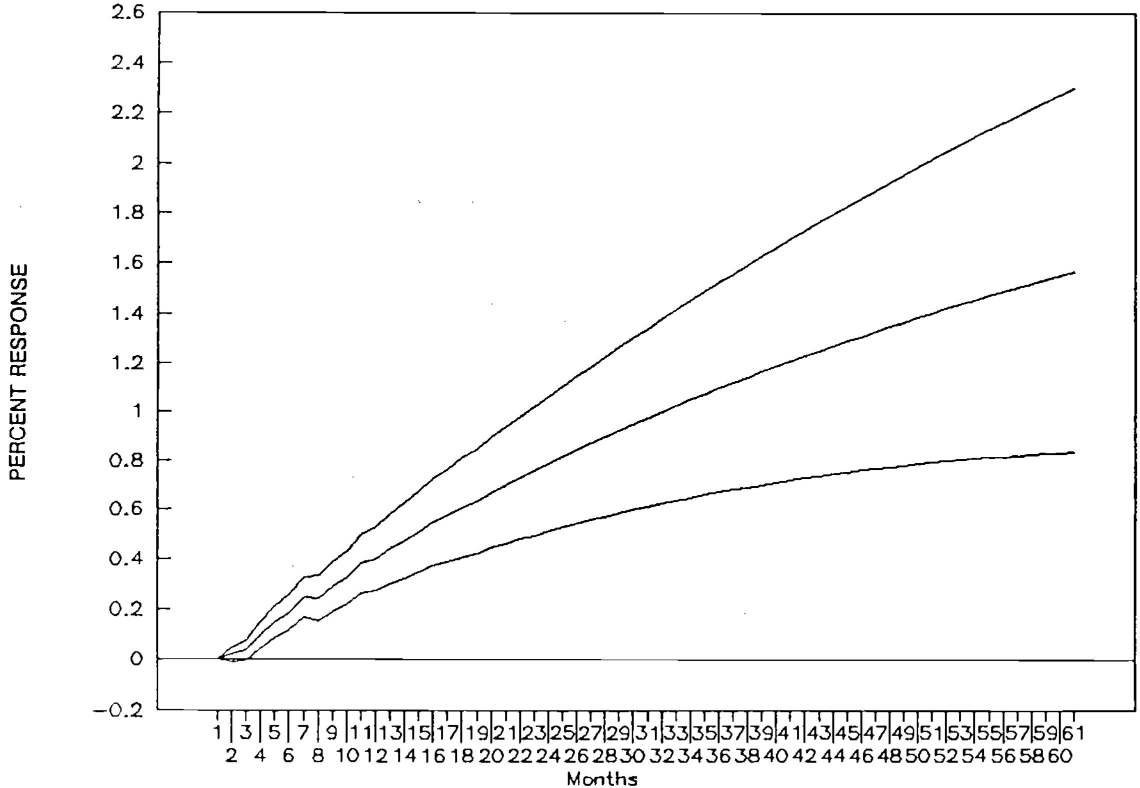

Figure 3b
IMPULSE RESPONSE FUNCTION
OF CPI
Permanent Increase in CE by 1 Percent