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Contents

Over the past decade cash management has become increasingly sophisticated, significantly affecting the use of financial instruments for conducting transactions. Economist John Carlson describes how the new methods affect the demand for money and the implications of deregulation for this process. After reviewing empirical studies of money demand, he presents evidence of another kind of change in the relationship between money and income. In the context of the conventional model, Carlson finds a sizable shift in the speed of adjustment of cash balances to desired levels. Although the shift is consistent with the cash-management process, other interpretations are identified and discussed.

The traditional simple-sum approach to monetary aggregation inefficiently measures the total flow of medium-of-exchange (MOE) services in the economy. The traditional approach is inefficient because it treats financial assets dichotomously—either totally including or totally excluding assets from the aggregate being constructed. Divisia aggregates provide, at least on the theoretical level, a more efficient approach. Through the rental prices of financial assets, Divisia aggregates possess a MOE thermometer—a thermometer that can register an infinite number of degrees in the MOEness provided, at the margin, by financial assets. By taking better account of the many different degrees of marginal MOEness across various assets, Divisia aggregates could provide a more precise measure of the total flow of MOE services in the economy.

Money Demand: Cash Management and Deregulation

by John B. Carlson

I. Introduction

The relationship of money to economic activity is one of the most closely studied relationships in economics. Prior to 1974, there seemed to be consensus about the stability of an empirical form of this relationship, known as the **money-demand function.** The basic theoretical underpinnings of this function are the models of Baumol (1952) and Tobin (1956), who treat money as an asset that is held primarily for transactions purposes. As estimated, the money-demand function includes a positive relationship to income and a negative relationship to interest rates with partial adjustment of money balances (measured as M-1) to desired levels in the short run. While many variations on the basic model were estimated, almost every specification was reported as functionally stable before the mid-1970s. That is, the estimated parameters linking money to income and interest rates did not change significantly over time.

The stability of the relationship of money to income and interest rates had important implications for monetary policy. Functional stability suggested that the level of money balances provided reliable information concerning the current level of economic activity, which is not observable until several months after the fact. More importantly, functional stability suggested that monetary aggregates might serve as readily observable targets. Monetary policymakers could aim at these targets to promote price stability, economic growth, and high employment. In fact, during the 1970s monetary aggregates evolved as the primary targets of monetary policy. Ironically, as the role of the narrow money measures grew in importance, their relationship to income became less stable.[1] Specifically, between the mid-1970s and late 1981, M-1 grew on average at a much slower rate than any of the money-demand functions would have predicted for the existing levels of interest rates and income. The literature suggests that the shortfall in money demand occurred in two episodes: one in the period 1974–76, and another around 1980–81. The second episode may be obscured in part by deregulation, particularly the introduction of interest-bearing checking accounts for households.

The breakdown in the money-demand function has been viewed in two (but not mutually exclusive) ways. One view holds that the instability of money demand results from a mea-

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1. For a comprehensive survey of money demand and the stability problem, see Judd and Scadding (1982).

surement problem. Financial innovations, such as overnight repurchase agreements (RPs) and money market mutual funds (MMMFs), are not included in M-1 but are close substitutes for assets in M-1. Because these assets are not included, their growth has depressed the growth of M-1 relative to its historical relationship to income and interest rates. Initially, the solution seemed simple: just add the new substitutes to M-1. Their tremendous growth since 1979, however, suggested that these assets had qualities making them suitable to serve both as transactions balances and investment media. The measurement view has led to research on methods obtaining an index of transactions services from a broad class of assets.[2]

The other view of money-demand instability emphasizes the consequences of developments in cash-management technology and deregulation. Rather than focusing on new assets arising from financial innovation, this second approach analyzes from a microeconomic perspective the effects of developments on the opportunity cost of cash balances. The demand for money has been reduced, in principle, because it has become cheaper to economize systematically on money balances. Explicit behavioral models suggest alternative specifications of money demand. These specifications are used to estimate the impact of indirect measures of cost and support the role of cash management in explaining the shortfalls in M-1.

This article describes the fundamental ways in which new cash-management practices affect the level of cash balances. Part III of this article reviews some empirical studies of these effects. Part IV presents an empirical finding that raises questions about money demand not addressed in previous studies of cash management. In the context of the conventional money-demand regression, this study finds a sharp increase in the speed of adjusting cash balances to desired levels. While this change may be consistent with the cash-management process, it may also be explained by alternative hypotheses. To the extent that this result reflects a money-demand effect, it has important implications for monetary control. Specifically, the result suggests that, in the short run, the responsiveness of M-1 to changes in opportunity cost is much stronger than was previously thought.

II. The Cash-Management Process

Cash management—the control of payments, receipts, and any resulting transactions balances—has become increasingly sophisticated over the past decade.[3] High interest rates have made it feasible for many firms to invest in information and forecasting systems that accelerate the collection of receivables and reduce uncertainty about the timing of receipts and clearing of disbursements. Recent developments in computer and communications technology have sharply reduced the costs of these systems, thereby increasing their rates of return. Declining costs of funds transfers have reduced the costs of concentrating receipts in one account. Investing collected balances in larger denominations enables balance holders to reduce average investment costs by spreading fixed costs over a larger volume.

The development of markets for immediately available funds (IAFs), such as overnight RPs, and other very liquid assets, such as MMMFs, has facilitated the growth of more intensive cash management. There are now investment opportunities for periods as short as one day, making profitable cash-management techniques that free funds only temporarily. Because of new, high-yielding, short-term assets, particularly MMMFs, it is worthwhile for households and small-to-medium size firms to manage their own demand-deposit balances more carefully.

Effects of Cash Management

Porter, Simpson, and Mauskopf (1979) studied the role of more intensive cash management

2. For example, see Barnett (1980); Barnett, Offenbacher, and Spindt (1981); Spindt (1983); and Zupan (1983).

3. See Carlson (1982) for a description of the more popular cash-management techniques.

in explaining the first episode of money-demand shortfall. Essentially, they identified three fundamental elements of this process: declining information costs, reduced uncertainty regarding cash flow, and reduced costs of funds transfers. They stressed the incentives that high market rates of interest create for managers to implement available cash-management techniques. The cash-management process has reduced the cost of shifting in and out of assets yielding market rates of interest, increasing the opportunity cost of holding transactions deposits not yielding market rates. Thus, a proximate impact of more intensive cash management has been to reduce the demand for transactions balances.

Other effects of cash management are specific to the basic types of cash-management techniques being adopted. Observing these effects may give clues to the intensity of cash-management practices and hence the impact on money demand. One important effect is shown by **controlled disbursement,** a payment technique adopted by many large corporations. Controlled disbursement allows a firm to control the funding of its disbursement account so that, for a given day, the firm need not deposit funds in excess of the clearings against such an account for that day. Because it is not *known* what the clearings will be on the *next* day, excess funds are freed for only one day; hence, investment opportunities are limited to the market for overnight instruments, e.g., the RP and Eurodollar markets. Although funds may be released for only one day, average balances may be reduced permanently, in some cases to zero. Fixed transactions costs make this arrangement feasible only for firms with large disbursements (e.g., $1 million or more). The RP market accelerated sharply during the first wave of cash management when disbursement techniques were being adopted by many of the largest firms.

Techniques that tend to accelerate receipts, on the other hand, tend to release funds for broader investment opportunities. An example of this technique is the use of lock boxes. The **lock-box system** enables businesses to decentralize the processing and collection of their receipts, locating this function near the source of payment. The firm receives payment earlier by eliminating mailing time (**mail float**) and may obtain earlier availability of funds by reducing the collection time once the payment enters the banking system (**bank float**).[4]

The key implication of these practices is that released balances become "permanently" available. That is, users of these techniques are not confined to invest these funds in IAFs, but may use them for any purpose. The lock-box system is often a profitable arrangement for intermediate-size firms not large enough to take advantage of disbursement techniques. It is largely this class of firms that became eligible for cash-management services when short-term rates peaked in 1981. Unfortunately, there is no close correspondence between the balances made available for investment and growth in any one set of short-term instruments to corroborate empirical significance of this technique.

Cash management by small businesses and households, on the other hand, is typically limited to the use of financial assets as a buffer for the variability of cash flow created by the lack of synchronization between receipts and expenditures. Historically, direct investment of cash balances has been inhibited by the round lot (or size) requirements of the investment and by transactions costs. Treasury bills, for example, are sold only in lots of $10,000 or more and are not redeemable before they mature; hence, if the funds are needed, the sale of the bill would involve a cost. Innovations such as MMMFs pool funds of many investors

4. The reduction in the aggregate money supply results from the elimination of mail float, which has never been subtracted from demand deposits. The impact of the reduction of mail float on the money supply depends on the behavior of the drawers of the checks. If the drawers were formerly successful in exploiting mail float, then money balances are not affected because the drawers actually had been using the balances and need to hold additional balances to offset the decline in mail float. On the other hand, if the drawers considered the funds extinguished at the time the checks were written, then the impact on demand-deposit balances equals the amount of mail float eliminated.

and thereby reduce denomination requirements and transactions costs for any one investor. Their development has facilitated more efficient cash management by small-balance holders. Increased cash management by small businesses and households also has contributed to the explosive growth of MMMFs since 1979. Thus, the MMMF growth can be viewed as both a cause and an effect of the cash-management process.

Because MMMFs are also attractive as a store of value, they have lured funds from nontransactions sources.[5] The MMMF explosion also reflects factors other than cash-management usage, e.g., cyclical buildup of precautionary balances. Thus, it is not likely that the impact of the cash-management process is mirrored in any simple sum of assets not included in M-1. This raises doubts about using alternative, broader measures (simple-sum) of transactions balances to remedy the shortfall problem. Nevertheless, monitoring growth in assets linked to cash management may be useful in anticipating effects on transactions balances. The growth of money market instruments, such as MMMFs, indicates a broadening of the scope of cash management over time. The second wave of cash management involved more participants as techniques became attractive to smaller businesses and households.

Deregulation and Cash Management

Since the early 1970s the financial industry has faced a large number of regulatory changes, most of which have led to a less restrictive financial environment. Deregulation has important implications for cash management, particularly for households and small businesses. Because these deposit holders typically maintain relatively small average balances, their investment opportunities have been limited. Deregulation has expanded such opportunities and reduced the investment costs for the small-balance holder.

Assets created under deregulation can serve both as complements and as substitutes for cash-management techniques. By reducing investment costs, new **nontransactions** accounts—such as money market certificates (MMCs), small-savers certificates (SSCs), and money market deposit accounts (MMDAs)—have increased incentives to economize on transactions balances not bearing interest or subject to interest-rate ceilings. Thus, deregulation has served to complement more efficient cash management, especially during periods of high interest rates and effective interest-rate ceilings.

The new interest-bearing transactions assets, on the other hand, have reduced incentives for adopting new cash-management practices. Many households do not have sufficient funds to maintain the minimum requirements of the most convenient investment opportunities (e.g., $1,000 for most MMMFs and $2,500 for MMDAs). Prior to interest-bearing checking accounts, cash management for many small-balance holders could be characterized chiefly by going to the bank to transfer excess transactions balances into a passbook savings account. These over-the-counter transfers involved obvious fixed costs and seemed worthwhile only when the amount of funds transferred was relatively large. The advent of negotiable order of withdrawal (NOW) and automatic transfer service (ATS) accounts and credit union share drafts (CUSDs) meant that transactions balances could earn interest without the "shoe leather" costs. The new accounts reduced incentives for such transfers, especially since the explicit yield on these accounts has been only about 25 basis points less than on passbook savings. Parke and Taubman (1982) estimate that in the first five months of 1981 approximately 7 percent of the funds flowing into NOWs came from savings deposits held by the same institution where a NOW account was opened. This suggests that some NOWs were opened for savings and hence

5. A more extensive analysis of the impact of MMMFs is found in Dotsey, Englander, and Partlan (1981-82).

served to substitute for a common cash-management practice of households.

In providing for assets that *complement* cash management, deregulation *raises* the opportunity cost of holding transactions balances and hastens the cash-management process. To the extent that these assets are priced attractively, they enhance cash-management practices and thereby could reduce the demand for transactions balances. Conversely, by authorizing instruments that *substitute* for cash management, deregulation *lowers* the opportunity cost of these balances and could limit or even reverse the impact of the cash management process. The net impact on money demand also depends on the relative prices (or perhaps the perception of these prices) of the new instruments.

III. Empirical Forms of the Cash-Management Hypothesis

The cash-management hypothesis essentially views the money-demand shortfall as a consequence of incomplete specification of the money-demand function. A "complete" form, in principle, would include the return on investment (or profitability) of cash-management techniques to determine the level of money balances, particularly noninterest-bearing transactions deposits. Because profitability of cash management is so closely linked to transactions costs, a measure of these costs alone might capture the effects of cash management.

Several studies have attempted to estimate the effects of cash management indirectly. Enzler, Johnson, and Paulus (1976) and Quick and Paulus (1977) use past peaks of interest rates as a proxy for the incentive to adopt new cash-economizing methods. Building on this approach, Simpson and Porter (1980, pp. 179–80) propose a more flexible proxy variable, also with a ratchet property, to represent the perceived profitability of investment in cash management:

One justification for using the previous peak in interest rates is that there might be an awareness threshold that is related to interest rate peaks and once the previous peak has been surpassed more attention is drawn to the opportunity cost of holding money balances and to the profitability of investing in new techniques. Or, alternatively, if interest rate peaks imply a higher level of rates in the future than prevailed in the past—as would be the case, for example, if rates followed a random walk—then firms might be willing to undertake investments in new money management techniques that were previously judged unprofitable. In essence, this approach suggests that once a past peak has been surpassed, investments are made in new money management techniques that lead to a more permanent effect on money demand, even after market rates have dropped below the previous peak. That is, once the fixed costs of an investment are borne, it remains in place and is not discarded even though rates have declined.

The relationship between peaks in interest rates and the subsequent impact on cash management, and thereby money demand, may be lengthy and somewhat variable for a number of reasons. If the threshold effects are large, the new investments to be undertaken may be more sizable than otherwise and take a longer time to implement. Such episodes may also spur the development of new technologies, new research and development efforts and the promotion of new practices by the suppliers of cash management services. Bringing the new technology in line—learning by doing—takes time as does recruiting the skilled labor force to operate it. Finally, it takes time before the new technology is diffused throughout the industry.

The particular ratchet variable used by Simpson and Porter is given by:

$$(1) \quad S_t = \sum_{j=1}^{t} \left(r_j - \frac{1}{12} \sum_{i=j-13}^{i=j} r_i\right)^+ ,$$

where

r_i = the five-year Treasury bond rate (chosen to be the relevant opportunity cost of evaluating a cash-management investment),
$(\ )^+$ = the non-negative values, and
S_t = the cumulative sum of the non-negative deviations of r_t from its 12-period moving average.

This approach differs from that of Quick and Paulus by using a moving average of the opportunity cost rather than a past peak. Hence, the Simpson-Porter approach is somewhat more flexible, ratcheting up more continuously both before and after new peaks in the opportunity cost.

Simpson and Porter include the ratchet variable in several different money-demand regressions, each a special case of the following equation:

$$(2)\quad \ln (M/P) = \beta_0 + \sum_{j=0}^{3} \beta_{1j} \ln r_{it-j} + \beta_2 \ln r_{2t} + \sum_{j=0}^{2} \beta_{3j} \ln Y_{t-j} + \sum_{j=0}^{5} \beta_{4j} g(S_{t-j}) \ ,$$

where

M/P = real M-1 balances,
r_1 = three-month T-bill rate,
r_2 = commercial bank passbook rate,
y = real GNP, and
g = one of three functions of S: S_t, $S_t \times \ln (S_t)$, or S_t^λ.

The regressions are estimated over the periods 1955:IQ through 1974:IIQ and 1955:IQ through 1980:IIQ, using a Schiller-lag technique. The results are then compared with the standard specifications of money demand, which do not account for the effects of cash management. Simpson and Porter find equations that include the ratchet variable overall are superior to those that do not, particularly on the basis of post-sample forecasting performance since 1974. For example, the mean forecast errors of all the alternative cash management specifications are at least as small as the lowest mean forecast error of the standard specifications estimated. The mean error of the best cash-management equation is less than one-half the mean error of the best of the standard forms. Thus, their approach offers at least some measure of improvement on the standard form.

More recently Porter and Offenbacher (1982) have pursued the idea that what is truly relevant about the effect of cash management (on money demand) is captured sufficiently in transactions costs or the "brokerage fee." Based on the analytical results of the Miller and Orr (1966) transactions model, Porter and Offenbacher derive indirect estimates of the brokerage fee. Essentially, the Miller-Orr model explains the levels of both average money balances and "financial debits" in terms of brokerage fees, the variability of cash flows, and the opportunity cost of money. These relationships are used to solve for two measures of brokerage fees, one in terms of financial turnover (the ratio of average money balances to debits) and the other in terms of debits. When these proxies for transactions costs are added to the standard money-demand function, evidence of money-demand shortfall diminishes significantly. While the approach must overcome some obstacles in estimation (too lengthy to discuss here), it builds on the well-defined theories of Baumol, Tobin, and Miller and Orr.

Kimball (1980) proposes another approach for estimating the impact of cash management. He posits that, because most cash-management techniques involve the use of wire transfers, the number of wire transfers can be used as a proxy variable to estimate the impact of cash-management techniques on money balances. Kimball finds that respecification of the relationship between money and transactions to include the number of wire transfers greatly reduces money-demand forecast errors in the post-1974 period using annual data.

Dotsey (1983) also uses wire-transfer data as a proxy for cash-management effects, finding that this measure performs well relative to other proxies in an annual model. He analyzes the influence of six different proxies on the demand for demand deposits, since it is largely this component of M-1 that seems to be most affected by cash management. The proxies are divided into two classes: measures representing the equilibrium level of demand deposit economization and measures for technological innovation. The first class includes the number and real value of electronic funds transfers (EFTs) and the ratio of demand-deposit debits to consumption. Like Kimball, Dotsey argues that EFT usage is directly related to most of the major cash-economizing techniques adopted in the mid-1970s—lock boxes, cash concentration, and zero balancing. The ratio of debits to consumption reflects the increase in financial transactions relative to spending.

The proxies for technological innovation include the real price of office computing and accounting equipment, a Simpson-Porter ratchet, and a time trend. Because the price index was adjusted for quality (hedonic), it dropped sharply in the 1970s. It was assumed that the decline in the cost of this technology represents the inducement to adopt the more sophisticated techniques, causing demand deposits to decline. Lieberman (1977) initially proposed the rationale for a time trend, i.e., the adoption of new technology will be fairly uniform and proceed at a smooth rate.

Dotsey analyzes the influence of the various proxies on the basis of three criteria: how they affect other coefficients of money demand, the out-of-sample predictive power, and the stability of money demand over the whole sample period (1920–79). The money-demand model used takes an inventory approach originally proposed by Barro and Santomero (1972).[6] Without controlling for cash management, Dotsey finds that the model is not stable when the sample period is divided at 1965. Most notably, after 1965 the coefficient of transactions income (proxied by consumption) diminishes sharply, and the coefficient of the value of time (real wage rate) increases sharply. When each of the cash-management proxies is included separately and the model is re-estimated, each has the desired effect of restoring parameter estimates to levels comparable to estimates of the pre-1965 sample. Of the alternatives, the specification using the number of EFTs had the smallest standard error of estimate (SEE). In a comparison of one-step-ahead forecasts beginning in 1966, the specification including the number of EFTs produces the smallest forecast root mean square error, although the predictive power of the basic model is improved greatly when any of the proxies is included. Finally, in tests of functional stability, only with the model including EFTs could the data reject the hypothesis of instability.

Although these results suggest that the number of EFTs is the best proxy for the effects of cash management, it is not possible to extend this conclusion to apply to quarterly models without explicit comparisons using quarterly data. The standard errors of the Dotsey regression models are much higher than those of typical quarterly money-demand regressions that employ similar proxies for cash management. Nevertheless, the message that seems to emerge from empirical investigations is that the effects of cash management are large and important regardless of the way in which one proxies the cash-management process.

IV. The Adjustment of Cash Balances

Although some theoretical models of the cash-management process account for interaction among the determinants of money, empirical forms thus far have not been as general. Simply adding cash-management proxies to log-linear forms of money demand implies that cash management has no effect on the parameters linking money to its other determinants. However, as cash management has become more broadly based over the last several years, M-1 has appeared to become more

6. This specification differs from the conventional approach in several distinct ways. First, the model uses consumption rather than income as the scale variable. It also includes two variables not found in the conventional specification: an implicit interest rate on demand deposits and the real wage rate. The latter variable is included as a measure of the value of time of cash managers. Finally, the model assumes complete adjustment on average.

responsive to changes in interest rates and income. That is, the short-run elasticities of the determinants of money seem to have increased, suggesting that cash holders are adjusting their M-1 balances to desired levels more quickly. The hypothesis of higher short-run elasticities can be examined in the context of the conventional model.

The Conventional Specification

The conventional money-demand specification has followed a basic approach proposed by Chow (1966) and also associated with Goldfeld (1973). The basic feature of this approach is to allow temporary differences between the observed stock of money and the public's desired balances, a long-run equilibrium level. The mechanism guiding adjustment of actual money to its desired level is most frequently defined as follows:

$$(3)\quad \frac{m_t}{m_{t-1}} = \left(\frac{m_t^*}{m_{t-1}}\right)^{\gamma},$$

or equivalently in log form

$$(4)\quad \ln m_t - \ln m_{t-1} = \gamma(\ln m_t^* - \ln m_{t-1}),$$

where

m = money deflated by the price level (P),
γ = the adjustment rate, and
$*$ = desired.

Because it is assumed that $0 < \gamma < 1$, real money balances adjust only partially to the gap between the desired balances—the quantity of money demanded in the long run—and the holdings of the previous period. In the absence of a firm theoretical basis, the partial adjustment framework is often defended on the grounds that transactions costs inhibit complete adjustment to equilibrium.[7] That is, adjustment speed depends on transactions costs.

The determinants of desired money (i.e., the long-run equilibrium level) are based on the theoretical underpinnings of Baumol (1952) and Tobin (1956), who relate the demand for real money balances to the level of real income and "the" interest rate:

$$(5)\quad m^* = \alpha_0 y^{\alpha_1} r^{\alpha_2},$$

where

m_t = money deflated by the price level,
y_t = real income, and
r_t = opportunity cost of holding money.

According to the theory, the parameter α_0 is related to transactions costs. Thus, transactions costs can also affect equilibrium levels of money. In addition, the basic theoretical result of the Baumol model implies that the elasticities of y_t and r_t (α_1 and α_2) should equal ½ and -½, respectively.

Most estimated forms include two interest-rate variables, a money market rate—often the three-month Treasury bill (rtb_t)—and the commercial bank passbook rate (rcb_t). In log form, desired money is specified as

$$(6)\quad \ln m^* = \ln \alpha_0 + \alpha_1 \ln y_t + \alpha_2 \ln rtb_t + \alpha_3\, rcb_t.$$

Because desired balances are not observable, m^* is eliminated by substituting equation 6 into equation 4, yielding the familiar empirical form in terms of observed money:

$$(7)\quad \ln m_t = a_0 + a_1 \ln y_t + a_2 \ln rtb_t + a_3 \ln rcb_t + a_4\, m_{t-1},$$

where

$a_0 = \gamma \ln \alpha_0$,
$a_i = \gamma\, \alpha_i$ for $i = 1, 3$, and
$a_4 = (1 - \gamma)$.

Thus, all parameters of equation 4 and equation 6 can be identified exactly from this log-linear form.

To test for a shift in the adjustment rate, the adjustment scheme was modified to include the

7. This rationale has been criticized, especially since the estimated adjustment rate is commonly too low to be defended on adjustment costs alone. It is not the intent here to defend the partial adjustment approach but to identify further evidence of change in the conventional specification that could be related to the cash-management process.

Table 1 Nonlinear Model
Estimation period: 1960:IQ to 1981:IVQ[a]

		Estimated parameters[b]						
				Long-run elasticities				
Money measure[c]	Ratchet variable	γ	$1 + \delta$	α_1	α_2	α_3	α_4	α_5
M-1a	SP-2	0.353	2.34	0.463	-0.041	-0.046	-0.010	0.054
		(5.18)	(2.88)	(11.75)	(-2.68)	(-1.48)	(-11.43)	(5.58)
	SP-1	0.200	2.80	0.671	-0.104	-0.039	-0.308	0.093
		(5.88)	(2.82)	(10.75)	(-4.66)	(-0.75)	(-6.19)	(7.02)
M-1	SP-2	0.349	2.54	0.453	-0.041	-0.045	-0.006	0.067
		(5.10)	(2.85)	(11.06)	(-2.78)	(-1.38)	(6.69)	(6.83)
	SP-1	0.251	2.76	0.573	-0.076	-0.042	-0.186	0.090
		(6.03)	(2.74)	(11.24)	(-4.61)	(-0.95)	(-4.58)	(8.53)

				Implied short-run elasticities			
Money measure[c]	Ratchet variable	Period	Adjustment rate	Income	T-bill rate	Passbook rate	Ratchet
M-1a	SP-2	Through 1979:IIIQ	0.353	0.163	-0.014	-0.016	-0.004
		After 1979:IIIQ	0.826	0.382	-0.034	-0.038	-0.008
	SP-1	Through 1979:IIIQ	0.200	0.134	-0.021	-0.008	-0.062
		After 1979:IIIQ	0.561	0.377	-0.058	-0.022	-0.173
M-1	SP-2	Through 1979:IIIQ	0.349	0.158	-0.014	-0.016	-0.002
		After 1979:IIIQ	0.888	0.403	-0.037	-0.040	-0.005
	SP-1	Through 1979:IIIQ	0.251	0.144	-0.019	-0.010	-0.047
		After 1979:IIIQ	0.692	0.396	-0.052	-0.029	-0.129

a. The model was estimated using "Program for Computation," IBM version 9.
b. t-Statistics are in parentheses.
c. This variable was measured on an end-of-period basis as an average of the two months surrounding the end of the quarter.

factor $(1 + \delta\ DG_t)$, where DG_t is a dummy variable that equals 0 prior to 1979:IVQ and 1 thereafter and δ is an additional parameter to be estimated:

$$\ln m_t - \ln m_t = \gamma(1 + \delta DG_t)(\ln m_t^* - \ln m_{t-1}). \tag{8}$$

The desired money-demand specifications examined include a cash-management proxy. Two variables were used, both based on the Simpson-Porter ratchet formula. The first (*SP*-1) was a simple linear version proposed in Simpson and Porter (1980), i.e., equation 1. The second ratchet (*SP*-2) was also in linear form but was initiated in 1970 and assumed a shorter lag length (four quarters), making it more flexible than the former.[8] All equations included a

8. Money demand appeared stable prior to 1970. There is little evidence to suggest intensive adoption of techniques that were permitted by developments in information and communications systems during the 1970s. Thus, if the ratchet is in fact a relevant proxy variable for the waves of cash management in the 1970s, it should not be effective before then.

Table 2 Test of Complete Adjustment[a]
After 1979:IIIQ; H_o: $\gamma(1 + \delta) = 1$

Money measure	Ratchet variable	t-Statistic	Reject null hypothesis[b]
M-1a	SP-2	0.91	No
	SP-1	2.88	Yes
M-1	SP-2	0.53	No
	SP-1	1.74	Yes

a. This test was based on results of large sample theory presented by Rao (1973, pp. 386–9). The estimated variance of $\gamma(1 + \delta)$ is given by

$$\hat{\sigma}_{11}\ (1 + \hat{\delta})^2 + 2\ \hat{\sigma}_{12}\ \ \hat{\gamma}(1 + \hat{\delta}) + \hat{\sigma}_{22}\ \hat{\gamma}^2.$$

b. One-tailed test with 0.05 acceptance level.

dummy variable ($D1$) to test for an intercept shift in mid-year 1974.[9]

$$(9)\quad \ln m^* = \ln \alpha_0 + \alpha_1 \ln y_t + \alpha_2 \ln rtb_t + \alpha_3 \ln rcb_t + \alpha_4\ SP_t + \alpha_5\ \mathrm{Dl}_t\,.$$

Modifying the conventional framework to test for a change in the adjustment rate poses some problems for estimation. Specifically, substitution of equation 9 into equation 8 does not yield a linear form that allows identification of the parameters of the model; hence, nonlinear methods were employed to estimate the parameters of both equations directly.

Estimation results for two measures of money, M-1 and M-1 adjusted for NOWs (M-1a), are shown in table 1.[10] The results indicate a large change in the rate of adjustment that is statistically significant for all specifications.[11] Adjustment rates jump about two and one-half times after 1979:IIIQ. For the M-1a measure, this implies an adjustment rate as high as 0.89 in the latter period. The data do not reject the hypothesis that, after 1979, the adjustment rate is statistically equal to 1 in two equations examined (see table 2). In these equations lagged money is no longer a relevant explanatory variable. This clearly creates a new puzzle for the partial adjustment approach to money demand.

Table 3 shows the same basic specifications estimated for a sample ending in 1979 before the apparent shift. Because all parameters of this model could be identified from the parameters of a linear form, they were estimated in the linear form, using a maximum likelihood iterative routine that corrected for serial correlation. The short-run elasticity estimates are comparable with those in table 1. An interesting result is that the marginal significance of the cash-management proxies increased over the longer sample periods, indicating that the ratchet proxy was no less useful during the second wave of cash management.[12]

The evidence of quicker adjustment would

9. This variable was included to examine whether the cash-management proxy accounted for all the unexplained shifts in the conventional equation. Hafer and Hein (1979) found that before 1979 the stability of the conventional equation could be restored if the regression accounted for an intercept shift between 1974:IQ and 1974:IIQ. Although the dummy variable reported in table 1 assumes that the shift occurred between 1974:IIQ and 1974:IIIQ, the Hafer-Hein shift variable was also examined. The results were not significantly affected. The choice of which dummy variable to report was based on which equation fit the data better.

10. The adjustment method followed partly the approach in Lindsey *et al.* (1981). Prior to 1981, the adjusted series is constructed as if interest-bearing checkable accounts—ATS and NOW accounts—were not permitted. Specifically, one-third of other checkables was excluded. Unlike Lindsey *et al.*, this approach did not attempt to adjust for the impact of savings accounts for businesses and state and local governments. For further details, see Lindsey *et al.* (1981, table 10, fn. 2). Beginning in 1981, the change in shift-adjusted M-1B was added to the base of the adjusted series. Adjustment for 1981 followed precisely the approach implicit in the reported data.

11. A wider variation in specifications was examined than reported in this article. The main result of a statistically significant shift in the adjustment rate was robust across all specifications.

12. Nevertheless, it is difficult to justify how the cash-management proxy fits into the partial adjustment framework.

Table 3 Linear Model
Estimation period: 1960:IQ to 1979:IVQ[a]

Money measure[b]	Ratchet variable	Adjustment rate	Short-run elasticities: Income	T-bill rate	Passbook rate	Ratchet variable	Intercept shift
M-1a	SP-2	0.316	0.156	-0.016	-0.017	-0.004	0.015
		(10.78)	(6.09)	(-4.18)	(-1.47)	(-3.53)	(3.29)
	SP-1	0.169	0.124	-0.023	-0.007	-0.059	0.017
		(17.86)	(5.49)	(-6.51)	(-0.636)	(-2.42)	(3.85)
M-1	SP-2	0.334	0.162	-0.016	-0.019	-0.003	0.017
		(9.76)	(5.97)	(-3.91)	(-1.59)	(-3.06)	(3.58)
	SP-1	0.206	0.138	-0.021	-0.010	-0.060	0.019
		(15.58)	(5.84)	(-6.20)	(-0.93)	(-2.48)	(4.07)

a. *t*-Statistics are in parentheses.
b. This variable was measured on an end-of-period basis as an average of the two months surrounding the end of the quarter.

seem easy to rationalize from the cash-management view. It could simply reflect lower transactions costs. But if this hypothesis were true, one would expect to find other systematic changes in the adjustment rate as transactions costs have declined relative to the opportunity cost of money in recent years. Several additional specifications were estimated to test whether the speed of adjustment had changed around 1974 or whether it was systematically related to the Simpson-Porter proxies of cash management. No evidence of such effects was found.

The absence of such effects in the earlier period could reflect the limited scope of the cash-management process then. As indicated above, the dominant effects of cash management seemed to be reflected largely by the significant development of the market for IAFs. This suggested that the cash-management process could be characterized adequately by large firms learning to conduct transactions with fewer (in some cases zero) demand deposits, with the result mirrored in the growth of IAFs. The adjustment rates of large firms were probably close to one (within three months) before the advent of the new technology.[13] Thus, these techniques probably did little to change average speed of adjustment in the aggregate. The cash-management process then would affect only the long-run, or "desired," level of M-1 balances during the first wave.

Although many innovations suitable to a broader scope of cash holders were available during the first wave, the extent of their adoption was limited—perhaps by information costs. The availability of MMMFs, for example, which were introduced in 1973, sharply reduced investment costs for small-balance holders. However, MMMFs grew to only $3.5 billion by the mid-1970s. As interest rates began to rise in the late 1970s, the advantages of MMMFs as an investment vehicle became widely known. MMMF growth exploded, reaching a level over $230 billion by the end of 1982.

13. When examining alternative proxies for cash-management effects, Porter and Offenbacher (1982) use a measure of nonfinancial business demand deposits as a dependent variable in their regressions. They find that the lagged value of this variable was not statistically significant when added to the equation; hence, adjustment rates of corporate cash holders appear to be close to one.

Because MMMFs were clearly being used by a broader scope of cash holders—particularly those with fewer investment opportunities—it is likely that widespread usage facilitated faster adjustment to desired M-1 levels in addition to affecting the desired level. A consumer who needed $10,000 to invest in a Treasury bill in 1974 (most consumers were unaware of MMMFs at that time) learned by the late 1970s that a share of this investment could be bought for as little as $500. Household balances now need not accumulate for as long before average adjustment costs are low enough to make a financial transaction. Since the previously high transactions costs for small-balance holders probably accounted for the slow adjustment speed of total balances, the widespread participation of households in the second wave of cash management suggests their transactions costs had been reduced sharply.

Other Qualifications

Evidence of a change in the short-run relationships among the variables included in the money-demand function appears substantial. However, the structural interpretations must be qualified. Recent critiques of the conventional money-demand function suggest alternative explanations that are especially relevant in light of the October 6, 1979, change in operating procedure—the procedure the Federal Reserve uses to control the money supply.

Goodfriend (1983) illustrates one way a change in operating procedure could affect the estimates of the parameters of the conventional money-demand function. Specifically, Goodfriend offers an interpretation of the conventional function that does not rely on a partial adjustment rationalization. Instead, he posits that money demand adjusts completely each period to appropriate current interest-rate and transactions variables that in turn are generated by independent first-order autoregressive processes. He shows that if the regressors are not measured correctly, the coefficient on lagged money is positive, even though lagged money plays no role in the true money-demand function. Lagged money enters significantly because, under the hypothesis, it helps to predict money. Goodfriend also shows that each of the coefficients in the conventional money-demand regression is a function of all the parameters in true money-demand models and all the regressor-generating process parameters. Thus, to the extent the change in operating procedure implies a change in the process-generating interest rates, it could produce a change in the estimated coefficient of the lagged dependent variable, which under the hypothesis does not imply a change in the adjustment rate.[14]

The coincidence of a change in operating procedure and a stronger short-run association between changes in money income and interest rates also raises questions about the exogeneity of interest rates. A common criticism of the conventional approach is that it assumes interest rates are independent of money. Under the new operating procedure, if interest rates systematically respond to changes in money, the relationship between interest rates and income is simultaneous, and the methods typically used to estimate the model are not appropriate.

A popular defense for assuming the exogeneity of interest rates was based on the contention that the Federal Reserve pegged interest rates in the short run. Thus, the Fed had to supply the quantity of money demanded. The perfectly elastic supply curve implied that money was endogenous—not interest rates. Under the operating procedure implemented between October 1979 and mid-1982, changes in money were not fully accommodated at a pegged interest rate. Deviations of money from target led to an automatic impact on the federal funds rate in the same direction. As money moved above (below) its target path, interest rates tended to increase (decrease).

14. This insight was brought to my attention by Dick Porter. Although Goodfriend's hypothesis provides a basis for the shift observed above, it is not an unambiguous implication. That is, unless the regressor-generating processes are known, it is not possible to identify the direction or magnitude of the effect.

The parameter estimates in table 1 indicate that the short-run elasticity of the Treasury bill rate was significantly higher after the change in the operating procedure, i.e., more like that of a demand curve than a supply curve. This elasticity is more negative than for any short-run interest-rate elasticities reported in a recent survey of the literature.[15] To the extent simultaneity was a problem before 1979, it would seem to be less so afterward. Nevertheless, little solace should be taken in these results, as the simultaneity problem is still an open issue.[16]

Finally, other shortcomings of the conventional model also could account for an "apparent" change in the adjustment rate. Brayton, Farr, and Porter (1983) present evidence that the response of transactions balances to their opportunity cost increases with the level of interest rates. This implies that the conventional approach, which restricts this elasticity to be constant, would have underpredicted the M-1 impact of interest-rate changes since 1979—a period when interest rates have been historically high. Because the partial adjustment framework restricts the adjustment pattern of money holdings to be the same with respect to all determinants of money, it is conceivable that the estimated shift in adjustment rate inappropriately reflects the nonlinearity in the interest-rate elasticity.[17]

V. Some Concluding Remarks

Although it is difficult to assess the precise impact of cash management on M-1, the results of a variety of studies indicate that the impact is large and cannot be ignored. Furthermore, it is evident in the conventional money-demand framework that the parameter estimates linking money with income and interest rates (contemporaneously) have changed significantly since 1979. Interpreted in this context, the evidence implies that cash managers are adjusting their balances to desired levels more quickly than before. To the extent M-1 is more responsive to changes in its opportunity cost, closer monetary control need not imply greater interest-rate volatility. But, this article also questions the basis of the conventional model. Qualified interpretations are presented to highlight important empirical issues in need of closer examination.

Attempts to study this issue more closely are likely to be obscured by continued deregulation. It has been argued that new interest-bearing assets have reduced the opportunity cost of holding transactions balances. If the yields of the new instruments are market-determined and parallel the yields of other short-term assets, then small-balance holders may find little incentive to manage these balances so closely. This implies that adjustment rates of this class of cash holder could decline. Furthermore, the stronger the covariability between yields on transactions and nontransactions assets, the more difficult it would be for the Federal Reserve to affect the opportunity cost of transactions balances, especially after 1986 when NOW rates will be decontrolled. Thus, although M-1 may respond more quickly to changes in opportunity cost, the Federal Reserve may not be able to take advantage of this in a demand-oriented procedure for monetary control.

15. See Judd and Scadding (1982).

16. To be comparable with the results of Brayton, Farr, and Porter, it would be necessary to investigate this issue in the context of their framework.

17. For an excellent discussion of the intractable nature of the simultaneity problem in money demand, see Cooley and LeRoy (1981).

References

Barnett, William A. "Economic Monetary Aggregates: An Application of Index Number and Aggregation Theory," *Journal of Econometrics,* vol. 14, no. 1 (September 1980), pp. 11-48.

____, Edward K. Offenbacher, and Paul A. Spindt. "New Concepts of Aggregated Money," *Journal of Finance,* vol. 36, no. 2 (May 1981), pp. 497-505.

——, Paul A. Spindt, and Edward K. Offenbacher. "Empirical Comparisons of Divisia and Simple Sum Monetary Aggregates," NBER Conference Paper 122, National Bureau of Economic Research, Cambridge, MA, August 1981.

Barro, Robert J., and Anthony M. Santomero. "Household Money Holdings and the Demand Deposit Rate," *Journal of Money, Credit and Banking,* vol. 4, no. 2 (May 1972), pp. 397-413.

Baumol, William J. "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly Journal of Economics,* vol. 66 (November 1952), pp. 545-46.

Brayton, Flint, Terry Farr, and Richard Porter. "Alternative Money Demand Specifications and Recent Growth in M-1," Board of Governors of the Federal Reserve System, May 23, 1983, Processed.

Brunner, Karl, and Allan H. Meltzer. "An Aggregative Theory for a Closed Economy," in Jerome L. Stein, Ed., *Monetarism.* Amsterdam: North Holland Publishing Company, pp. 69-103.

Carlson, John B. "Methods of Cash Management," *Economic Commentary,* Federal Reserve Bank of Cleveland, April 5, 1982.

Chow, Gregory C. "On the Long-Run and Short-Run Demand for Money," *Journal of Political Economy,* vol. 74, no. 2 (April 1966), pp. 111-31.

Cooley, Thomas F., and Stephen F. LeRoy. "Identification and Estimation of Money Demand," *American Economic Review,* vol. 71, no. 5 (December 1981), pp. 825-44.

Dotsey, Michael. "The Effects of Cash Management Practices on the Demand for Demand Deposits," Working Paper 83-2, Federal Reserve Bank of Richmond, January 1983.

——, Steven Englander, and John C. Partlan. "Money Market Mutual Funds and Monetary Control," *Quarterly Review,* Federal Reserve Bank of New York, vol. 6, no. 4 (Winter 1981-82), pp. 9-17.

Enzler, Jared, Lewis Johnson, and John Paulus. "Some Problems of Money Demand," *Brookings Papers on Economic Activity,* 1976:1, pp. 261-80.

Goldfeld, Stephen M. "The Demand for Money Revisited," *Brookings Papers on Economic Activity,* 3:1979, pp. 576-638.

——. "The Case of the Missing Money," *Brookings Paper on Economic Activity,* 3:1976, pp. 683-730.

Goodfriend, Marvin. "Measurement Error and a Reinterpretation of the Conventional Money Demand Regression," Working Paper 83-3, Federal Reserve Bank of Richmond, March 1983.

Hafer, R.W., and Scott E. Hein. "Evidence on the Temporal Stability of the Demand for Money Relationship in the United States," *Review,* Federal Reserve Bank of St. Louis, vol. 61, no. 12 (December 1979), pp. 3-14.

——. "The Shift in Money Demand: What Really Happened?" *Review,* Federal Reserve Bank of St. Louis, vol. 64, no. 2 (February 1982), pp. 11-16.

Judd, John P., and John L. Scadding. "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature," *Journal of Economic Literature,* vol. 20, no. 3 (September 1982), pp. 993-1023.

Kimball, Ralph C. "Wire Transfer and the Demand for Money," *New England Economic Review,* Federal Reserve Bank of Boston, March/April 1980, pp. 5-22.

Lieberman, Charles. "The Transactions Demand for Money and Technological Change," *Review of Economics and Statistics,* vol. 59, no. 3 (August 1977), pp. 307-17.

——. "Structural and Technological Change in Money Demand," *American Economic Review,* vol. 69, no. 2 (May 1979), pp. 324-29.

Lindsey, David, *et al.,* "Monetary Control Experience under the New Operating Procedures," in *New Monetary Control Procedures,* Federal Reserve Staff Study, Vol. II, Washington, DC: Board of Governors of the Federal Reserve System, February 1981, pp. 1-102.

Miller, Merton H., and Daniel Orr. "A Model of the Demand for Money by Firms," *Quarterly Journal of Economics,* vol. 79 (November 1966), pp. 413-35.

Parke, Darrel W., and Stephen B. Taubman. "Cross-Section Regression Estimates of the Sources of NOW Account Deposits," *Proceedings of the Business and Economic Statistics Section,* Washington, D.C., American Statistical Association, 1982, pp. 554-55.

Porter, Richard D., Thomas D. Simpson, and Eileen Mauskopf. "Financial Innovation and the Monetary Aggregates," *Brooking Papers on Economic Activity,* 1:1979, pp. 213-29.

——, and Edward K. Offenbacher. "Financial Innovations and the Measurement of the Money Supply," Paper presented at the Conference on Financial Innovations, Federal Reserve Bank of St. Louis, October 1982.

Quick, Perry D., and John Paulus. "Financial Innovation and the Transactions Demand for Money," Unpublished paper, Board of Governors of the Federal Reserve System, February 1977.

Rao, C. Radhakrishna. *Linear Statistical Inference and Its Applications,* 2nd ed., New York: John Wiley & Sons, Inc., 1973.

Simpson, Thomas D. "The Redefined Monetary Aggregates," *Federal Reserve Bulletin,* vol. 66, no. 2 (February 1980), pp. 97-114.

——, and Richard D. Porter. "Some Issues Involving the Definition and Interpretation of the Monetary Aggregates," in *Controlling Monetary Aggregates III,* Conference Series No. 23, Federal Reserve Bank of Boston, October 1980, pp. 161-234.

Spindt, Paul A. "Money is What Money Does: A Revealed Production Approach to Monetary Aggregation," Processed, Board of Governors of the Federal Reserve System, April 1983.

Tinsley, P.A., Bonnie Garrett, and Monica E. Friar. "The Measurement of Money Demand," Special Studies Paper 133, Board of Governors of the Federal Reserve System, October 1978.

Tobin, James. "The Interest Elasticity of Transactions Demand for Cash," *Review of Economics and Statistics,* vol. 38, no. 3 (August 1956), pp. 241-47.

Wenninger, John, and Charles M. Sivesind. "Defining Money for a Changing Financial System," *Quarterly Review,* Federal Reserve Bank of New York, vol. 4, no. 1 (Spring 1979), pp. 1-8.

Zupan, Mark A. "Divisia Monetary Aggregates: Would They Be More Palatable than the Traditional Simple-Sum Stews?" *Economic Review,* Federal Reserve Bank of Cleveland, Spring 1983.

Divisia Monetary Aggregates: Would They Be More Palatable than the Traditional Simple-Sum Stews?

by Mark A. Zupan

I. Introduction

The Federal Reserve System constructs and attempts to control the monetary aggregates M-1, M-2, M-3, and L. Empirical evidence suggests that variations in these aggregates can be related to variations in vital economic conditions such as the unemployment rate, national output, and the rate of inflation. Regulating monetary aggregates to attain employment, output, or inflation goals, however, is difficult. The difficulty arises from four factors. First, the achievement of one objective, such as a suitable level of employment, may be inconsistent with the achievement of another objective, such as a desired rate of inflation. Second, the relationships between the monetary aggregates and specific economic objectives are not necessarily stable and can shift in unforeseen ways. Third, the Federal Reserve System's control of the monetary aggregates is indirect and incomplete. In attempting to influence the growth of monetary aggregates, that is, the Federal Reserve System must operate indirectly by either changing reserve requirements, altering the discount rate, or conducting open-market operations. Finally, the construction of meaningful monetary aggregates is in itself a problematic exercise, since financial assets differ in their individual relationships to ultimate policy goals. Properly mixing together a selected group of financial assets to obtain a useful monetary measure is thus no piece of cake. It has become an even more difficult exercise of late, with the rapid proliferation in types of financial assets.

The first three problems associated with the regulation of monetary aggregates are quite important. This article, however, focuses on the issue of constructing meaningful monetary aggregates by analyzing an alternative to the measures currently used by the Federal Reserve System—Divisia monetary aggregates. Although several articles on Divisia aggregates have been published recently (see Barnett 1978, 1980a, 1980b, and 1981), the nature and potential usefulness of such alternative measures are probably not widely known. To spread the news, this article presents a simple characterization of Divisia aggregates. A "beginner's-level" explanation should help a wider audience to (1) evaluate the merits, as well as demerits, of Divisia aggregates and (2) decide whether such measures could improve both the Federal Reserve System's policy performance and the public's understanding of monetary policy.

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II. Inside the Fed Kitchen Today

In recent years monetary policymakers have emphasized the control of M-1, a monetary aggregate whose ingredients include financial assets that can be transferred directly to other parties in making payments. In other words, M-1 is a transactions aggregate consisting of financial assets that more fully provide medium-of-exchange (MOE) services than do other financial assets. The emphasis on controlling M-1 reflects a large body of historical evidence showing a short-run relation between this MOEness measure and the level of economic activity and a strong long-run relation between the growth of this MOEness measure and the rate of inflation.

As shown in table 1, M-1 is formed by taking a simple sum of its ingredients. Successively higher-level aggregates (M-2, M-3, and L—in that order) are constructed by adding to the M-1 "base" sets of financial assets that appear to provide MOE services less fully. To construct M-2, for example, the Federal Reserve System stirs such additional ingredients as savings and small-denomination time deposits, repurchase agreements (RPs), overnight Eurodollars, and general purpose and broker/dealer money market mutual funds into the M-1 stew—ingredients considered to provide MOE services less completely than the assets in M-1.

Although M-1 has received primary emphasis, monetary policymakers have also devoted some attention to the higher-level traditional aggregates. There are two valid reasons for this. First, financial assets not included in M-1 can still be used, to some extent, by transactors to finance expenditures. The expected relation between money and economic activity thus need not be restricted to M-1 ingredients. While funds held in a savings account, for example, cannot be directly transferred to a retailer to purchase an appliance, a simple withdrawal can convert the savings funds into a transactions medium. Although money market mutual funds (MMMFs) do not appear to supply MOE services as fully as currency, MMMFs still can provide a certain amount of MOE services. Fluctuations in MMMF holdings can consequently indicate changes in the national output, employment level, and inflation rate.

Second, it is not always easy to determine "where" (i.e., in which level of aggregate) a particular financial asset belongs. This fact has been highlighted in recent years by the appearance of financial assets, e.g., negotiable order of withdrawal (NOW) accounts, Super-NOWs, and money market deposit accounts (MMDAs). Such new assets have blurred the former distinction between M-1 level and M-2 or higher-level assets. The inability to ascertain precisely the extent to which particular assets provide MOEness suggests a certain "fuzziness" with regard to the traditional monetary aggregates and points to why monetary policymakers have begun to pay more attention to movements in M-2 and M-3—even though these higher-level aggregates historically have been less reliable indicators and more difficult to control.

While paying attention to higher-level aggregates may serve to increase the efficacy of monetary policymaking, recent research in index-number theory (Barnett 1982) suggests that the current method of "drawing and quartering" financial assets is still an inefficient way to report and use information about the total flow of MOE services in the economy. To the extent that the usefulness of monetary aggregates lies in their ability to measure the total flow of MOE services in the economy, the inefficiency of the traditional measures is readily understood. This inefficiency derives from the fact that simple sums are taken of all financial assets belonging to particular aggregates to obtain values for those aggregates. Reliance on simple sums carries with it the implicit assumption that the relevant assets being mixed together are perfect substitutes as far as providing MOEness. Such an assumption leads to inaccurate aggregate measures to the degree that the assets being mixed together are nonhomogeneous with regard to the provision of MOEness.

In the case of the traditional aggregates, the information loss attendant to simple-sum mixing increases with the breadth of the aggregate.

Table 1 Monetary Aggregate Ingredients

As of January 1983; seasonally adjusted unless otherwise noted

Aggregate	Ingredient	Amount, billions of dollars
M-1:	Currency held by the public	$134.2
	Travelers' checks	4.1
	Demand deposits at commercial banks and mutual savings banks	239.4
	Other checkable bank and thrift deposits, including credit union share drafts and negotiable order of withdrawal (NOW), Super-NOW, and automatic transfer service (ATS) accounts	104.5
	Total M-1	**$482.1**
M-2:	M-1	482.1
	Savings and small-denomination time deposits at all depository institutions	1132.5
	Money market deposit accounts (MMDAs)[a]	189.1
	Overnight repurchase agreements (RPs) at commercial banks[a]	40.1
	Overnight Eurodollars held by U.S. residents (other than banks) at Caribbean branches of Federal Reserve System member institutions[a]	7.2
M-2: (cont.)	Money market mutual funds (MMMFs)—general purpose and broker/dealer[a]	$116.7
	Total M-2[b]	**$2,010.0**
M-3:	M-2	2,010.0
	Large-denomination time deposits at all depository institutions	310.7
	Institutions-only MMMFs[a]	46.1
	Term RPs at commercial banks and thrift institutions[a]	40.6
	Total M-3[c]	**$2,403.3**
L:	M-3	2,403.3
	U.S. savings bonds	68.1
	Treasury bills and other liquid Treasury securities	219.3
	Bankers acceptances	45.3
	Commercial paper	113.5
	Term Eurodollars held by U.S. residents (other than banks)[a]	81.2
	Total L	**$2,930.7**

SOURCE: Board of Governors of the Federal Reserve System.

a. Not seasonally adjusted.

b. M-2 differs from the sum of components through a consolidation adjustment that represents the estimated amount of demand deposits and vault cash held by thrift institutions to service time and savings deposits.

c. M-3 differs from the sum of components by a consolidation adjustment that represents the estimated amount of overnight RPs held by institutions-only MMMFs.

The broader traditional aggregates consist of less (MOE) homogeneous assets than the narrower aggregates.[1] Even the narrower aggregates, however, lose some information in the stirring—provided that the assets constituting these aggregates are not perfect substitutes with respect to the provision of MOE services.

The inefficiency of traditional aggregates can be partially avoided by focusing on individual financial assets rather than on the current aggregates. For example, the econometric models used by the Federal Reserve estimate relationships between individual financial assets (i.e., currency, demand deposits, etc.) and key economic variables. Reliance on such individual relationships in effect provides a vehicle for unequally weighting the components of a traditional monetary aggregate when simulating the results of shocks to the economy. Unfortunately, however, individual econometric relationships cannot always be relied on. In the case of new financial assets, such as MMDAs, there are simply not enough observations or "data points" to permit econometric estimation. In the case of established financial assets, econometric relationships may not remain stable when new assets are invented or monetary regulations are altered.

Because of the occasional problems in relying on individual econometric relationships, policymakers have continued to search for alternative means of avoiding the inefficiency of the traditional monetary aggregates. Divisia measures are being discussed more and more, precisely because it has been claimed that they provide a better means for estimating the total flow of MOE services in the economy.

III. How Divisia Measures Measure the Flow of MOE Services

Divisia aggregates assume that the value of MOE services provided, at the margin, by each financial asset can be directly and quite easily ascertained. In essence, Divisia aggregates presume that financial assets can be measured with a MOE thermometer (see figure 1). The higher the MOE "temperature" of an asset, the greater the value of MOE services provided, at the margin, by the asset; and thus the farther up the asset registers on the MOE thermometer. Assets that are relatively more acceptable, divisible, liquid, and reversible would thus register higher (i.e., farther up) on the MOE thermometer—assuming that such characteristics were all positively related to the marginal MOEness of an asset.[2]

To determine an asset's MOE temperature, Divisia measures rely on the "rental price" of the asset. The rental price of an asset is equal to the difference between the return on the asset and the return on a "benchmark" asset serving primarily as a store of value (SOV) and providing essentially no MOE services (e.g., Moody's Baa bonds). If the annual return on currency were 0 percent while the return on Moody's Baa bonds (the benchmark asset) were 14 percent, the rental price of currency would equal 14 percent (14 percent minus 0 percent). Given such a rental price, currency would register 0.14 on the MOE thermometer. The MOE temperature of currency would increase in this hypothetical situation if either the return on

1. To some degree, the inefficiency of the traditional simple-sum method could be mitigated if the monetary aggregates consisted of the following four categories of financial assets: M-1; assets in M-2 but not in M-1; assets in M-3 but not in M-2; and assets in L but not in M-3. This alternative categorization would avoid the information loss inherent in the current procedure of mixing progressively more disparate financial assets into the M-1 base. Reliance on the four financial asset categories, however, would still not afford a means for dealing with cases where financial assets *within* a particular asset category were not perfect MOE substitutes. Nor would it provide a gauge of the extent to which assets located in different asset categories were imperfect MOE substitutes.

2. Also assuming all other things are equal—notably the supply curves of the various assets. This latter assumption is important, since the amount of MOE services provided, at the margin, by any asset is determined by the intersection of the asset's supply and demand curves. Characteristics such as acceptability, divisibility, and reversibility all affect the magnitude of an asset's demand curve—they act as shift parameters.

Fig. 1 MOE Scale (à la Divisia)

currency fell or the return on Moody's Baa bonds rose.

The assumption that rental prices reflect the amount of MOE services individuals or businesses derive, at the margin, per dollar of an asset held is not unrealistic if assets provide only two services (MOE and SOV).[3] The lower the return on a particular financial asset, the greater the opportunity cost of holding the asset in terms of the return that could be earned if the benchmark, primarily SOV, asset were held instead. A higher opportunity cost quite plausibly implies that rational individuals and businesses must be obtaining a greater amount of MOE services, at the margin, per dollar of the particular financial asset being held.

If rental prices accurately reflect the marginal MOEness of financial assets, reliance on such rental prices would appear to offer several benefits. First, rental prices can be straightforwardly and inexpensively calculated. Precise data on the returns of most assets are readily available—on a daily basis, in fact. No econometric relationships between individual assets and key economic variables would have to be estimated.

Second, rental prices would allow for an infinite number of gradations or degrees in the marginal MOEness of financial assets. This contrasts with the current simple-sum approach, which essentially assumes that there are only four degrees of marginal MOEness, i.e., a financial asset can register at any one of only four levels on the MOE thermometer.[4] By not having to pour financial assets into just four MOEness pots, rental prices would allow Divisia aggregates to avoid the information loss inherent in the current simple-sum procedure. The traditional aggregates, for example, treat NOW accounts and currency as if they register "close enough" on the MOE thermometer (both are assigned to an M-1 MOEness pot). Rental prices, however, would permit a much finer distinction to be drawn between NOW accounts and currency. Indeed, to the extent that NOW accounts and currency register farther apart on the MOE thermometer (i.e., have more disparate rental prices), reliance on rental prices would eliminate some of the fuzziness of the current simple-sum measures of MOEness.

Third, rental prices would also provide a relatively simple mechanism for ascertaining the precise difference in the MOE temperatures of various assets, i.e., for ascertaining the difference in the amount of MOEness provided, at the margin, by different assets. In comparison, the current simple-sum approach does not have an easy method of determining the temperature difference between any two of the four presumed degrees of MOEness. As a result, there is no direct information-preserving means for estimating the aggregate amount of MOE services provided across all assets. This is troublesome to the extent that a significant number

3. The value of MOE services provided, at the margin, by an asset will not equal the value of MOE services provided by inframarginal holdings of the asset. Specifically, if demand curves for an asset slope downward, the value of MOE services provided by inframarginal holdings will always be higher than the value of MOE services provided by marginal holdings of the asset.

4. The four categories of MOEness under the current simple-sum system consist of those assets belonging to M-1; M-2 but not M-1; M-3 but not M-2; and L but not M-3. The first of these categories would register farthest up on the MOE thermometer. Succeeding categories would register progressively closer to zero on the thermometer.

of MOE services may be provided by financial assets located at degrees other than the M-1 degree of MOEness. Even though MMMFs have low marginal MOEness values, for example, the sheer size of MMMF holdings may ensure that transactors derive a sizable amount of MOE services from this non-M-1 asset.

The specific manner in which rental prices are used to construct Divisia aggregates is outlined in detail in the appendix. In essence, however, Divisia measures take a weighted average of growth rates of ingredient assets to determine the growth rate in the flow of MOE services provided by any designated set of assets. The weights assigned to growth rates of ingredient assets are "expenditure-share" weights. The weight assigned to an asset's growth rate, in other words, depends on the share of the total expenditure by asset holders on MOEness that is accounted for by that asset. Suppose, for example, that (1) there were only three financial assets—currency, demand deposits, and Moody's Baa bonds (the benchmark SOV asset); (2) the returns on currency, demand deposits, and Moody's Baa bonds were 0 percent, 5 percent, and 10 percent, respectively; and (3) the quantities of currency, demand deposits, and Moody's Baa bonds in the economy were $1 million, $20 million, and $5 million, respectively. The relevant rental prices in this particular situation thus would be 0.1 for currency (10 percent minus 0 percent equals 10 percent), 0.05 for demand deposits (10 percent minus 5 percent equals 5 percent), and 0.0 for Moody's Baa bonds (10 percent minus 10 percent equals 0 percent). The total expenditure made by transactors for MOEness would be obtained by multiplying the quantities of assets held by their respective rental prices and then by summing the multiplied asset quantities as follows:

[(0.1)($1 million) + (0.05)($20 million)
+ (0.0)($5 million)] = $1.1 million.

Of the total expenditure on MOEness, the shares accounted for by the individual assets would be:

(1) [(0.1)($1.1 million)]/($1 million) = 1/11 for currency;
(2) [(0.5)($20 million)]/($1.1 million) = 10/11 for demand deposits; and
(3) [(0.0)($5 million)]/($1.1 million) = 0/11 for Moody's Baa bonds.

It is these shares that would be used by a Divisia aggregate to determine the weights assigned to the growth rates of the three respective assets, and thereby to determine the growth rate in the MOE services provided by the three assets as a whole.[5]

While the weights assigned by Divisia aggregates to growth rates of ingredient assets depend on the expenditure shares of the assets, the current simple-sum aggregates weight growth rates of component assets by their respective "quantity shares." The simple-sum aggregates, in other words, weight the growth rate of any relevant asset by the share of the total quantity of asset holdings within the aggregate that is accounted for by that asset.

To compare the different weighting schemes used by simple-sum aggregates, suppose that in the preceding hypothetical example monetary policymakers decided that only currency and demand deposits were relevant to the construction of M-1. Such a decision essentially would imply that the quantities of currency and demand deposits would be multiplied by unity (since these two types of assets were deemed to belong to M-1), while the quantity of Moody's Baa bonds would be multiplied by zero (since this asset was deemed not to belong to M-1) when computing the total quantity of M-1 asset holdings. The total quantity of M-1 asset holdings would thus be:

[(1.0)($1 million) + (1.0)($20 million)
+ (0.0)($5 million)] = $21 million.

To determine the growth rate of MOE services provided by M-1 assets, the simple-sum approach would assign the following quantity-share weights to component assets:

5. See the appendix for a detailed recipe.

(1) [(1.0)($1 million)/($21 million)] = 1/21 for currency;
(2) [(1.0)($20 million)/($21 million)] = 20/21 for demand deposits; and
(3) [(0.0)($5 million)/($21 million)] = 0/21 for Moody's Baa bonds.

The preceding comparison highlights the crucial difference between the weighting schemes employed by Divisia and simple-sum aggregates to determine the growth rate in the MOE services provided by any designated set of assets. The expenditure-share weights employed by Divisia aggregates rely on both the quantities and rental prices of assets. The quantity-share weights used by simple-sum aggregates, however, rely on just the quantities of the relevant assets—where the "relevance" of any asset to the particular simple-sum MOEness aggregate being constructed must be decided on a 0/1 basis by monetary policymakers.[6] Provided that rental prices are accurate indicators of marginal MOEness, the traditional simple-sum approach produces fuzzier aggregates. This is because the traditional simple-sum approach ignores the MOEness information contained in rental prices; the traditional aggregates do not rely on the many degrees of marginal MOEness that could be identified by a MOE thermometer. When an asset falls into one of the degrees of MOEness between the four traditional levels, the asset must be reassigned by policymakers to the nearest of the four levels. Such a reassignment dissipates information about the flow of MOE services along the way.[7]

In addition to providing details on the construction of Divisia aggregates, the appendix also describes several other alternative monetary aggregate recipes that depend centrally on rental prices when weighting component asset growth rates. While the particular manner in which Divisia and these alternative aggregates rely on rental prices differs, all assume that rental prices reflect the marginal MOEness of financial assets. Divisia aggregates have been singled out for attention in the academic press because it has been mathematically shown that they supply a more accurate measure of the flow of MOE services provided by a given set of financial assets than do the other alternatives.[8]

IV. Cooking à la Divisia: What Can Go Right

Ideally, there would be only one Divisia aggregate. Such an aggregate would be constructed across the entire set of financial assets in the economy. If rental prices correctly reflected the marginal MOEness of financial assets, the Divisia aggregate would yield one major advantage—a better approximation of the total flow of MOE services in the economy. The approximation afforded by a Divisia aggregate would be more useful to the extent that (1) MOEness is a more reliable indicator of vital economic conditions; (2) the flow of MOE services is more easily controllable by monetary policymakers; (3) greater heterogeneity

6. The problems inherent in such a dichotomous approach are analogous to the difficulties encountered by analysts attempting to determine the breadth of a market on a 0/1 basis. A market-concentration measure is based on a market that includes all commodities deemed to be close substitutes for the good under consideration (and thus given a weight of unity). The market excludes all commodities not considered to be close substitutes (commodities that are consequently given a weight of zero). Because a practical "middle ground" has not been developed between unity and zero, it is necessary to consider market-power measures defined over various levels of market breadth (e.g., either including or excluding fresh lemon juice in the case of Borden's ReaLemon; either including or excluding recycled aluminum in the case of Alcoa). Such consideration is often subject to a great deal of controversy since whether an additional substitute is stirred into the market often significantly affects the measure of a firm's market power (e.g., note antitrust cases such as DuPont, Brown Shoe, Von's Grocery, Bethlehem Steel, Alcoa, and ReaLemon).

7. At a theoretical level, the only case in which a simple-sum aggregate would provide as much information as a Divisia aggregate would be if the rental prices of all relevant non-benchmark assets were identical. In this particular case, a Divisia aggregate "collapses" to the simple-sum aggregate.

8. See, for example, Barnett (1980a).

exists in financial asset MOEness—heterogeneity that is accurately reflected in rental prices; (4) substitutions occur between financial assets; and (5) a Divisia aggregate can be integrated into the policymaking process.[9]

A Divisia aggregate would be particularly useful when substitutions occurred between financial assets—substitutions induced by changes in government regulations or financial technology (e.g., the appearance of new assets or changes in the ability of existing assets to provide MOE services). Substitutions would not undercut the ability of a Divisia aggregate to keep track of the total flow of MOE services in the economy.[10] This is because a Divisia measure relies on a simple method for determining the marginal MOEness of assets. In the face of substitutions between financial assets, the rental prices of *existing* assets would merely have to be observed to account for any changes in marginal MOEness. In addition, the marginal MOEness of *new* assets could be determined quickly by calculating the rental prices of the new assets.

For a number of reasons, substitutions between financial assets prove much more troublesome for the traditional aggregates. First, the current simple-sum measures must generally rely on econometric relationships to determine the MOEness of an asset—i.e., to determine into which MOEness pot an asset should be stirred. Second, econometric relationships may be either unstable or impossible to estimate in the face of substitutions between financial assets. As noted before, reliance on econometric relationships is impossible in the case of a new asset or a change in the ability of an existing asset to provide MOE services—there simply are not enough data observations. As a result, the traditional aggregates must utilize some other less dependable criterion for determining the MOEness of a new or altered financial asset—a factor that makes it harder for the traditional aggregates to track the flow of MOE services in the economy. Third, the traditional approach assumes that there are only four MOEness pots and that when calculating the MOE services in any of the four pots, an asset either belongs or does not belong to the pot. There is no middle ground between unity (including the asset in the pot) and zero (excluding the asset). The many degrees of marginal MOEness afforded by a MOE thermometer are thus set aside in favor of the more rough "0/1" cut. This potentially can produce sizable changes in the level of a traditional aggregate if an important asset (important in the sense that the holdings of the asset in the economy are large) switches from unity to zero or vice versa.

The relative ease with which a Divisia aggregate deals with substitutions between financial assets will be of greater value the more frequent or substantial are the substitutions. Consequently, periods of financial innovation, regulatory modification, and high and variable returns on financial assets all should increase the attractiveness of a Divisia aggregate. This partially explains why Divisia measures have received greater attention in the past few years.

9. Although the Federal Reserve System monitors the total flow of MOE services, it is conceivable that the flow of SOV services might better indicate changes in key economic variables. In the case of nominal national income, partial evidence against this possibility is provided by the fact that the narrower a traditional aggregate, the better the explanation of fluctuations in national income provided by that aggregate (see Berkman 1980). A further test might involve examining the explanatory power (with respect to fluctuations in nominal national income) of the four categories of current financial assets: M-1; assets in M-2 but not in M-1; assets in M-3 but not in M-2; and assets in L but not in M-3. Focusing on MOE services would gain greater support if the categories of assets that appear to provide MOE services more fully better explained fluctuations in nominal national income. It is also conceivable that aggregates combining information on MOE and SOV services are most indicative of changes in key economic variables. To test this hypothesis, it would be necessary to test the comparative explanatory power of different "mixes" of MOE and SOV services relative to aggregates that focus on either MOE or SOV services.

10. This is true, provided that rental prices continue to reflect the marginal MOEness of financial assets; see the discussion in the following section on the third drawback of a Divisia aggregate.

V. What Can Go Wrong

There are three principal drawbacks associated with a Divisia aggregate. First, the extent to which an asset's return differs from the return on a primarily SOV asset may not entirely reflect the value of MOE services provided, at the margin, by the asset. Among other characteristics, differences in the returns on financial assets depend on the extent to which assets are divisible, liquid, and reversible. The fact that an asset's return depends on many characteristics, however, need not pose a problem for a Divisia aggregate if asset characteristics are "reducible" to a two-dimensional scale, i.e., if the characteristics of financial assets can all be "lined up" by a MOE thermometer. This is the case if the extent to which an asset possesses characteristics such as divisibility, liquidity, and reversibility is positively related to the marginal MOEness of the asset and is negatively related to the asset's rate of return. Under these circumstances rental prices would be accurate measures of marginal MOEness. The rental price of each distinquishable asset with a unique bundle of characteristics would measure, in summary form, the value of MOE services provided, at the margin, by the asset.

Although many asset characteristics are directly related to an asset's marginal MOEness and inversely related to an asset's rate of return, some asset characteristics may affect an asset's return rate but may be unrelated to the value of MOE services provided, at the margin, by the asset.[11] If such characteristics were present, rental prices would be inaccurate measures of marginal MOEness. It would be necessary to adjust an asset's return rate for the presence of such characteristics and then to estimate the amount of MOE services provided by the asset, at the margin, per asset dollar.[12]

The second drawback of a Divisia aggregate is that it may not be possible to ascertain accurate rental prices even if all financial asset characteristics are positively related to marginal MOEness and negatively related to a financial asset's return rate. This is the case if published information on the return rates of financial assets is incorrect—if an asset's implicit return differs from its explicit return. Some regulations, for example, force transactors to pay a specific rental price for certain financial assets (e.g., demand deposits). If such price floors are effective, sellers of the regulated assets may attempt to lure buyers by lowering the implicit price of their products (provided that the implicit price remains above the cost of producing the asset). Constrained to offer no more than 5.25 percent interest on NOW accounts, for example, banks may decrease the implicit price of NOW accounts to buyers by offering free toasters, free checking, or more branch offices. To the extent that banks engage in such actions, the reported return of 5.25 percent on NOW accounts would be incorrect—the actual, implicit return to purchasers of demand deposits would be higher.

If the reported return on a financial asset is incorrect, one solution would be to calculate the asset's implicit return. This is difficult, however. In the case of demand deposits, Barnett and Spindt (1982) assume that the implicit return is 40 percent of the "competitive rate" (e.g., the rate of return on a primarily SOV asset), even though the explicit return on demand deposits is constrained by law to be zero. Barnett and Spindt base their assumption on the fact that firms own about 40 percent of

11. Porter and Offenbacher (1982) argue that portfolio riskiness is such a characteristic.

12. Another method for avoiding such a problem would involve calculating a "subset" or "baby" Divisia across all assets whose rental prices are accurate—i.e., whose rental prices reflect only marginal MOEness. This method would avoid the difficulty of attempting to adjust financial asset returns when estimating the total flow of MOE services in the economy. It would do so, however, at the cost of ignoring the flow of MOE services provided by the "incorrect" assets.

all demand deposits. Since firms have ready access to assets earning competitive returns, Barnett and Spindt argue that firms must earn enough implicit interest on demand deposits to make holding such assets worthwhile.

The extent to which the second drawback of a Divisia aggregate should be considered worrisome depends, of course, on the amount of financial asset holdings that have implicit returns differing from explicit returns for regulatory reasons. Historically, demand deposits and savings and small-denomination time deposits have been the major financial assets for which regulations have caused implicit returns to deviate from reported returns. To the extent that the Depository Institutions Deregulation and Monetary Control Act of 1980 is decontrolling the financial industry, the second drawback of a Divisia aggregate will recede and a Divisia aggregate will become a more accurate indicator of the total flow of MOE services in the economy.

The third drawback of a Divisia aggregate stems from the possibility that, while accurate rental prices may be obtainable, they may not be equilibrium prices. The construction of a Divisia aggregate depends fundamentally on the assumption that markets for every "ingredient" asset are in equilibrium. If this were not the case, estimated rental prices would represent "way stations" on the path to equilibrium prices. To the extent that rental prices for various financial assets did not follow analogous paths, reliance on such prices then would not accurately indicate changes in the equilibrium flow of MOE services supplied by a designated set of financial assets. The longer it took financial asset markets to attain equilibrium, and the more dissimilar were the disequilibrium paths followed by different rental prices of assets, the more wary one would have to be in utilizing a Divisia aggregate.

Besides the three major drawbacks associated with a Divisia aggregate, it has sometimes been claimed that it would be difficult to integrate a Divisia aggregate into the policymaking process. This is unlikely to be an overwhelming problem, however, since reliance on a Divisia aggregate need not affect the manner in which the Federal Reserve System effects monetary policy (i.e., via changes in reserve requirements, changes in the discount rate, or open-market operations). As long as policymakers recognize that tightening actions reduce the flow of MOE services in the economy, they can use a Divisia measure as a policy guide. For all intents and purposes, the choice between relying on a Divisia aggregate or on the traditional measures is separable from actual monetary policymaking. A Divisia aggregate would merely serve as an indicator—hopefully as a better indicator than the traditional aggregates—of the total flow of MOE services in the economy and of the effect of monetary policymaking on this flow.

It must be stressed that the choice between Divisia and simple-sum aggregates is not an either/or choice. Reliance on Divisia aggregates, that is, would not necessitate the discarding of traditional aggregates. Indeed, even if Divisia aggregates became the primary indicators of the total flow of MOE services in the economy, the traditional aggregates might still prove valuable in certain cases.[13] The choice between Divisia and simple-sum aggregates is rather a choice of whether Divisia aggregates should be included in the information-set menu used by policymakers—whether such aggregates would enhance the ability of policymakers to track and regulate the total flow of MOE services in the economy.

More fundamental questions concerning ***both*** Divisia and simple-sum aggregates include the desirability of monitoring the total flow of MOE services in the economy and the ability of the Federal Reserve System to regulate this total flow. While a full discussion of such "deeper" issues is beyond the purposes of this article, they are forests that should not be lost sight of. The desirability of monitoring MOE services, for example, stems from the presumption that movements in the total flow of

13. For one situation where traditional aggregates might prove helpful, see the second mathematical drawback to Divisia aggregates noted in the appendix.

MOE services are closely related to changes in the ultimate goals of policy, such as the employment level, national output, and rate of inflation. It well may be, however, that there are more accurate indicators than the flow of MOE services when it comes to monitoring the ultimate goals of policy—indicators more highly related to key economic variables.[14] It may also be true that there are indicators that are easier to regulate and use to attain ultimate policy goals.

VI. The Theory May Be Fine . . . But Will It Fly?

Empirical evidence on the ability of Divisia aggregates to provide information about key economic conditions is just beginning to surface. The research to date has generally compared the traditional aggregates (M-1, M-2, M-3, and L) with corresponding Divisia measures constructed across the component assets of the traditional aggregates (Divisia M-1, Divisia M-2, Divisia M-3, and Divisia L). One can make four observations about the findings to date (best summarized in Barnett 1982). First, higher-level Divisias (the M-2, M-3, and L Divisias) consistently outperform their simple-sum counterparts. Divisia M-3, that is, typically provides more information than simple-sum M-3 about such economic conditions as the growth rate of personal income, the unemployment rate, and the rate of change of prices. Second, while Divisias generally outperform their simple-sum counterparts at higher levels of aggregation, both Divisia and simple-sum M-1 provide comparable indications of economic conditions. This suggests that the manner in which the traditional M-1 aggregate mixes together ingredient assets may not be too far off the mark. Third, among *all* aggregates considered (both traditional and Divisia), Divisia L generally is the most informative measure. Divisia L consistently explains more of the variance in the inflation, unemployment, and output levels than any of the traditional aggregates as well as any of the other Divisia aggregates. The only case in which Barnett (1982) finds a simple-sum measure to be the most informative aggregate is in explaining the variance in the rate of unemployment among males over the age of 25.[15]

Finally, Divisia aggregates partially explain some puzzles that have cropped up in recent investigations of financial asset markets. Divisia aggregates, for instance, may help to account, at least partially, for the breakdown of the traditional money-demand equations in the 1970s. In the face of high and volatile interest rates, money-demand equations for the traditional aggregates no longer appeared to be stable and began persistently to overpredict the growth rate of money demand. The results of Porter and Offenbacher (1982) and Barnett (1982) suggest that this instability may result from the inaccuracy of traditional aggregates in measuring the flow of MOE services provided by a given set of financial assets. These inaccuracies are accentuated by periods of higher and more volatile asset returns. Porter and Offenbacher find that the demand for Divisia money aggregates is relatively more stable than the demand for traditional money aggregates.[16] Porter and Offenbacher also find that, among all aggregates considered, the demand for Divisia L is most stable.

In addition to partially explaining the recent breakdown in the money-demand equations of the traditional aggregates, Divisia measures also afford some insights on the trend in simple-sum "multipliers" over the 1970s. A monetary aggregate multiplier consists of the ratio of a monetary aggregate to the monetary base (total currency in the hands of the public

14. See footnote 9.

15. In several of the differently specified models examined econometrically, the traditional M-2 measure provides more explanatory power than any of the other aggregates.

16. Porter and Offenbacher confirm this after first accounting for the possibility that the demand for money may have shifted inward because of technological reasons—computer and telecommunications innovations as well as new cash-management procedures such as sweep accounts and remote disbursement.

Table 2 Divisia and Simple-Sum M-2
October 1979 — May 1980

Date	Monthly level		Annual growth rate, percent	
	Divisia M-2	Simple-sum M-2	Divisia M-2	Simple-sum M-2
1979				
September	226.4	263.6	—	—
October	225.8	264.9	-3.1	5.8
November	224.8	266.1	-5.0	5.3
December	225.2	267.6	2.3	7.1
1980				
January	225.3	269.2	0.5	6.8
February	225.5	271.4	1.0	10.0
March	225.1	272.6	-2.2	5.4
April	223.3	271.9	-9.5	-3.1
May	223.7	274.2	2.3	10.2

SOURCE: Barnett and Spindt (1982). Figures are seasonally adjusted, with January 1969 = 100.

plus the vault cash of commercial banks plus commercial bank deposits with the Federal Reserve System). Money multipliers are useful in that they allow policymakers to predict the effect of a given change in the rather narrow monetary base on the flow of MOE services provided by a much broader set of financial assets in the economy. Stable money multipliers consequently permit policymakers more reliable control of the flow of MOE services in the economy via regulation of the monetary base.

During the 1970s the multipliers for the traditional aggregates were not stable; the multiplier for M-1 decreased, while the M-2, M-3, and L multipliers increased. Barnett and Spindt (1982) argue that the rising interest rates of the 1970s caused substitutions out of assets with high marginal MOEness into assets with low marginal MOEness, thereby producing the observed changes in the traditional multipliers. Compared with the simple-sum multipliers, the higher-level Divisia multipliers (the multipliers for Divisia M-2, Divisia M-3, and Divisia L) were much more stable in the 1970s.

Policymakers should be encouraged by the apparent greater stability of higher-level Divisia multipliers. Such stability suggests that the relationship between the monetary base and the flow of MOE services in the economy is more predictable than the corresponding simple-sum multipliers would indicate. The possibility that higher-level Divisia aggregates could enhance the controllability of the flow of MOE services in the economy is further supported by the fact that the variations that do exist in the multipliers for the Divisia aggregates are strongly (negatively) correlated with interest rates, whereas variations in interest rates explain an insignificant part of the movements in simple-sum multipliers (see Barnett and Spindt 1982). Cyclical variations in Divisia multipliers, in other words, are more predictable than the cyclical variations in traditional multipliers.

With regard to actual information provided about recent monetary policymaking, the Divisia aggregates sometimes provide a very different picture about MOE services growth than do their simple-sum counterparts. Following the Federal Reserve System's move away from controlling interest rates and toward controlling money-supply growth in October 1979, Divisia M-2 suggests much more restrictive monetary policymaking than does traditional M-2. Between September 1979 and May 1980, Divisia M-2 grew at an average rate of around -1.7 percent, whereas simple-sum M-2 grew at an average rate of 5.9 percent over the same period (see table 2).[17]

Over 1981 and 1982, the higher-level Divisia aggregates also indicate slower MOE services growth than their simple-sum counterparts. Between the fourth quarter of 1980 and the fourth quarter of 1981, Divisia M-2 grew 1.4 percent, while simple-sum M-2 increased 9.4 percent. Between the fourth quarter of 1981 and the fourth quarter of 1982, Divisia M-2 rose 2.4 percent, while simple-sum M-2 climbed 12.1 percent.[18]

17. During the same period, changes in the primary traditional aggregate (termed M-1B at the time) correspond quite well with changes in its Divisia counterpart. Divisia M-1B grew by 2.1 percent, while simple-sum M-1B grew by 1.4 percent.

The latest Divisia figures indicate that the recent upswing in MOE services growth may not be as dramatic as the simple-sum aggregates would suggest. During the first quarter of 1983, simple-sum M-1 and simple-sum M-2 rose 14 percent and 20.3 percent, respectively. Divisia M-1 and Divisia M-2, however, grew only 10.6 percent and 3.6 percent, respectively.[19] Thus, the recent money-supply bulge does not appear to be so large when viewed from the Divisia perspective. This suggests that monetary policymakers should be wary about constricting the total flow of MOE services in the face of the apparent bulge. It also suggests that fears about reigniting inflationary fires may be less well-founded than the traditional aggregates seem to indicate.

VII. Conclusion

The current simple-sum approach to monetary aggregation treats financial assets dichotomously—either including or excluding individual assets from the aggregate being constructed. Such a dichotomous scheme is inefficient for two reasons. First, financial assets *included* in a particular aggregate are not perfect substitutes as far as medium-of-exchange (MOE)ness goes. Second, financial assets *excluded* from a particular aggregate are, to some extent, substitutes for the assets included in the aggregate. While the Federal Reserve System attempts to avoid the inefficiency of the traditional monetary aggregates by estimating econometric relationships between individual financial assets and key economic indicators, such econometric relationships are not always stable over time; nor are they always estimable.

Divisia aggregates provide an alternative means of avoiding the inefficiency inherent in the traditional aggregates by focusing on the information contained in the rental prices of financial assets, rental prices being the difference between an asset's return and the return on a benchmark store-of-value (SOV) asset that is likely to provide very few MOE services. Through rental prices, Divisia aggregates possess a MOE thermometer—a thermometer that measures the amount of MOE services provided, at the margin, by various assets. Such a thermometer allows Divisia aggregates to account for many more degrees of marginal MOEness than does the dichotomous approach employed by the traditional aggregates.

If rental prices were accurate measures of the MOE services provided, at the margin, by an asset, they would offer an attractive substitute for econometric estimation. Rental prices could provide a measure of an asset's marginal MOEness with only one data or observation point. This would be particularly helpful in the case of a new financial asset or in the case of changes in the marginal MOEness of existing financial assets. The ability of Divisia aggregates to deal with such situations partially explains the current appeal of Divisia measures.

While Divisia measures could, in theory, provide better approximations of MOE service flows, Divisias do not offer a foolproof recipe. The dangers of relying on Divisia aggregates stem primarily from the fact that rental prices may not be accurate marginal MOEness indicators. Such would be the case if the implicit return on an asset differed from the explicitly reported return; or, if an asset's rental price reflected a characteristic of the asset unrelated to the amount of MOE services provided, at the margin, by the asset; or, if an asset's rental price were not an equilibrium rental price. Whether these dangers are sufficient to warrant keeping Divisia aggregates off the information-set menu of monetary policymakers is in need of greater examination. The limited

18. Over the same periods, Divisia and simple-sum M-1 tracked similarly. Between the fourth quarter of 1980 and the fourth quarter of 1981, Divisia M-1 grew 6.5 percent, while simple-sum M-1 rose 5.1 percent. Between the fourth quarter of 1981 and the fourth quarter of 1982, Divisia M-1 increased 8.2 percent, while simple-sum M-1 grew 10.4 percent.

19. Whereas the previous percentages were based on 1969 = 100, the most recent figures treat 1982 as the base, i.e., 1982 = 100.

empirical evidence does suggest that Divisia measures might offer a better approximation of the total flow of MOE services in the economy. The relationships between Divisia aggregates and key policy goals, such as the rate of inflation, unemployment level, and national output, appear to be stronger than the analogous relationships between traditional simple-sum aggregates and key policy goals. The evidence also suggests that Divisia aggregates might, in addition to providing a more informative MOE services measure, offer monetary policymakers an additional layer of icing. To the extent that Divisia multipliers are more stable and predictable, Divisia aggregates might improve the ability of monetary policymakers to regulate the total flow of MOE services in the economy through changes in the monetary base.

Appendix The Divisia Recipe

Divisia aggregates are constructed via the following formula:

$$(1)\quad D_t = \sum_{i=1}^{N} \left[\frac{1}{2} \left[\frac{(RP_{it})\,(A_{it})}{\sum_{j=1}^{N} (RP_{jt})\,(A_{jt})} \right] + \left[\frac{(RP_{it-1})\,(A_{it-1})}{\sum_{j=1}^{N} (RP_{jt-1})\,(A_{jt-1})} \right] \left[\ln(A_{it}) - \ln(A_{it-1}) \right] \right],$$

where

D_t = Divisia measure (the Törnqvist-Theil discrete time approximation) of the growth in the MOE services provided by a set of j=1, 2 . . . N different assets between time t-1 and time t;

A_{it} = amount of the i^{th} financial asset at time t;

A_{it-1} = amount of the i^{th} financial asset at time t-1;

RP_{it} = rental price of the i^{th} financial asset at time t; and

RP_{it-1} = rental price of the i^{th} financial asset at time t-1.

As shown in equation 1, the Divisia measure of MOE services growth is derived by taking a weighted sum of the growth rates (as measured in natural log terms) of individual financial assets—where the weight on the i^{th} asset equals the average of (1) the fraction of total transactor expenditure for MOE services devoted to the i^{th} asset at time t and (2) the fraction of total transactor expenditure for MOE services devoted to the i^{th} asset at time t-1.

Whereas equation 1 is a Divisia measure of the *growth* rate of MOE services between two different points in time, the actual *level* of a Divisia aggregate at any particular point in time is derived by setting the amount of MOE services provided by a set of financial assets equal to an arbitrary number (e.g., 100.0) for a given time (e.g., 1969). Then the equation 1 formula is used to determine the level of the Divisia aggregate for points in time other than the reference time point (i.e., 1969).

Four Divisia aggregates are currently estimated on a monthly basis by the Federal Reserve System and are available to the general public on request. The four Divisias—Divisia M-1, Divisia M-2, Divisia M-3, and Divisia L—are calculated across the financial assets spanning the traditional aggregates M-1, M-2, M-3, and L, respectively.

In addition to Divisia aggregates, reliance on rental prices allows for the construction of several other measures of the total flow of MOE services provided by a set of financial assets. Among these alternative measures are Laspeyres, Paasche, and money-income aggregates.

Laspeyres aggregates are obtained via the formula:

$$(2)\quad L_t = \sum_{i=1}^{N}\left[\left[\frac{(RP_{it-1})(A_{it-1})}{\sum_{j=1}^{N}(RP_{jt-1})(A_{jt-1})}\right]\left[\frac{A_{it} - A_{it-1}}{A_{it-1}}\right]\right]$$

$$= \frac{\left[\sum_{i=1}^{N}(RP_{it-1})(A_{it})\right] - \left[\sum_{i=1}^{N}(RP_{it-1})(A_{it-1})\right]}{\sum_{j=1}^{N}(RP_{jt-1})(A_{jt-1})}$$

$$= \left[\frac{\sum_{i=1}^{N}(RP_{it-1})(A_{it})}{\sum_{j=1}^{N}(RP_{jt-1})(A_{jt-1})}\right] - 1\ ,$$

where L_t is the Laspeyres measure of the growth in the MOE services provided by a set of j=1, 2 . . . N different assets, and all other symbols are as before.

Paasche aggregates are constructed via the formula:

$$(3)\quad P_t = \sum_{i=1}^{N}\left[\left[\frac{(RP_{it})(A_{it})}{\sum_{j=1}^{N}(RP_{jt})(A_{jt-1})}\right]\left[\frac{A_{it} - A_{it-1}}{A_{it}}\right]\right]$$

$$= \frac{\left[\sum_{i=1}^{N}(RP_{it})(A_{it})\right] - \left[\sum_{i=1}^{N}(RP_{it})(A_{it-1})\right]}{\sum_{j=1}^{N}(RP_{jt})(A_{jt-1})}$$

$$= \left[\frac{\sum_{i=1}^{N}(RP_{it})(A_{it})}{\sum_{j=1}^{N}(RP_{jt})(A_{jt-1})}\right] - 1\ ,$$

where P_t is the Paasche measure of the growth in the MOE services provided by a set of j=1, 2 . . . N different assets, and all other symbols are as before.

Money-income aggregates are derived via the formula:

$$(4)\quad MI = \frac{\left[\sum_{i=1}^{N}(RP_{it})(A_{it})\right] - \left[\sum_{i=1}^{N}(RP_{it-1})(A_{it-1})\right]}{\sum_{i=1}^{N}(RP_{it-1})(A_{it-1})},$$

where MI is the money-income measure of the growth in the MOE services provided by a set of j=1, 2 . . . N different assets, and all other symbols are as before.

Although the three alternative measures presented here provide good approximations of changes in the total flow of MOE services and may closely parallel the behavior of a Divisia measure, the Divisia measure is preferred to any of the three alternatives on *a priori* theoretical grounds (Diewert 1976). Despite the fact that Divisias fall within Diewert's class of superlative index numbers, two mathematical problems remain with a Divisia aggregate. First, a Divisia index based on equation 1 (the Törnqvist-Theil approximation) is a line integral whose value depends on the time path over which it is evaluated (Usher 1974). While in continuous time, the Divisia index always provides an exact measure of the change in the total flow of MOE services in the economy (Hulten 1973; Barnett, Spindt, and Offenbacher 1981b), the Törnqvist-Theil discrete time approximation of a Divisia index may not always be exact.

Second, when a new asset is introduced, its initial growth rate is equal to infinity if no adjustments are made to the equation 1 Divisia formula. This inappropriately makes the Divisia measure of the growth rate in the MOE services flow also equal to infinity. To correct for this possibility, the Federal Reserve System computes Divisia aggregates according to a

Fisher Ideal index formula during the initial months of a financial innovation ideal—with the rental price of the new asset being assigned a "reservation" price in the period immediately preceding its innovation. See Barnett (1983) for details on the Fisher Ideal formula.

References

Barnett, William A. "The User Cost of Money," *Economics Letters,* vol. 1 (1978), pp. 145–49.

_____. "Economic Monetary Aggregates: An Application of Index Number and Aggregation Theory," *Journal of Econometrics,* vol. 14, no. 1 (September 1980), pp. 11–48.

_____. "Economic Monetary Aggregates: Reply," *Journal of Econometrics,* vol. 14, no.1 (September 1980), pp. 57–59.

_____. *Consumer Demand and Labor Supply: Goods, Monetary Assets, and Time.* Amsterdam: North-Holland, 1981a.

_____. "The New Monetary Aggregates," *Journal of Money, Credit and Banking,* vol. 13, no. 4 (November 1981b), pp. 485–89.

_____. "The Optimal Level of Monetary Aggregation," *Journal of Money, Credit and Banking,* vol. 14, no. 4, pt. 2 (November 1982), pp. 687–710.

_____. "New Indices of Money Supply and the Flexible Laurent Demand System," *Journal of Business and Economic Statistics,* vol. 1, no. 1 (January 1983), pp. 7–23.

_____, and Paul A. Spindt. "The Velocity Behavior and Information Content of Divisia Monetary Aggregates," *Economics Letters,* vol. 4 (1979), pp. 51–57.

_____, and Paul A. Spindt. "The Information Content of Divisia Monetary Quantity Indices," Special Studies Paper 146, Board of Governors of the Federal Reserve System, Washington, DC, August 1980.

_____, and Paul A. Spindt. "Divisia Monetary Aggregates: Their Compilation, Data, and Historical Behavior," Staff Studies Paper 116, Board of Governors of the Federal Reserve System, Washington, DC, May 1982.

_____, Paul A. Spindt, and Edward K. Offenbacher. "Empirical Comparisons of Divisia and Simple Sum Monetary Aggregates," NBER Conference Paper 122, National Bureau of Economic Research, Cambridge, MA, August 1981a.

_____, Paul A. Spindt, and Edward K. Offenbacher. "The New Divisia Aggregates," Processed, University of Texas at Austin and Board of Governors of the Federal Reserve System, 1981b.

Berkman, Neil G. "The New Monetary Aggregates: A Critical Appraisal," *Journal of Money, Credit and Banking,* vol. 12, no. 2, pt. 1 (May 1980), pp. 135–54.

Diewert, W. Erwin. "Exact and Superlative Index Numbers," *Journal of Econometrics,* vol. 4, no. 2 (May 1976), pp. 115–45.

Hulten, Charles R. "Divisia Index Numbers," *Econometrica,* vol. 41, no. 6 (November 1973), pp. 1017–1025.

Porter, Richard D., and Edward K. Offenbacher. "Financial Innovations and the Measurement of the Money Supply," Unpublished paper for Conference on Financial Innovations, Federal Reserve Bank of St. Louis, October 1982.

Tinsley, Peter A., Paul A. Spindt, and Monica E. Friar. "Indicator and Filter Attributes of Monetary Aggregates: A Nit-Picking Case for Disaggregation," *Journal of Econometrics,* vol. 14, no. 1 (September 1980), pp. 61–91.

Usher, D. "The Suitability of the Divisia Index for the Measurement of Economic Aggregates," *Review of Income and Wealth,* series 20, no. 3 (September 1974), pp. 273–88.

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