Some Issues in Controlling the Stock of Money

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There has been a great deal of debate during the last few years over the ability of the Federal Reserve to control the stock of money. The participants in the debate are easy to identify. Economists of the monetarist persuasion assert that not only is the stock of money the proper instrument to use in influencing economic behavior, but they also argue that it is relatively easy to control, even in the short run. On the other hand, economists with a Keynesian bent seem to argue that money is not all that important to begin with, nor is it subject to short-run control by the monetary authorities.

This debate has not been characterized by a great deal of theoretical analysis nor by much empirical work, although the amount of empirical analysis has increased in the last few years. The most complete theoretical discussion of the issue of determination of the money stock has been provided in a series of papers by Brunner and Meltzer.[1] While their analysis added greatly to our understanding of the money supply and demand nexus, their analysis was of static

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[1]Brunner, Karl and Meltzer, Allan H., "Some Further Investigations of Demand and Supply Functions for Money," *The Journal of Finance,* (May, 1964), pp. 240-283, and "Liquidity Traps for Money, Bank Credit, and Interest Rates," *The Journal of Political Economy,* (January/February, 1968), pp.-1-37.

equilibrium and provided no way of dealing with control problems in a dynamic context. The work of Modigliani, Rasche, and Cooper has added some dynamic elements.[2] Be that as it may, we are still a long way from isolating the crucial elements in the debate and probably equally far away from understanding, at least in an empirical context, the determination of the money stock in the United States.

This paper addresses four basic issues:

1. The relationship between the demand and the supply of money in a simple stochastic environment and the implications of this environment for selection of the proper instrument for gaining best control of the money stock.

2. The forecasting ability of various models describing the determination of the money stock – including both structural and reduced-form approaches.

3. The control problem implied by these various models, including a discussion of the impact of placing constraints on short-run movements in money-market conditions, for controlling the stock of money.

4. The implications for the real sector of erratic short-run movements in the money stock.

I. The Choice of the Proper Operating Instrument

There has been considerable debate within the Federal Reserve System concerning whether or not closer control over the money stock or other aggregates could be achieved by placing less emphasis on a Federal funds rate target and more emphasis on a reserve target. This is a substantive issue because there *is* a predictable relationship between the Federal funds rate and the money stock as well as between reserves and the money stock. The issue reduces to whether the relationship between reserves and the money stock is more predictable than that between the funds rate and money.

It would be fortunate if the Federal Reserve could control both reserves and interest rates simultaneously. This, of course, is not possible. For instance, if the Fed wishes to keep interest rates constant, then reserves must move sufficiently to equate the stock of money demanded and supplied. In contrast, if the Fed wishes to keep reserves constant, then interest rates must move sufficiently to

[2] Modigliani, Franco; Rasche, Robert; and Cooper, J. Phillip, "Central Bank Policy, the Money Supply, and the Short-Term Rate of Interest," *Journal of Money, Credit and Banking*, (May, 1970), pp. 166-218.

equate the stock of money demanded and supplied. A couple of simple examples should further illustrate the point:

Assume a situation where the Fed wishes to achieve a particular M_1 path by maintaining the Federal funds rate at a level thought consistent with predicted money demand and supply relationships. Assume also that the public's demand for money ends up stronger than anticipated, perhaps because income is stronger than anticipated. Given prevailing interest rates, the public would sell assets in an attempt to increase its money balances, thereby driving interest rates up. The Fed, however, would not allow the funds rate to move up. Thus, reserves would be supplied, which the banks would then utilize to expand the volume of demand deposits and essentially satisfy the higher demand for money balances. Bank reserves, an endogenous variable under a funds-rate policy, would end up being whatever was necessary to keep the Federal funds rate from rising. In this case, the aggregate target could not be achieved by controlling the funds rate.

In contrast, if the Fed had focused on reserves, closer control of the money stock could have been achieved. As the public bids up interest rates, commercial banks would respond by buying securities and expanding loans. But if the Fed were maintaining a given path of *total* reserves, the banks would expand their portfolio of earning assets only to the extent that they were willing to reduce their limited holdings of excess reserves. Without new reserves, the ability of banks to supply additional deposits would be severely restricted. Thus the stock of money would be prevented from rising significantly to meet the increased quantity demanded, and interest rates, including the funds rate, would have to rise sufficiently to stifle the desire for increased money balances. If the Fed maintained a given path of nonborrowed reserves, there would be some offset as banks would increase their borrowed reserves and hence their deposits. Given the relatively low interest elasticity of bank demand for borrowed reserves, however, the offset would not be sufficiently large to prevent rising interest rates from reducing most of the initial increase in the demand for money.

Assume a second situation, however, where the Fed was again attempting to achieve some given M_1 path by maintaining the Federal funds rate at some given level thought to be consistent with desired M_1. Assume also that there was an unexpected upward shift on the supply side. This shift might occur, for example, because there was an unexpected shift of reserves from reserve city to country banks. Banks would, in this case, purchase more earning assets than anticipated, thereby driving interest rates down. The Fed would prevent the funds rate from falling by selling securities in the open market and thereby reducing bank reserves. The Fed would continue to withdraw reserves until the desired funds rate level was once again attained. Due to the reduction in reserves, banks would be prevented from expanding demand deposits. Hence, when the money supply shifted, the Fed would have achieved quite tight control over the monetary aggregate by focusing on the Federal funds rate.

If the target had been set on reserves, the Fed would not have achieved the desired M_1 path. With the expansion in the supply of deposits, interest rates would have had to adjust downward in order to induce the public to hold a greater stock of money. Whether the Fed set nonborrowed reserves or total reserves would condition the extent to which deposits would expand and interest rates would have to fall. If the Fed fixed nonborrowed reserves, there would be a partial offset to the expansion in deposits as banks reduced their borrowings in response to the decline in interest rates themselves. If the Fed fixed total reserves, however, the decline in borrowings would be offset by a rise in nonborrowed reserves and the money stock would rise by more than it would under a nonborrowed-reserve target. With either reserve target, interest rates would have to adjust downward sufficiently to induce the public to hold the larger money stock.

A Simple Linear Model

The issues concerning the proper control variable can be illustrated by a simple two-equation linear model plus an equilibrium condition.[3]

(1) $M_D = a_1 Y - a_2 r + u$

(2) $M_S = b_1 R + b_2 r + v$

(3) $M_D = M_S$

Money demand is assumed to be a linear function of income, the interest rate and an error term. Money supply is assumed to be a linear function of reserves (either nonborrowed or total), the interest rate, and an error term. The interest rate enters the supply function

[3] If the reader wishes he can view the model as being log-linear and thus all coefficients are interpreted as elasticities.

since a higher rate induces banks to reduce their holdings of excess reserves. If the R that the Fed controls is nonborrowed rather than total reserves, higher market rates will increase the money stock further by providing a profit incentive for banks to borrow reserves from the Fed.

The role of the error terms u and v can be seen by solving for the money stock using reserves and interest rates as alternative control variables. When reserves is the control variable, the interest rate can be eliminated by renormalizing money demand on the rate, and substituting into the supply relationship to yield the following reduced form:

$$(4)\quad M = (a_1b_2/(a_2+b_2))Y + (a_2b_1/(a_2+b_2))R + (a_2/(a_2+b_2))v + (b_2/(a_2+b_2))u \ .$$

If the interest rate is the exogenous control variable, we first equate the right side of (1) and (2) and solve for reserves,

$$(5)\quad R = (a_1/b_1)Y - (1/b_1)v + (1/b_1)u - (a_2+b_2/b_1)r \ .$$

When (5) is substituted into the supply relationship, we obtain a reduced form that is identical to the demand function,

$$(6)\quad M = a_1Y - a_2r + u \ .$$

The reduced form in (6) is not surprising because when the Fed sets the market rate, it provides an infinitely elastic supply function; quantity is determined by demand factors.

The target (desired) money stock for control through reserves is given by

$$(7)\quad M^T = \left(\frac{a_1b_1}{a_2+b_2}\right)\hat{Y} + \left(\frac{a_2b_1}{a_2+b_2}\right)R$$

where $\hat{Y}$ is the forecast of Y (assumed to be unbiased and constant variance). The target money stock for control through interest rates is given by

$$(8)\quad M^T = a_1\hat{Y} - a_2r \ .$$

The errors that will be realized under each regime are given respectively by:

$$(9)\quad (M - M^T)^R = \left(\frac{a_1b_2}{a_2+b_2}\right)(Y - \hat{Y}) + \left(\frac{b_2}{a_2+b_2}\right)u + \left(\frac{a_2}{a_2+b_2}\right)v$$

and

$$(10)\quad (M - M^T)^r = a_1(Y - \hat{Y}) + u \ .$$

It is assumed that desired values of both reserves and the interest rate can be achieved exactly.

It is assumed that the Fed should choose between the reserve and interest rate regimes depending upon which one produces the smaller variance of error. For the reserves regime let $w_1 = b_2/(a_2 + b_2)$ and $w_2 = a_2/(a_2 + b_2)$.[4] The expression for the deviation of money from its target value becomes

$$(11)\quad (M - M^T)^R = a_1 w_1 (Y - \hat{Y}) + w_1 u + w_2 v = w_1[a_1(Y - \hat{Y}) + u] + w_2 v = a_1(M - M^T)^r + w_2 v.$$

The variance is given by

$$(12)\quad VAR\,(M - M^T)^R = w_1^2 VAR\,(M - M^T)^r + w_2^2 VAR(v) + 2w_1 w_2 COV[a_1(Y - \hat{Y}) + u, v] \ .$$

The variance under the interest rate regime is given by

$$(13)\quad VAR(M - M^T)^r = a_1^2 VAR(Y - \hat{Y}) + VAR(u) + 2a_1 COV(Y - \hat{Y}, u) \ .$$

An evaluation of the ratio of the error variances under the two regimes will indicate which control variable is to be preferred. If $\frac{VAR\,(M - M^T)^R}{VAR\,(M - M^T)^r} < 1$, reserves should be used as the control variable. If the ratio exceeds unity, interest rates should be used to control the money stock.

[4]We are indebted to Robert Rasche for suggesting the following analysis of relative variances.

$$\frac{VAR(M - M^T)^R}{VAR(M - M^T)^r}$$

$$= \frac{w_1{}^2 VAR(M-M^T)^r + w_2{}^2 VAR(v) + 2w_1 w_2 COV[a_1(Y - \hat{Y}) + u,v]}{VAR(M - M^T)^r}$$

$$= w_1{}^2 + \frac{w_2{}^2 VAR(v) + 2w_1 w_2 COV[a_1(Y - \hat{Y}) + u,v]}{VAR(M - M^T)^r}$$

or

$$(14)\quad \frac{VAR(M-M^T)^R}{VAR(M-M^T)^r} = [b_2/(a_2+b_2)]^2 +$$

$$\frac{[a_2/(a_2+b_2)]^2 VAR(v)+2[b_2/(a_2+b_2)][a_2/(a_2+b_2)] COV[a_1(Y-\hat{Y})+u,v]}{a_1{}^2 VAR(Y-\hat{Y})+VAR(u)+2a_1 COV(Y-\hat{Y},u)}$$

It is extremely difficult, if not impossible, to evaluate the expression in (14). There simply is not enough information on the variances and covariances of the various error terms to allow any kind of general statement.

Problems in Predicting Money Demand and Supply

The money demand and supply relationships specified above are gross oversimplifications of the sophisticated models that appear in the literature. Even sophisticated models produce sizeable prediction errors. These errors are not surprising in light of the complexity of the money determination process. The sources of these errors are outlined in the following brief review of the determinants of money demand and supply.

The public's response to changes in interest rates is complex and the time span of adjustment may be long. If interest rates rise, money holders must be convinced that the change is not just transitory before reducing their money balances. Furthermore, changes in relative interest rates can have an indirect effect on money demand. For example, if the public switches from one asset to another (such as selling bonds to buy Treasury bills), desired money balances will rise on average simply because money is held between transactions.

These indirect portfolio adjustment effects imply that the lag structure relating interest rates and money is highly complex. Needless to say, the lag structures are very difficult to estimate.

Since money acts in part as a buffer stock, short-run changes in income and transactions – including random movements – will be reflected immediately in the size of money balances. For instance, if income unexpectedly falls, the public's first response is to let its money balances decline. If income quickly returns to previous levels, so, too, will money balances. However, if the loss of income appears permanent, then the public will sell other assets to restore some of its lost money balances to a new desired level. Obviously, this latter kind of response involves a longer time period. It takes time for each individual to realize a change in permanent income has taken place, to decide what to do, and then to respond. Furthermore, these kinds of adjustments are constantly being made by large and shifting numbers of the population, which imply long and variable lags. Even if our knowledge in these areas were complete, we could not anticipate random fluctuations in income and the volume of transactions, which can produce sharp shifts in the demand for money. Money demand is obviously also dependent upon business and household confidence and expectations, factors that have thus far been hard to quantify.

The money supply function is also exceedingly complicated and hard to predict. The Federal Reserve, of course, can manipulate the supply of reserves through open-market operations. Control over the supply relation is not complete, however, because banks have alternative uses for reserves. For instance, when the Federal Reserve increases nonborrowed reserves, banks can use them to increase their excess reserves, or repay borrowings at the Federal Reserve, or buy earning assets. It is only the third alternative that causes the money stock to rise.

Banks hold excess reserves and look upon borrowing from the Fed as buffers from unexpected movements in deposits and loan demand. Large and erratic weekly changes in both excess and borrowed reserves can be expected. These movements are masked when the data are aggregated for longer periods, such as a quarter. Longer-run changes in these two accounts are made in response to changes in interest rates and sustained changes in deposits. As is the case on the demand side, there are lags in this adjustment process. Although empirically the lags do not appear to be long, they do exist and, as mentioned earlier, lag structures are notoriously difficult to predict.

Further complications for predicting the money supply function are produced by the existence of numerous different reserve requirements. Money supply functions must allow for shifts of funds among different reserve classifications. This includes shifts between 1) the various classes of member banks, 2) member and nonmember banks, 3) other capital market instruments and commercial bank time deposits and 4) demand deposits and time deposits. The problem is compounded by diverse reserve requirements 5) on Eurodollars, 6) on commercial paper, and 7) according to size of bank deposit liabilities. In the short run, these shifts are erratic and extremely hard to predict. Simplifying the structure of reserve requirements would greatly aid attempts to control the money stock through the use of reserves.

This discussion strongly suggests that we can expect sizeable errors in attempts to hit a money target using either reserves or an interest rate as the control device. The choice of the appropriate instrument is an empirical question. In order to assess the reliability of reserves versus the funds rate as an operating target, we examine several empirical models of the money determination process in the next section.

II. Monthly Forecasts of the Money Stock Using Different Econometric Models

In this section monthly forecasts of changes in the money stock for the years 1970 and 1971 are presented. Three different kinds of econometric models – multiplier, structural, and reduced form – are used.

Multiplier Models

Two different multiplier models are considered. Both postulate a predictable relationship between bank reserves and the money stock. While never specified, the structure of these models is most consistent with a money-supply function in which the interest elasticity is zero, because no variables influencing the demand for money, such as income, are included. The first model is a very simple one; it assumes that the money stock can be predicted each month by applying the previous month's multiplier to the current month's reserves. In order to keep this multiplier consistent with the more elaborate one to be discussed below, the multiplier is defined as the ratio of the money stock to the nonborrowed monetary base – nonborrowed reserves plus currency and nonmember bank vault cash. The second multiplier model is the one estimated by Burger, Kalish and Babb (BKB), which asserts that the multiplier between the money stock and the nonborrowed base is determined by a moving average of previous multipliers plus seasonal factors.[5] The model was fit to monthly data over the 36-month period ending in December 1969. Because the character of this model has been described in detail by BKB, it will not be described here.

Structural Model

The structural model considered in this paper is a monthly money-market model estimated at the Federal Reserve Board.[6] There are three sectors in this model: public, commercial bank, and Government. The interaction of these sectors determines values for currency, demand deposits, CDs, other time deposits, public and bank holdings of Treasury bills, excess reserves, borrowed reserves as well as rates on CDs, 30- and 180-day Treasury bills and prime commercial paper. The purpose of this model is to specify structural relationships and to have a vehicle for adjusting predictions for changes in structure. Because of its structural orientation, this model does not necessarily provide the best technique for forecasting the money stock. The structure of the model was estimated over the period January 1961 through June 1968. The solutions in Table I were obtained by solving the model with the Federal funds rate exogenous. The model solves for a Treasury bill rate which then, along with retail sales, wealth, and seasonal variables, determines the public's demand for demand deposits and currency.

Reduced-Form Models

The third model considered here is the one presented by Davis in an interesting recent paper.[7] Davis's approach is to look at reduced

[5] Burger, Albert E.; Kalish, Lionel III; and Babb, Christopher T. "Money Stock Control and Its Implications for Monetary Policy," Federal Reserve Bank of St. Louis *Review*, (October, 1971).

[6] Thomson, Thomas D.; Pierce, James L.; Parry, Robert T., "A Monthly Money Market Model," unpublished manuscript.

[7] Davis, Richard G., "Estimating Changes in Deposits with Reduced-Form Equations," unpublished manuscript, Federal Reserve Bank of New York.

forms of a linearized version of the money demand and supply relationship in which nonborrowed reserves and the funds rate are taken, respectively, as the policy variable. The reduced forms include current and lagged values of nonborrowed reserves or the funds rate, business sales, Government deposits, and a variable that attempts to capture the effects of Q ceilings.[8] His reduced-form models use the demand deposit component of the money stock as a variable to be explained. The model was estimated over the period January 1965 through December 1969. In order to make the projections of the Davis models comparable to those of the other models, we have added to his demand-deposit projections monthly projections of the change in currency holdings generated by the monthly money-market model. The performance of the currency projections is generally quite good; for the years 1970 and 1971, the root mean squared forecast error was only $221 million.

The fourth model was estimated by Schadrack and Skinner as an extension of Davis's work.[9] They predict M_1 rather than demand deposits but, like Davis, their explanatory variables include a distributed lag on both the funds rate and business sales and the concurrent change in Government deposits. They also use the same 1965-69 sample period for estimation.

Projection Errors

The projection errors of changes in the money stock for 1970 and 1971 using these six models – the two multiplier models, the structural model, Davis's nonborrowed reserves and Federal funds rate reduced-form models, and Schadrack and Skinner's reduced form – are presented in Table I along with the actual changes in the money stock. Statistics on the mean absolute errors and the root mean squared errors are also reported. The projections from the money-market model and the several reduced forms use actual rather than forecasted values of exogenous variables. Thus the material presented in Table I no doubt understates the errors for true *ex ante* forecasts for these models. Experience with the monthly model suggests, how-

[8] As indicated in Section I if the funds rate is the control variable, only demand factors should appear in the reduced form. Thus the inclusion of the Q ceiling variable and perhaps Government deposits is inappropriate.

[9] F. C. Schadrack and S. Skinner, "A Reduced Form M_1 Equation," May, 1972, unpublished manuscript, Federal Reserve Bank of New York.

TABLE I

PROJECTION ERRORS IN PREDICTING CHANGES IN THE MONEY STOCK
(Predicted Less Actual Changes)

		Actual Changes	Simple Multiplier	St. Louis Multiplier	Monthly Model	Davis Nonborrowed Reserves Version	Davis Fed Funds Version	Schadrack-Skinner Equation
1970	Jan.	1.8	−2.0	−1.900	−2.1	−1.464	−1.427	−1.100
	Feb.	−0.8	5.0	− .279	1.8	1.689	1.348	1.530
	Mar.	2.0	−1.5	−1.090	−2.6	−1.671	−1.041	−1.560
	April	1.6	−1.6	.227	−2.2	− .790	− .602	−1.060
	May	.7	4.8	− .223	−1.4	− .253	− .642	.463
	June	.4	−1.6	.125	− .4	− .155	.769	.246
	July	.9	.4	− .667	.7	− .305	.957	.289
	Aug.	1.3	2.3	.924	.1	− .552	.188	− .049
	Sept.	1.2	− .7	1.11	.9	.568	.599	.061
	Oct.	.3	−1.1	− .58	1.8	1.122	.990	.824
	Nov.	.5	− .5	− .738	− .5	.081	.020	.020
	Dec.	1.2	−1.0	.178	− .2	− .125	− .255	− .222
1971	Jan.	.5	0	2.242	1.3	.769	.886	.907
	Feb.	2.4	4.1	− .105	.7	− .615	− .329	− .594
	Mar.	2.0	−1.1	− .236	− .5	.286	.834	.116
	April	1.5	−2.1	− .294	1.4	.360	1.140	.382
	May	2.6	4.3	− .844	− .2	− .227	.364	− .672
	June	1.7	−3.2	−1.557	.7	.405	1.224	.631
	July	1.9	.3	− .788	1.4	− .352	.435	− .498
	Aug.	.6	.9	−1.192	1.9	.399	.557	.274
	Sept.	− .6	.8	2.081	3.2	2.345	2.524	.808
	Oct.	− .1	0	1.296	.5	1.341	.759	.599
	Nov.	0	.1	.988	− .7	.753	.469	.367
	Dec.	.5	−1.5	.407	.2	.574	.464	.010
	M.A.E.		1.704	.836	1.142	.700	.784	.553
	R.M.S.E.		2.2617	1.0398	1.4101	.9214	.9367	.7028

ever, that the use of projected rather than actual values of exogenous variables does not seriously alter the forecasts of the money stock. For example, the root mean squared error for 1971, using forecasted values of all exogenous variables in the monthly model, was $1.22 billion.

The simple multiplier model gives very poor projections, as one might expect, but, perhaps more importantly, the St. Louis approach is no more superior in projection ability than the reduced forms. The Schadrack and Skinner equation does give substantially better results than the other models. This indicates, contrary to the assumption of many previous researchers, that forecasts are improved when one estimates the sum of currency and deposits instead of estimating each separately. *A priori,* one might expect the public's behavior concerning the two assets to be quite distinct and that the two demand functions should be modeled separately. Schadrack and Skinner's results indicate that there is substantial negative covariance between the errors in the currency and demand deposit equations resulting in improved forecasts by summing the two assets.

Also, the model tests shed very little light on which control variable – reserves or interest rates – produces more reliable results. In the Davis models, although the nonborrowed reserves equation holds a slight edge, the forecasting results using either control variable are very similar. This suggests that both demand and supply errors are relevant. Neither reserves nor the Funds rate appears to be decidedly superior, at least during the twenty-four months tested. Since Schadrack and Skinner did not run their equation with reserves, we have little evidence from their results. Experience with the monthly model indicates that results are somewhat improved using the Funds rate rather than nonborrowed reserves as the control variable.

In summary, there is no evidence that problems in hitting a target for the money stock are caused simply by using the Federal funds rate as the Federal Reserve's operating variable.[10] The real problems in controlling the money stock appear to stem from two factors. First, the money stock is not the sole aim of the Federal Reserve. Consideration is often given to such factors as target values for interest rates as well as to constraining their short-term movements. Interest rates are considered important for their own sake and not merely as instruments to control the aggregates. Second, the fore-

[10]Incidentally, we found that averaging the results of the individual models in Table I did not improve the quality of the projections.

casting errors of the various models indicate that controlling the money stock on a short-term basis, even if it were the only target for policy, can be quite difficult. Control problems are further discussed in the next section.

III. Short-Run Control Problems

Given the implied changes in short-run contemporaneous multipliers, along with relatively sizable projection errors, it seems unlikely that the Federal Reserve can effect close short-run control over the money stock – say within a band of plus-or-minus two percentage points in its growth rate. Lagged responses were present in all the models considered, except the naive model. Lags are hard to quantify but even if their characteristics were known with certainty, their existence intensifies the money control problem.

Lags in response of money demand and supply to changes in interest rates, income, reserves, and other variables pose particularly acute problems if control within a very short horizon such as a month or a calendar quarter is attempted. If, for example, there were an unexpected reduction in aggregate demand in the economy, *cet. par.,* there would be a reduction in the demand for money. In order to keep the money stock from falling below its desired growth path, it would be necessary to expand bank reserves and reduce interest rates sufficiently to induce the public to hold the target money balances. Due to the interest rate lags in the demand for money, a relatively large reduction in interest rates and a sizable increase in bank reserves would be required to keep the money stock on track.

With the passage of time following an injection of reserves, the public would have an opportunity to adjust to the lower interest rates and the quantity of money demanded would rise for unchanged values of income and interest rates. The impact of the lower interest rates would be accumulating over time. Thus, a reserve injection provided initially to keep the money stock from falling below target would tend, through time, to lead to an increase of money above target unless reserves are reduced accordingly. If income should also rise in subsequent periods, say to its previous value, the control problem is intensified. In this case reserves would have to be reduced sufficiently to offset both the lagged interest-rate effect and the income effect.

The existence of these lags suggests that following a myopic, period-by-period strategy for staying on a monetary growth path could create substantial fluctuations in financial markets and could, under certain conditions, lead to uncontrollable movements in interest rates.[11] That is, ever-wider movements in interest rates might be required to keep the money stock on target period by period. These problems can be avoided, in large part, if a longer time horizon is used. Thus, aiming at an average growth path for money, say, over six months rather than month by month or even quarter by quarter would greatly reduce the problem.

Davis's reduced form that uses the Federal funds rate as the policy variable provides an interesting example of the money-control problems that could develop with a myopic rule. According to his results, seven months are required for the money stock to adjust fully to a change in the funds rate. Furthermore, a change in the funds rate of approximately 400 basis points is required to change demand deposits by $1 billion in the current month. Yet a current change of only 70 basis points is required to get the $1 billion change three months hence, and a current change of 37 basis points for seven months hence. Estimates of the monthly structural model indicate that a given change in the funds rate requires approximately two months longer to have the same impact on deposits as Davis's reduced form. If these estimates are even remotely close to reality, the Federal Reserve must use a control horizon of several months if it is to avoid finding itself in impossible situations.

It should be stressed that these results for required changes in the Federal funds rate are obtained from linear models. Since the actual structure of the money market is not known, it is quite possible that linear equations are not applicable and that the extent of the required interest-rate variability is overstated. Until we know of the existence and character of these nonlinear equations, however, very little can be said about the extent of any overstatement of required interest-rate movements.

Thus, policy strategy involving pursuit of a monthly money-stock path appears to be out of the question because it would imply large fluctuations in interest rates. Pursuit of quarterly or semi-annual paths would not require such extreme rate fluctuations. Irrespective of the control horizon, it appears to us that the world could learn to live with greater variability in the Federal funds rate than it has experienced in the past. The rate on one-day money can fluctuate widely without great impact on interest rates for longer maturity

[11] For the use of a linear decision rule for controlling the money stock, see Burger, Kalish and Babb, above. For discussion of money control problems using more elaborate control procedures, see Brito, D. L., and Hester, D. D., "Stability and Control of the Money Supply," unpublished manuscript, University of Wisconsin.

loans. One would expect that with wider short-run movements in the funds rate, money-market participants would start using somewhat longer-term instruments. Arbitrage in the money market would imply that movements in the funds rate would get diffused over a wide spectrum of short-term rates. Investors taking advantage of short-run profit opportunities could be expected to smooth the fluctuations in short rates. On the other hand, wider fluctuations in short-term interest rates would suggest that the demand for money would be less sensitive to monthly movements in these rates because there would be less information contained within any given monthly change. Thus, the degree of short-run control over the money stock might be weakened.

IV. Economic Consequences of Erratic Movements in the Money Stock

As mentioned earlier, the money stock is not the only target variable for monetary policy. When the control problems just discussed in the previous section are combined with a decision to concentrate attention on other factors, control of the money stock necessarily suffers. It is then more likely than ever for erratic rather than steady money growth rates to obtain.

Money behavior in 1971 and the first half of 1972 was characterized by just such erratic movements. Economists with a monetarist persuasion have looked with horror on the wide swings in M_1 in the last year and a half and have been most vocal in their criticisms. Whether one is a monetarist or not, the issue is relevant to the current discussion. Therefore, in this section, we try to determine some of the costs to the economy of having erratic movements in the money stock.

Because most of the criticism of erratic movements in the money stock has come from monetarists, it seems appropriate to analyze the issue by using a monetarist econometric model. Thus, the quarterly model of the Federal Reserve Bank of St. Louis was used to perform the following simulation exercises.[12]

The exercise began by running a control simulation for the years 1972 and 1973 in which it was assumed that the Federal Reserve maintained a constant 6 percent M_1 growth path for all eight quarters. The "control" values thus obtained for GNP, real GNP,

[12] Andersen, Leonall C., and Carlson, Keith M., "A Monetarist Model for Economic Stabilization," Federal Reserve Bank of St. Louis *Review*, (April, 1970), pp. 7-21.

prices (GNP deflator) and the unemployment rate were used as a standard for comparison. A series of additional simulations then run in which the money stock was assumed to grow at various rates for various time periods. In the initial period, which consisted of an increasing number of quarters, the money stock was assumed to grow at a 10 percent rate. This was succeeded by a period of 2 percent rate money growth for the same number of quarters. For the remainder of the two-year interval it was assumed that the money stock returned to a steady 6 percent rate growth path.[13] Thus, the average growth rate over the entire two-year period was 6 percent. The values of GNP, prices and unemployment obtained from these various "solution" simulations were then compared to the values of the control simulation. The results are reported in the tables at the end of this section.

Simulation Results

The exercise indicates that the money stock can wander off path for up to two consecutive quarters without materially affecting the expected impact upon the economy. However, sizeable effects begin to appear when the money-stock fluctuations continue for three or more quarters. By that time, the absolute values of output, prices and employment vary substantially from the values of the variables in the control simulation (in which a steady 6 percent money growth was maintained). In addition, it then takes considerably longer for the economy to return to the control values. This suggests, then, that a latitude for errors exists for short-term money growth provided that the average growth rate over a period as long as one year equals the desired growth.[14] This also implies (with the same caveat) that

[13]Another series of simulations was run in which the same procedure was followed except that the money stock was assumed to fluctuate from an 8 percent rate to a 4 percent rate, and then level out at a 6 percent rate. The results of this series show the same kind of results as those reported above.

[14]This contention is also supported by simulation exercises concerning economic performance in 1971. The money stock actually grew at about a 10 percent rate in the first half of the year and then at about a 2 percent rate in the last half, which averages out to about a 6 percent growth rate for the year as a whole. If the money stock had grown at a constant 6 percent rate – instead of vacillating from 10 to 2 percent – results of simulations from the St. Louis quarterly econometric model show that aggregate output would have been only slightly lower, price behavior would have been the same, and the differences in the unemployment rate would have been miniscule. (These differences in the econometric variables – small as they are – are all in the same direction, thus indicating that the economy actually was better off than would have been the case if money growth had been at a steady 6 percent rate.)

the Federal Reserve can focus on other target variables – such as interest rates or disintermediation problems – for short periods without seriously affecting ultimate economic goals.

The simulation results also point up the fact that because of distributed lags, it takes at least several quarters for monetary policy to work its complete influence on economic behavior. Thus, an instantly-effective monetary policy cannot be expected. But at the same time, the same distributed lags make it possible for relatively extreme, but short-lived, policy reversals to be not necessarily disruptive. An easy monetary policy starts a chain of effects in the economy, but if a tight monetary policy is instituted shortly thereafter – in three to six months – the uncompleted portion of the chain will be counterbalanced by the new policy. Such vacillations can thus cancel out competing effects and the ultimate impact on the economy tends to be nearly the same as if a steady money growth policy had been followed. In any event, the simulation results suggest that it is desirable to set a money strategy to extend over at least several quarters rather than focusing on month-by-month, or quarter-by-quarter changes.

When looking at the following tables, it is important to remember that some sectors of the economy respond to monetary policy more quickly (and more intensely) than others. For instance, the effects of the fluctuating money-stock growths on prices are not fully felt within two years, the length of the period shown in the tables. We ran the experiments out further and found in the most extreme case – four quarters of 10 percent growth followed by four of 2 percent – the price solutions do not start to converge to the control solution until the second quarter of 1975. In the least extreme case, this convergence commences in the first quarter of 1974.

It should be stressed that all econometric models are approximations of the real world and they may, at times, give deceptive results. It is quite possible, for example, that the economy adjusts more rapidly to sharp variations in the growth of the money stock than to more gradual changes. If this is the case, then the model simulations understate the costs to the economy of erratic changes in the growth of the money stock. While there is no strong evidence that this sort of reaction exists, the possibility of its existence reminds us to treat all model simulations with some reservation.

TABLE II

EFFECTS ON THE ECONOMY IN RESPONSE TO VARYING MONEY-GROWTH RATES *ONE* QUARTER AT 10%, *ONE* QUARTER AT 2%, REMAINING QUARTERS AT 6% COMPARED TO A STEADY 6% MONEY-GROWTH RATE

	1972				1973			
	I (10%)*	II (2%)*	III (6%)*	IV (6%)*	I (6%)*	II (6%)*	III (6%)*	IV (6%)*
GNP								
10, 2, 6→SOLUTION	1095.3	1111.8	1128.4	1146.7	1166.0	1186.9	1208.0	1229.3
CONTROL (Steady 6)	1092.9	1108.5	1125.8	1145.6	1166.3	1187.3	1208.4	1229.7
SOLUTION – CONTROL	2.4	3.3	2.6	1.1	–.3	–.4	–.4	–.4
REAL GNP								
10, 2, 6→SOLUTION	755.0	759.3	764.0	770.3	777.8	786.7	796.3	806.4
CONTROL (Steady 6)	753.3	757.1	762.4	769.8	778.3	787.4	797.0	807.1
SOLUTION – CONTROL	1.7	2.2	1.6	.5	–.5	–.7	–.7	–.7
PRICE DEFLATOR								
10, 2, 6→SOLUTION	145.1	146.5	147.7	148.9	150.0	150.9	151.8	152.5
CONTROL (Steady 6)	145.1	146.4	147.7	148.9	149.9	150.9	151.7	152.4
SOLUTION – CONTROL	0	.1	0	0	.1	0	.1	.1
UNEMPLOYMENT RATE								
10, 2, 6→SOLUTION	6.1	6.2	6.3	6.5	6.5	6.5	6.5	6.5
CONTROL (Steady 6)	6.1	6.3	6.4	6.5	6.5	6.5	6.5	6.4
SOLUTION – CONTROL	0	–.1	–.1	0	0	0	0	.1

*Money growth (annual rate) in solution simulation. Money growth in control simulation is always at a constant 6%.

TABLE III

EFFECTS ON THE ECONOMY IN RESPONSE TO VARYING MONEY-GROWTH RATES *TWO* QUARTERS AT 10%, *TWO* QUARTERS AT 2%, REMAINING QUARTERS AT 6% COMPARED TO A STEADY 6% MONEY-GROWTH RATE

	1972				1973			
	I (10%)*	II (10%)*	III (2%)*	IV (2%)*	I (6%)*	II (6%)*	III (6%)*	IV (6%)*
GNP								
10, 10, 2, 2, 6→SOLUTION	1095.3	1116.8	1137.8	1155.9	1171.7	1188.2	1207.6	1228.9
CONTROL (Steady 6)	1092.9	1108.5	1125.8	1145.6	1166.3	1187.3	1208.4	1229.7
SOLUTION – CONTROL	2.4	8.3	12.0	10.3	5.4	.9	−.8	−.8
REAL GNP								
10, 10, 2, 2, 6→SOLUTION	755.0	762.7	770.3	776.2	781.0	786.7	794.9	804.8
CONTROL (Steady 6)	753.3	757.1	762.4	769.8	778.3	787.4	797.0	807.1
SOLUTION – CONTROL	1.7	5.6	7.9	6.4	2.7	−.7	−2.1	−2.3
PRICE DEFLATOR								
10, 10, 2, 2, 6→SOLUTION	145.1	146.5	147.8	149.0	150.1	151.1	152.0	152.8
CONTROL (Steady 6)	145.1	146.4	147.7	148.9	149.9	150.9	151.7	152.4
SOLUTION – CONTROL	0	.1	.1	.1	.2	.2	.3	.4
UNEMPLOYMENT RATE								
10, 10, 2, 2, 6→SOLUTION	6.1	6.2	6.2	6.2	6.3	6.4	6.5	6.5
CONTROL (Steady 6)	6.1	6.3	6.4	6.5	6.5	6.5	6.5	6.4
SOLUTION – CONTROL	0	−.1	−.2	−.3	−.2	−.1	0	.1

*Money growth (annual rate) in solution simulation. Money growth in control simulation is always at a constant 6%.

TABLE IV

EFFECTS ON THE ECONOMY IN RESPONSE TO VARYING MONEY-GROWTH RATES *THREE* QUARTERS AT 10%, *THREE* QUARTERS AT 2%, REMAINING QUARTERS AT 6% COMPARED TO A STEADY 6% MONEY-GROWTH RATE

	1972				1973			
	I (10%)*	II (10%)*	III (10%)*	IV (2%)*	I (2%)*	II (2%)*	III (6%)*	IV (6%)*
GNP								
10, 10, 10, 2, 2, 2, 6→SOLUTION	1095.3	1116.8	1142.9	1168.2	1187.4	1200.8	1213.7	1230.2
CONTROL (Steady 6)	1092.9	1108.5	1125.8	1145.6	1166.3	1187.3	1208.4	1229.7
SOLUTION – CONTROL	2.4	8.3	17.1	22.6	21.1	13.5	5.3	.5
REAL GNP								
10, 10, 10, 2, 2, 2, 6→SOLUTION	755.0	762.7	773.8	784.3	791.0	794.2	797.6	804.0
CONTROL (Steady 6)	753.3	757.1	762.4	769.8	778.3	787.4	797.0	807.1
SOLUTION – CONTROL	1.7	5.6	11.4	14.5	12.7	6.8	.6	-3.1
PRICE DEFLATOR								
10, 10, 10, 2, 2, 2, 6→SOLUTION	145.1	146.5	147.8	149.0	150.2	151.3	152.3	153.1
CONTROL (Steady 6)	145.1	146.4	147.7	148.9	149.9	150.9	151.7	152.4
SOLUTION – CONTROL	0	.1	.1	.1	.3	.4	.6	.7
UNEMPLOYMENT RATE								
10, 10, 10, 2, 2, 2, 6→SOLUTION	6.1	6.2	6.2	6.1	6.0	6.1	6.3	6.4
CONTROL (Steady 6)	6.1	6.3	6.4	6.5	6.5	6.5	6.5	6.4
SOLUTION – CONTROL	0	–.1	–.2	–.4	–.5	–.4	–.2	0

*Money growth (annual rate) in solution simulation. Money growth in control simulation is always at a constant 6%.

TABLE V

EFFECTS ON THE ECONOMY IN RESPONSE TO VARYING MONEY-GROWTH RATES *FOUR* QUARTERS AT 10%, *FOUR* QUARTERS AT 2%, REMAINING QUARTERS AT 6% COMPARED TO A STEADY 6% MONEY-GROWTH RATE

	1972				1973			
	I (10%)*	II (10%)*	III (10%)*	IV (10%)*	I (2%)*	II (2%)*	III (2%)*	IV (2%)*
GNP								
10, 10, 10, 10, 2, 2, 2, 2, 6→SOLUTION	1095.3	1116.8	1142.9	1173.4	1200.0	1219.6	1233.1	1243.4
CONTROL (Steady 6)	1092.9	1108.5	1125.8	1145.6	1166.3	1187.3	1208.4	1229.7
SOLUTION – CONTROL	2.4	8.3	17.1	27.8	33.7	32.3	24.7	13.7
REAL GNP								
10, 10, 10, 10, 2, 2, 2, 2, 6→SOLUTION	755.0	762.7	773.8	787.8	799.2	806.2	809.4	811.0
CONTROL (Steady 6)	753.3	757.1	762.4	769.8	778.3	787.4	797.0	807.1
SOLUTION – CONTROL	1.7	5.6	11.4	18.0	20.9	18.8	12.4	3.9
PRICE DEFLATOR								
10, 10, 10, 10, 2, 2, 2, 2, 6→SOLUTION	145.1	146.5	147.8	149.0	150.2	151.4	152.5	153.4
CONTROL (Steady 6)	145.1	146.4	147.7	148.9	149.9	150.9	151.7	152.4
SOLUTION – CONTROL	0	.1	.1	.1	.3	.5	.8	1.0
UNEMPLOYMENT RATE								
10, 10, 10, 10, 2, 2, 2, 2, 6→SOLUTION	6.1	6.2	6.2	6.0	5.8	5.7	5.8	6.0
CONTROL (Steady 6)	6.1	6.3	6.4	6.5	6.5	6.5	6.5	6.4
SOLUTION – CONTROL	0	–.1	– .2	– .5	– .7	– .8	– .7	– .4

*Money growth (annual rate) in solution simulation. Money growth in control simulation is always at a constant 6%.

DISCUSSION

JOHN H. KAREKEN*

I was given the task of discussing the very interesting paper prepared by Jim Pierce and Tom Thomson. I am going to put off doing that, however, if only briefly, and begin by posing a question – a not altogether irrelevant question – which is, I believe, both interesting and important. It is one which ought to be in the record of this conference, even if it cannot be considered by the participants. So I feel justified in taking a little time to pose my question and, of course, take a crack at answering it. I shall be only a few moments before returning to the Pierce-Thomson paper. Besides, discussants have been digressing since the art form known as conference was invented, presumably by someone in ancient Greece. But I do have to apologize, particularly to Pierce and Thomson.

Should the FOMC Control M_1?

Should the FOMC try to control M_1, say, or any of the other familiar aggregates? That is my question. And some of you are even now, I am sure, wondering why I felt I had to ask it. After all, that was the central question of the first of these Boston Fed conferences, the one held in June, 1969. Moreover, the FOMC has since seen the error of its ways and is now committed, to some degree at least, to trying to control M_1. Quite properly, therefore, the discussion has shifted to how best that can be done. I am not, however, asking whether as an alternative to trying to control money market conditions, or perhaps just the Federal funds rate, the FOMC should try to control M_1 or M_2. Rather, I am asking whether it should try to

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control any variable or variables other than those which truly matter – or which, so to speak, appear in the Committee's objective function.

My concern would be real enough even if the FOMC were trying to control some particular interest rate – for example, the Aaa corporate bond rate. To be sure, any nominal rate is a potential instrument variable. There is no rate which the FOMC, if it wanted, could not control exactly, although perhaps effectively only over a relatively brief stretch of time. Certainly it could control the Aaa corporate bond rate exactly if it were willing to trade in Aaa corporate bonds. But it is difficult to imagine the Account Manager buying and selling such bonds. And that is why a moment ago I took the Aaa corporate bond rate as an example of an interest-rate control or intermediate-target variable. There would seem to be so many, however, who believe that the FOMC should try to control M_1. And that is evidently what it lately has been doing, although within the confines of rather limiting interest-rate constraints. I therefore had better proceed on the assumption that M_1 – or, more precisely, quarterly-average M_1 – is the control variable.

Let me sketch out how the FOMC might try to control quarterly-average M_1 for the current quarter. At the beginning of the quarter, it determines a desired or target value for the quarterly average of M_1. It does this using its quarterly econometric model, as modified perhaps by judgment, and the desired values of its ultimate target variables – the GNP deflator, say, and the unemployment rate. It also determines target values for the three monthly averages of M_1, although exactly how is not clear, at least to me. There would not seem to be any obviously right way. But, in any event, having determined a target value for first-month average M_1, the FOMC tells the Account Manager what it is and he sets about his task.

Of late, the FOMC has been instructing the Manager by providing him with target values for yet another variable, reserves against private nonbank deposits or, for short, RPDs. That is to say, it has in recent months been using this other control variable – why is not crystal clear. But here I can assume, without any loss of generality, that the FOMC simply gives the Manager a target value for monthly-average M_1 – or, the equivalent, the value for the instrument variable, whether his portfolio or some interest rate, that is implied by the monthly-average target value for M_1 and the monthly money demand and supply equations. I can also assume that there are no within-month instrument-variable adjustments, so what the Manager does is hold his instrument variable at the appropriate value straight through the first month.

Now we come to the beginning of the second month. The FOMC, meeting again, looks back and observes that the Manager, try as he did, was unable to make the actual first-month average of M_1 equal to the desired value. There was a miss. That assumption is not, I take it, all that unrealistic. But how does the FOMC contend with the M_1 miss? By somehow choosing two new desired monthly average values for M_1. The average of these new values and the actual value for the first month must be equal, though, to the desired quarterly average value specified originally.[1] That is implied by the objective of controlling quarterly-average M_1.

Revising the Target

There is no need for me to describe what the FOMC does at the beginning of the third month. I would just be repeating myself. Let me therefore go back to the first-month M_1 miss. There has to be an explanation for it. During the first month, there must have been some disturbance in the economy, perhaps several. On that we can all agree. But there having been one or more disturbances, the originally-selected target value for quarter-average M_1 is not any longer consistent with the desired values of the ultimate target variables.

To put the point differently, once an M_1 miss, or for that matter any miss, has been observed, the desired quarterly average for M_1 ought to change. Yet, if the objective is to control M_1, it does not. Thus, what trying to control M_1 must often involve is a striving for equality between actual M_1 and a wrong or inconsistent target value.

But please understand me. I am not saying that the FOMC should forget about M_1. Indeed not. It should always be keeping track of M_1. If it is proceeding month by month, it should use the observation on M_1 for the preceding month in deciding its policy for the current month. It should also, however, use all such other observations as it has – for example, observations on interest rates and, say, M_2. Why will be clear. The task is to identify disturbances, or find out what went on in the economy during the last month; and that requires the use of all available recent observations.

So the FOMC should, as it were, look at everything. It troubles me having to say that, since I might seem to be giving aid and comfort to the obscurantists in the System. And it does have a few – or did, last

[1] To say this, I have to assume no change in the FOMC's economic outlook – or its forecasts of exogenous variables.

time I looked. It is not, however, that the FOMC should simply look around, hoping to find some development in the recent past which might seem to justify its doing something silly (for example, nothing). The appropriate FOMC responses to observations are quite well-defined.

I am not here going to get into how the FOMC ought to respond to observations on M_1 and all the other variables which it observes relatively frequently. Doing that, I would go too far afield and, not so incidentally, bore you to tears. I did, however, want to warn the obscurantists that there is nothing for them in my view of how the FOMC ought to operate – a view which might, I suppose, be described as non-monetarist. I know that there are no obscurantists here, except possibly from the academic community. But my remarks may one day be printed up and read by others in the System.

It can be objected that for the FOMC to proceed as I have suggested it should, by each month revising its target value for (or expectation of) monthly-average M_1, it would have to have a monthly model of the U.S. economy. That is so, but we should not be too quick in insisting that it does not have such a model. It may strike some of you as strange, my saying that, especially since awhile back I and some colleagues at the Minneapolis Fed did some testing of the Board's monthly model of the financial sector, testing to which, we thought, it did not stand up very well. But the FOMC does have a quarterly model. And since it is a requirement that models of different time dimensions be consistent in structure, the Committee may have some semblance at least of a monthly model. It perhaps can be said to know the monthly structure, if incompletely and with considerable uncertainty. Whether it can is, it seems to me, something we ought to find out.

But what if it is so that the FOMC does not have a monthly model? Assuming that, how ought it to operate? Not, I am quite sure, by trying to control quarterly-average M_1. So far as I can see, there is no payoff in doing that. I can indicate why by assuming the existence of reliable monthly money demand and supply equations and considering two possible ways of operating. The Account Manager can, straight through the quarter, hold to a particular value of his instrument variable – that value which, according to the quarterly model, is consistent with the desired values of the ultimate target variables. Or he can operate in the above-described manner, possibly making month-by-month adjustments in his instrument variable and trying thereby to achieve some desired quarterly-average value for M_1, that value also having been determined using the quarterly model. But as is easily shown, for a linear economic structure anyway, the variance of outcomes is the same whichever way the Manager proceeds. Why then bother specifying a desired quarterly-average M_1 and making within-quarter instrument-variable adjustments? To repeat, there would seem to be no payoff. Thus, whether the FOMC does or does not have a monthly model, trying to control M_1 is not indicated. Or so it seems to me.

Need for a Monthly Model

I am clear in my own mind what some of the System's researchers ought to be doing over the near-term future: namely, trying to develop a monthly model and, more particularly, taking the quarterly model and seeing whether, by imposing the requirement of consistency of structure, a monthly model can be derived. Doing that will not be easy. But if the task is undertaken, there will be less time than there otherwise would be for further consideration of how best to control M_1. And that will be all to the good, since the problem of how best to do that is really a non-problem. There will also be less time for further consideration of the issue "interest rates versus M_1," which is really a non-issue because M_1 is not a potential instrument variable and all the various interest rates are.

Now, having described the problem of how best to control M_1 as a non-problem, I might just dismiss the Pierce-Thomson paper. I am not, however, going to do that. For one thing, I do not have all that much confidence in my judgment. For the time being, therefore, I am going to accept that trying to control M_1 is a reasonable objective.

In section I of their paper, Pierce and Thomson present a lucid exposition of what is involved in the instrument variable choice -- or, as they would say, the operating instrument or target choice, the choice between, say, the funds rate and unborrowed reserves. Earlier I said that "interest rates versus M_1" was a non-issue. But "interest rates versus reserves" is not, since there are some reserve aggregates (for instance, unborrowed reserves) which presumably are close enough to being controlled exactly by the FOMC that they can reasonably be regarded as potential instrument variables. So the issue to which Pierce and Thomson have addressed themselves is, at the very least, a near-genuine one. And as they point out (p.123), quite correctly, it is an empirical one. Yet, Pierce and Thomson present no evidence which goes to the "funds rate versus reserves" issue.

This issue cannot be resolved by a comparison of the M_1 variances or forecast errors generated by alternative-reserves reduced-form equations — or supposed-reserves reduced-form equations. It is necessary to compare the variances of M_1 generated by, respectively, a reserves reduced-form equation and a funds-rate reduced-form equation, both from the same economic structure. And that, for the most part, is not what Pierce and Thomson do.

Nor can it be said that the average forecast errors generated by naive equation — the Burger and Schadrack-Skinner equations and the Davis reserves equation, all presented in Table I of the Pierce-Thomson paper — are of any great interest. And my point is not that these errors were generated using known values of exogenous variables, although that is important. It is just that these equations cannot seriously be regarded as reduced-form equations. How can they, when the FOMC did not come to the use of a reserves aggregate until January, 1972 (at the earliest)? So nothing can be inferred about the ability of the FOMC to control M_1 from the forecast error generated by any of these equations.

Pierce and Thomson compare the two Davis equations, in one of which the funds rate appears as the independent variable and in the other of which a reserves aggregate appears. They should not do that either, though, since the Davis equations cannot both be true reduced-form equations. They were both estimated directly and, I gather, from the same data. It appears that the virus which was once confined to the St. Louis area has spread to New York.

Pierce and Thomson might have presented a proper comparison of variances, for they do have their own monthly structural model of the U.S. financial sector. Indeed, it is very surprising that they should have decided to present only the M_1 forecast error generated by their reserves reduced-form equation. By itself, that error means nothing — for the issue at hand, that is. Of course, it may be taken as showing that, contrary to the claims of some, the FOMC cannot control M_1 exactly. For myself, being a little suspicious of the Pierce-Thomson monthly model, I should prefer not to draw any conclusions from the error generated by their reserves reduced-form equation, although I have no doubt that the FOMC is unable to control M_1 exactly. And I cannot take much guidance from their intriguing, but regrettably unsubstantiated, assertion (p.127) that "experience with the monthly model indicates that results are superior using the funds rate rather than reserves as the control variable."

It is then easy for me to agree with the observation of Pierce and Thomson which appears on page127 . There is no evidence that by using some reserves aggregate instead of the funds rate as its operating variable the FOMC would do better controlling M_1. But the conclusion might be put differently: there is no evidence at all bearing on the funds rate-reserves issue. We are still quite up in the air.

It is also easy for me to agree with another of the Pierce-Thomson observations: that concern about interest-rate fluctuations complicates (or has complicated) the problem of controlling M_1. The question, though, is whether the FOMC ought to be concerned about interest-rate fluctuations, day-to-day or week-to-week. Perhaps it has to be, U.S. politics being what they are. But had I been in charge of planning this conference, I should certainly have scheduled a session on the desirability, from the economic standpoint, of limiting interest-rate fluctuations – along with a session, of course, on the desirability of trying to control M_1. I take it that no one would object to dallying a day longer in this splendid environment.

Need for Institutional Reform

Or possibly a day and a half longer, for there is another session which might have been scheduled – a session on institutional reform. Pierce and Thomson describe very well why exact control of M_1 should not be expected. And it is clear from their description that with certain institutional reforms, the variance of M_1 might well decrease. What is more important, the variances of certain ultimate target variables might also decrease. I recall that at the June 1969 Boston Fed conference Allan Meltzer presented a neat list of institutional reforms which could be made in the hope of decreasing the variance of M_1. He might have included the "un-lagging" of required reserves on his list, though, for it is apparent that if the object is to control M_1 by fixing some reserves aggregate, then it is better to have required reserves depend on current deposits rather than the total for some past week. Now, obviously, that hoary image of hide-bound central bankers, so favored by academics, does not fit at all the Board of Governors. Through the years, it has instituted many reforms. I do wonder, though, whether always for the right reason. Maintaining or increasing System membership would not seem to be all that important. But increasing control of M_1 ought to strike the Board and, even more, the FOMC as being of supreme importance. And so far as I am aware, the Board has not been terribly aggressive in seeking the kinds of reforms of thrift-institution practices which would make interest-rate fluctuations of lesser concern.

I pass now to the remaining sections of the Pierce-Thomson paper and, more specifically, to the simulation experiment which is reported in Section IV. What Pierce and Thomson have found is that the pattern of quarterly averages for M_1 can be varied quite considerably, over a year's time anyway, without the values of certain other important variables, as predicted by the St. Louis Fed model, changing very much. That is an interesting finding, from which some comforting conclusions would seem to follow. Before getting to those conclusion, though, I do have to emphasize that Pierce and Thomson's empirical result was obtained using the St. Louis model, in which not all of us have the greatest confidence. I can understand their wanting to use that model. Those St. Louis fellows are not only clamorous, but also most devoted to their particular view of the world. So there is a strong temptation to try, as it were, to beat them using their own rules. Still, what we are after are plausible empirical propositions and I should therefore have preferred to see Pierce and Thomson, in doing their experiment, use what to their minds is the best model – or even better perhaps, several of the available models.

Those comforting conclusions (or implications) to which I referred a moment ago can be paraphrased as follows: In deciding policy for the year ahead, the FOMC is quite free to pick nearly any reasonable pattern of quarterly increases for M_1 that averages to the appropriate yearly increase. And having once observed a difference between actual and desired M_1, an M_1 miss, whether for the month or for the quarter preceding, the FOMC does not have to react sharply. It does not have to push interest rates way up and in that way try to offset the M_1 miss in the current period. Unless of course the current period happens to be the last sub-period of the longer period – maybe the last quarter of the calendar year. If it is, then the FOMC does have to react sharply. The above conclusions should not therefore be taken as too comforting, even by those who accept the underlying empirical finding.

I can put my point another way. The Pierce-Thomson finding suggests that the FOMC might, without much cost, try to control calendar-year average M_1. It does not, however, suggest that the Committee can try to control the average M_1 for the year beginning with the current month or quarter. If it were to try to control that average M_1, then actual calendar-year GNP could be very different from desired calendar-year GNP. There has to be a last period – a last quarter, a quarter of reckoning. Thus, the Pierce-Thomson finding does not guarantee against sharp quarter-to-quarter changes in interest rates.

Pierce and Thomson have not presented a complete strategy for controlling M_1, although they could, I am sure, if asked. Rather, they have presented a justification for a particular definition of the control variable. Or should I say that they have recommended a particular definition, calendar-year average M_1. If I may quote them: ". . . .the simulation results suggest that it is desirable to set a money strategy to extend over at least several quarters." And using calendar-year average M_1 as the control variable would not appear grossly unreasonable. But what ought to be decided before the new definition is accepted is whether the Pierce-Thomson finding is valid over a range of models. Then, too, the FOMC might seriously want to consider how concerned it ought to be about near-term interest-rate fluctuations. As I have said, that is far from obvious. And, finally, there is the larger question which I began by asking: Should the FOMC try to control M_1 or, indeed, any variable or variables other than its ultimate target variables?