Conference Series No. 9

CONTROLLING MONETARY AGGREGATES II: THE IMPLEMENTATION

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PROCEEDINGS OF A CONFERENCE HELD IN SEPTEMBER 1972

FEDERAL RESERVE BANK OF BOSTON

CONTROLLING MONETARY AGGREGATES II: THE IMPLEMENTATION

Proceedings of a Conference
Held at
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THE FEDERAL RESERVE BANK OF BOSTON

THE FEDERAL RESERVE BANK OF BOSTON CONFERENCE SERIES

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FOREWORD

In the spring of 1969, the Federal Reserve Bank of Boston sponsored the first in a series of conferences on important monetary issues. That first conference was titled *Controlling Monetary Aggregates* and its proceedings were published, as were the proceedings of subsequent meetings sponsored by this bank.

This volume, the ninth in the series, is a timely sequel to that first publication. All papers were presented by persons from within the Federal Reserve System; discussants were primarily academicians. The result is, we believe, a unique examination of some of the important questions relating to the implementation of policy decisions. We hope it will prove to be useful to those concerned with monetary policy.

Frank E. Morris
President

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RPDs as the Target

FRANK E. MORRIS*

An important new set of initials has recently been added to the vocabulary of monetary policy: RPDs – reserves against private deposits. In this paper I propose to set forth the reasons why I, as a non-monetarist, have long supported the proposition that the primary operating instruction to the Manager of the Federal Open Market Account should be couched in terms of the rate of growth of reserves. In addition, I will attempt an assessment of what we have learned thus far in our relatively brief experiment with the use of RPDs as an operating target and speculate a bit about some potential problems which we have not yet encountered.

In a paper presented to the American Economic Association last December, Governor Andrew Brimmer placed the Boston Fed next to the St. Louis Fed in the spectrum of thinking on monetary issues among Federal Reserve Banks – with the St. Louis Fed at one extreme and the New York Fed at the other. This classification raised a good many eyebrows in Boston where monetarism has not yet been able to establish a foothold. I suspect that a major reason for Governor Brimmer's classification was my efforts to support a shift to a reserves operating target for monetary policy. The fact is, however, that my advocacy of a reserves target has been rooted in operational rather than ideological grounds.

I think money is important, but not so supremely important as to classify me as a monetarist. I am not persuaded by the evidence that there is a unique, or even an operationally reliable, relationship between the rate of growth in the money supply and real economic activity. My views on the efficacy of fiscal policy are neo-Keynesian, although this does not mean that I believe the manner in which a deficit is financed is unimportant. I do not believe that the private

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This is a personal testimony on monetary policy and should not, in whole or in part, be ascribed to the Federal Reserve System.

economy is inherently stable; quite the contrary, I believe that a capitalist economy is inherently unstable. I do not believe that the demand for money is stable; in fact, we had a dramatic demonstration in 1971 that the demand for money occasionally can be quite unstable, an episode to which I will refer later. I find a stable monetary growth policy economically unpersuasive and politically naive. Monetary policy must remain flexible, but we must seek ways of implementing a flexible policy more effectively than in the past. Having said this to establish that there is still a considerable distance between St. Louis and Boston, let me state my reasons for advocating a reserves target.

Debate on the implementation of monetary policy has been going on, more or less continuously, for decades within the Federal Reserve. Not unnaturally, a particular FOMC member's views are likely to be conditioned by the stage in this long debate in which he entered. Certainly this is true in my case. My first FOMC meeting was in September 1968 when the Federal Reserve was in the midst of making what, in my judgment, was its most serious policy error of the decade of the 60s.

Monetary policy was clearly too expansionary in the last half of 1968. The important fact, however, was not simply that a mistake in judgment had occurred. We will always be subject to such mistakes. The important fact was that the method of implementing monetary policy then in force, with its primary emphasis on short-term money rates, had led to an expansion in the monetary aggregates which was substantially greater than *any* member of the FOMC had thought appropriate in an economy with an unemployment rate averaging only 3.6 percent and suffering strong inflationary pressures. During the fourth quarter of 1968 RPDs grew at an 11 percent annual rate, M_1 at an 8.3 percent rate, and M_2 at an 11 percent annual rate. As a newcomer to the Federal Reserve System I was struck by the fact that our method of implementing monetary policy was not capable of assuring the sort of control over the growth of the monetary aggregates than even non-monetarists could agree we had to have.

In looking back at the late-1968 experience, it is clear that the initial source of error was a faulty economic forecast. The Federal Reserve forecasters in common with almost all other forecasters in the country, grossly overestimated the near-term impact of the income tax surcharge. Undoubtedly, the policymakers gave considerable weight to the fact that the Federal Reserve staff forecasting record before (and since) had been extremely good. Another factor, but one difficult to weigh, is the fact that the income tax surcharge had been sold to Congress, at least in part, on the ground that monetary policy could, thus, become more accommodative.

During the last half of 1968, the instructions of the FOMC to the Manager were geared primarily to short-term money rates, with a proviso clause stated in terms of the rate of growth of the bank credit proxy. In practice, the proviso clause had only marginal significance, in part because the limits on the growth of the proxy were never sufficiently quantified to give it teeth. The extent of the real restraining influence of the proviso clause is suggested by the fact that the proxy grew at a 12.3 percent annual rate during the last half of 1968.

During 1968 and 1970 the argument over the proper approach to implementing open market operations tended to be relegated to the back burner. During those years the conditions for conflict between a money-market strategy and a reserves-growth strategy did not exist. There was, as always, room for questioning the wisdom of the policy itself, but the manner of implementing open market operations was not a critical issue. The central policy issue of those years was the use of Regulation Q as the "cutting edge" of monetary policy and the maze of regulations which stemmed from it; but this subject had better be left to another day.

Oddly enough, interest in the manner of implementing open market policy was revived by an event of no economic significance: the sharply divergent growth rates of the aggregates in the first and second halves of 1971. This was not a mistake of monetary policy by my reckoning, since I have not been able to identify any adverse economic consequences. Nonetheless, the event served to evoke renewed concern in the Congress and among the public as to the ability of the Federal Reserve to control the money supply adequately and it served as a reminder to some of us in the Federal Reserve that we had not changed in any fundamental way the manner of implementing policy which had contributed to the mistake of 1968. It was this "non-event" of 1971, however, which led to increased support for the reserves strategy.

Somewhat ironically, perhaps, the statistical work presented in a supplement to this paper suggets that we would have had an uneven growth rate in M_1 in 1971 even if the FOMC had been following a stable RPD growth policy. There was a dramatic shift in the demand for money in 1971, the timing (if not the dimensions) of which was forecast quite accurately by the Federal Reserve Board staff. As a consequence, M_1 grew much faster than normal relative to RPD growth in the first half of the year and relatively much slower in the second half. Nonetheless, a variation in the rate of reserve input was a major contributing factor: RPDs grew at a 10.8 percent annual rate in the first half of 1971 and a 4.5 percent rate in the second half.

I am inclined to believe, however, that monetary policy in 1971 would not have been much different if we had been following a reserves strategy. During the spring months of 1971 we faced a very strong demand for money while, at the same time, our economic projections (quite correctly) were indicating relatively sluggish real growth in both the second and third quarters of the year. It appeared that the strong demand for money was not a function of a surge of strength in the economy. Nonetheless, there was always a chance that the forecast could be wrong and, in establishing policy, it was important to calculate the "cost of forecast error." In the context of the spring of 1971, with the unemployment rate averaging 6 percent, the "cost of forecast error" was negligible, since we would have plenty of time to correct an excessive rate of growth of the money supply long before the economy could get close to full employment levels of operation. Obviously, this was quite a different situation than we faced in the last half of 1968, when the "cost of forecast error" was extremely high.

As I stated earlier, my advocacy of a reserve-growth strategy has been based on operational rather than ideological considerations. A reserve-growth strategy will, in my judgment, provide a superior framework for decision-making by the FOMC. There will be occasions in which the Committee will, and should, subordinate its objectives with respect to the monetary aggregates to meet interest-rate objectives. However, as long as its primary instruction to the Manager is stated in terms of reserve growth, the FOMC will be forced to focus on the estimated rate of reserve growth required to meet its interest-rate objectives. An operating procedure which requires an assessment of the quantitative trade-off between interest rates and reserve growth will, in my judgment, make for better decision-making.

Would a reserve-growth strategy have made a difference in 1968? The reconstruction of history is a hazardous business. Historians still quarrel about whether it would have made a difference at Waterloo if Napoleon had been in good health. Judgments will differ, but mine is that the 1968 experience would have been different had we been following a reserve-growth strategy. The Committee, as we moved into the fall months, would have been faced with a choice between abandoning the prevailing interest-rate policy or permitting RPDs to grow at an 11 percent rate. Posed in this framework, I think the

Committee probably would have reacted sooner than it did. The weakness of the decision-making process then in use was that it did not compel a deliberate, quantified analysis of the trade-off between interest rates and reserve growth.

The Case for RPDs as the Target

It is a truism that if the central bank's economic forecast is correct and if the relationships between the economic forecast and interest rates, reserve growth and the rates of growth of other monetary aggregates are correctly forecast, it makes no difference whether the operating target of the central bank is expressed in terms of the Federal funds rate, M_1, M_2, RPDs or what have you. The critical choice, however, is the optimum variable for the central bank to control, from the standpoint of minimizing policy error, if the forecast should prove to be wrong. For a number of reasons, I believe reserve growth is the optimum control variable for the central bank in a forecast error situation.

The monetarist's answer to this question is that the central bank should abandon forecasting and seek, as a matter of deliberate policy, the second-best solution by following a constant monetary growth policy. While I cannot accept the solution, I recognize the critical importance for a central bank to follow a strategy which will minimize losses from forecasting error.

The money-market strategy fails this critical test since it is likely to produce more perverse results in a forecast-error situation than a reserves strategy – producing more money when the economy is stronger than expected and less money when it is weaker than expected. Late 1968 is a classic case of the former; late 1959-early 1960 is a classic case of the latter. Equally important, in my judgment, is the probability that a forecast-error situation will be recognized more rapidly if the Manager is controlling reserves than if he is controlling interest rates. I will elaborate on this point a little later on.

Reserves are superior as a control variable to M_1 or M_2 or the bank credit proxy for four critical operational reasons. First, the Manager of the System Open Market Account can control the rate of growth of reserves within narrow limits over periods as short as two or three months. He cannot be expected to hit M_1, M_2 or bank credit proxy targets within such a time frame; and experience suggests that nothing can muddy-up the decision-making process quite so thoroughly as for the FOMC to give its Manager a target that it has no conviction he can hit.

The other targets the Manager can hit in a two or three month time frame (and if the time frame is longer, control of monetary policy suffers) are the monetary base and the Federal funds rate. Because the demand for currency (unlike the demand for money) is reasonably stable, the monetary base could easily be substituted for reserves as a control variable. I suspect that one of the reasons that the New York Fed has been reluctant to surrender the Federal funds rate as the prime control variable is the fact that they know they can control it – no inconsiderable advantage.

Second, and of critical importance, is the information lag factor. I think it is difficult for anyone outside the Federal Reserve to appreciate the vital role that information lag can play in policy-making. Here again, the Federal funds rate scores high. There is a zero information lag with the funds rate. It is available instantaneously and the preliminary figure is not going to be revised. In day-to-day operations the Trading Desk is working with estimates for everything except short-term interest rates.

The FOMC Manager finds himself operating nine days to two weeks ahead of any reliable estimates of deposits at member banks. Only twice a year does he receive information on the level of deposits at nonmember banks, a secularly rising fraction of the total. The Manager with an M_1 target is in the position of a ship's navigator attempting to guide the ship only with the knowledge of where the ship was two weeks ago. In such a situation there will be an irresistible temptation for the navigator to look out the window and to be guided by what he can see immediately on the horizon. When the FOMC Manager looks out the window, the only things immediately visible are short-term money rates.

The information lag problem is greatly reduced when the Account Manager is instructed to focus on member bank reserves, since our intelligence on reserves is infinitely better and the information lags are very much shorter.

The third operating problem is the high random content in short-term movements in M_1, M_2, and the bank credit proxy. If we are pursuing an M_1 target and see that a bulge in M_1 occurred two weeks ago, we cannot be sure whether the bulge was due to random and self-reversing causes or whether we should interpret it as a basic change in trend. A number of weeks or even months may pass before we can accumulate enough evidence to make a confident judgment as to whether we are off course or not. In the case of reserves, on the other hand, if a miss occurs, we know very promptly why it happened and what is required to get reserve growth back on course.

The fourth operating problem is the diverging-aggregates problem, which frequently arises when the FOMC establishes targets for both M_1 and M_2. What does the FOMC Manager do when one aggregate is on course and the other is running substantially above or below its track? The potential for this sort of confusion is reduced if the divergence problem is ignored during the interval between FOMC meetings and taken into account only in the context of establishing the reserve-growth path for the next period.

Of course, the divergence problem would be eliminated if the FOMC could agree on a single concept of money. However, not even the monetarists have achieved this state of grace. My personal view is that all of our present concepts of money contain so many arbitrary and questionable elements that it is difficult to take any single money measure very seriously. To cite one minor example, I have always thought it curious that the demand deposits of foreign governments are included in M_1 and M_2, but the demand deposits of the U. S. Government are not.

Furthermore, our financial structure is changing so rapidly that a concept of money which might have been acceptable a few years ago may be obsolete now. A recent development in Massachusetts presents a good example of the limitations of static concepts of money. Depositors in mutual savings banks in Massachusetts, under a recent ruling of the Massachusetts Supreme Court, may now write checks against their savings accounts. The court ruled that this would not convert these accounts into demand deposits, because the savings banks had the legal right to defer payment for 90 days. However, since the savings banks in Massachusetts have not exercised this right for more than 40 years, their customers have sound historical grounds for viewing these accounts as demand deposits upon which 5¼ percent interest is paid. Certainly, economists are likely to agree that these deposits are closer to money than savings deposits at commercial banks, and yet we do not include them either in M_1 or M_2. If third-party payments and negotiable drafts on deposits at thrift institutions spread from Massachusetts to the provinces, it seems to me that we will be compelled to move to an M_3 concept of money, which includes such deposits. At that time, we may also be required to consider whether the Federal Reserve has the power to exercise adequate control over the growth rate of an M_3 concept of money from a steadily shrinking base of member commercial banks.

At this point I would like to elaborate on a judgment made earlier to the effect that a forecast-error situation is likely to be recognized more rapidly if the FOMC Manager has as his primary directive the control of reserves rather than interest rates. The reason lies in the very sensitivity of markets, the Congress and, consequently, the Federal Reserve to changes in interest rates.

In a situation where the economy is stronger than forecast and a reserves strategy is being employed, the Committee's attention will immediately be focused on the fact that interest rates are turning out to be much higher than expected and the faulty forecast is likely to be subjected to question rather promptly, for the only alternative would be to raise the reserve-growth path above the level previously thought appropriate to the forecast.

On the other hand, in the same situation with a money-market strategy, M_1 and M_2 will come in with much higher growth rates than forecast. The Committee's reaction in this case, however, is likely to be much slower: first, because of the information lag on the aggregates and, second, because the unexpected movements in the aggregates are likely, for a while, to be attributed to random and self-reversing movements before the faulty economic forecast is itself brought into question. This, in fact, was the history of the last half of 1968.

The opposite forecast error situation occurred in late 1959 and early 1960 when the economy was much weaker than had been forcast. RPDs *contracted* at a 2¼ percent annual rate in the first half of 1960 as the economy was poised to move into a recession. Even though RPDs were contracting, short-term interest rates declined during the first half of 1960. It is interesting to speculate what reserve-growth path would have been chosen by the FOMC if it had been following a reserves strategy in early 1960. From a reading of the minutes of the Committee meetings, I would guess that they would have chosen a low but positive number. I doubt that the Committee would have deliberately chosen to contract the level of reserves. If this judgment is correct, the decline in short-term rates would have been much more precipitous and the recognition of forecast error would probably have come much earlier than it did.

These, then, are the operational reasons why I believe a reserves strategy, by providing a superior framework for decision-making, will help to produce superior policy.

The Experiment Thus Far

At this point in time, we have had almost seven months experience with the implementation of a reserves strategy. The initial conditions for the experiment have been close to optimum. We have not yet encountered a crucially difficult choice between interest rates and reserve growth, nor have we yet encountered the diverging-aggregates problem.

Nonetheless, we have already learned a great deal. Most important, we have learned that the FOMC Manager can control reserve growth within fairly close limits over a two or three month span and that he can do so without producing undue instability in the Federal funds rate, day to day or week to week.

The advocates of a money-market strategy had for years raised the specter of chaotic conditions in the short-term money markets as a necessary price of any attempt to control reserve growth – with the implication, of course, that the price was excessive. Having a high regard for the talents of our associates at the Trading Desk, I had a strong conviction that, if put to the test of controlling reserve growth and maintaining orderly conditions in short-term money markets, they would find the means to accomplish both objectives simultaneously. Even though they may still not be completely enchanted with the reserves strategy, they have demonstrated to my satisfaction that they can manage it very effectively.

There are two problems which we have not encountered during the past seven months which will, at some point in time, put the reserves strategy to a more severe test. The most critical one, of course, is the policy issue generated when a desired intermediate-term path for interest rates cannot be reconciled with the desired reserve-growth path. The second, and lesser, problem is the diverging-aggregates or deposit-mix problem. Until such time as we return to the sort of stable growth path for the economy, which, in turn, will produce more stability in interest rates, the diverging-aggregates problem is likely to continue to plague the FOMC. The problem is complicated by the fact that we have no generally accepted theoretical structure for assessing the economic significance, if any, of diverging-growth paths among the aggregates.

If, for example, we are supplying reserves at a rate which will support a 6 percent growth rate in M_1 and a 9 percent growth rate in M_2 and the public, in utilizing these reserves, produces only a 3 percent growth rate in M_1 and a 15 percent growth rate in M_2 – should the FOMC be concerned? My own view is that the FOMC should not be overly concerned about the deposit-mix problem per se: first, because there is very little we can do about it and second, because we know so little about its economic significance. I would not alter the rate of reserve input in this sort of context unless the incoming economic indicators were suggesting that there was too much or too little liquidity in the economy.

The research staff of the Federal Reserve Bank of Boston has developed some simple estimating equations describing the relationships between RPDs, M_1 and M_2 since 1960. The only adjustment made in the equations to improve the fit was to take account of the secular rise since 1960 in the percentage of total deposits in non-member banks – a trend which, if continued, will have great significance for monetary policy in the future.

Their analysis suggests that when interest rates are relatively stable and the economy is on a relatively stable growth path, as from late 1962 through early 1966, relationships between the input of RPDs and the resulting growth rates in M_1 and M_2 are very tight. However, in an unstable economy with wide swings in interest rates, the variances can be very great.

If the reserves strategy is to have a proper test, it is important to recognize that the control of RPDs will not necessarily assure the precise control of any other particular monetary aggregate. The inventory of potential leakages between RPD growth and M_1 growth, for example, is quite lengthy – even though RPD was defined to eliminate two potential leakages, U. S. Government deposits and interbank deposits. The leakage inventory would include the following:

1. Changes in the level of excess reserves.
2. Abnormal changes in currency in circulation.
3. Shifts in the distribution of demand deposits between Reserve city banks and country banks.
4. Shifts in demand deposits between member and non-member banks.
5. Most important, shifts in the deposit mix between demand, time and savings deposits, CDs – and also non-deposit sources of funds of the sort which absorb reserves. These shifts, in turn, may reflect the following:
   (a) current and past growth rates in the economy
   (b) current and past trends in interest rates
   (c) the influence of Regulation Q and related regulatory actions
   (d) changes in the liquidity preference of the public

One of the theoretical beauties of a reserves target, however, is that the reserves concept used can easily be structured to control fairly precisely the movement of any single aggregate. For example, if the FOMC were to consider it important to control, in a single-minded way, the rate of growth in M_1, it would be necessary to make the following four changes:

1. Reserve requirements should be uniform for all member banks regardless of size.
2. Reserve requirements should be eliminated against time and savings deposits, CDs and non-deposit sources of funds.
3. All institutions offering demand deposits should be required to become members of the Federal Reserve System or to be subject to Federal Reserve reserve requirements.
4. The "reserves against M_1" concept which the FOMC would then be utilizing as a target would have to be adjusted for abnormal changes in excess reserves or currency in circulation.

With the reserves target so structured, M_1 could be controlled rather tightly. Technique aside, however, there would remain the basic question as to whether the tight control of M_1 is a sensible objective for monetary policy. I am not persuaded that it is. The purpose of the exercise was to illustrate that if we could agree on a single monetary aggregate to control, it would be easy to specify the requirements for a reserves strategy needed to control it.

Concluding Remarks

H. L. Mencken is reported to have said: "There is always an easy solution to every human problem – neat, plausible and wrong." I am not suggesting that the reserves strategy offers an easy solution to the complex problems of monetary policy. However, I think it provides a superior decision-making framework within which to formulate policy. There will be occasions when interest-rate policy must have first priority in the decisions of the FOMC, but the Committee is likely to make sounder decisions if it is compelled by the logic of the directive to specify the rate of reserve growth which it is willing to accept to meet the interest-rate objective.

A second major advantage of the reserves strategy is that, because of the very sensitivity to interest-rate changes and the zero information lag on interest rates, a forecast-error situation is likely to be recognized more promptly than would be the case if a money-market strategy were being implemented.

Having said this, I am nonetheless aware that the excellence of our operating procedures will never shield the FOMC from the necessity of occasionally having to make very difficult choices between interest rates and monetary growth. It is these decisions, in the face of a multitude of uncertainties, which will always make the formulation of monetary policy a fascinating and significant business.

SUPPLEMENT

THE HISTORICAL RELATIONSHIP BETWEEN RPDs AND THE MONETARY AGGREGATES

The quantity of RPDs is a primary determinant of the quantity of money. For example, if there were:

a. no shifts in the mix of time and demand deposits,
b. no changes in banks' holdings of excess reserves,
c. no nonmember banks in the commercial banking system,
d. no changes in CD holdings,
e. no changes in the ratio of country banks to Reserve city banks, and
f. no changes in the public's preferences for holding currency,

then any change in RPDs would result in an exact corresponding change in the monetary aggregate(s).[1]

In fact, the deposit mix changes, excess reserve positions fluctuate, the role of nonmember banks varies, the volume of CDs swings widely, and so forth. Changes in these factors have interacted to produce secular as well as cyclical changes in the relation between RPDs and the monetary aggregates. On a monthly basis, the relationship is quite erratic. The additional M_1 associated with an additional dollar of RPDs has fluctuated between +\$100 (in March, 1970) and −\$110 (in February, 1969). The fluctuation in the increment of M_2 is even wider, +\$150 to −\$190.

Chart I shows the ratio of money (broadly and narrowly defined) to RPDs in the period from January 1960 to June of 1972. In January, 1960, each dollar of RPDs supported \$6.74 of demand deposits, \$8.47 of M_1, and \$12.41 of M_2. By June, 1972, each dollar of RPDs supported on the average \$6.03 of demand deposits, \$7.84 of M_1, and \$16.26 of M_2. Much of the secular rise in M_2/RPDs can be explained by a shift in the deposit mix in favor of time deposits which lowered the effective average reserve requirement on total deposits. In contrast to the fairly steady rise in the ratio of M_2 to RPD, the ratio of M_1 to RPD has fluctuated around its downward

[1]The magnitude of the change would depend on the level of reserve requirements. This factor is ignored in the discussion below as the RPD data have been adjusted for changes in reserve requirements.

trend. Starting from 8.47 in January, 1960, the M_1 to RPD ratio declined to a low of about 7.75 in late 1968. Over the next year, coinciding with the large rundown in CDs, this ratio rose to about 8.32. Since early 1970, this ratio has resumed its downward course, reaching 7.84 last June.

How much of the changes in the monetary aggregates can be accounted for by changes in RPDs alone? Regressing changes in the monetary aggregates (3-month moving averages) on the contemporaneous changes in RPD produces the following simple relationships:[2]

(1) $\Delta M1 = .140 + 3.616\ \Delta RPD$
$R^2 = .48$ SEE = .32 D.W. = .68

(2) $\Delta M2 = .482 + 9.796\ \Delta RPD$
$R^2 = .74$ SEE = .49 D.W. = .65

Movements in RPDs alone "explain" about half of the variations in ΔM_1 and nearly three-quarters of the variations in ΔM_2. Charts II and III show the actual changes in M_1 and M_2, respectively, and the changes which would be projected by (1) and (2) above. The equations track historical experience fairly well, avoiding consistent, substantial underestimation or overestimation for more than a month or two, with the following major exceptions:

(1) They overestimate in the last half of 1960, the last half of 1970, and the last half of 1971.
(2) They underestimate throughout 1969 and early 1971.

These discrepancies may be attributable to any of the factors that the simple RPD-estimating equations omit or even to errors in the data. Part of the explanation is suggested by the historical context in which the errors occurred. For example, large errors are observed in 1969. In that year the Regulation Q ceilings brought about a rapid decline in large certificates of deposit and forced commercial banks to obtain nondeposit sources of funds. When the certificates of deposit ran off, the reserves which were required to support them became available to support demand deposits, savings deposits, and

[2]The dependent variables in these equations exclude deposits at nonmember banks, i.e., M_1 above = (M_1 – demand deposits at nonmembers), and M_2 above = (M_2 – total deposits at nonmembers). The changes in nonmember deposits were then added to both sides of the equation to produce the actual and estimated changes in M_1 and M_2 shown on Charts II and III respectively.

other time deposits at commercial banks. Only these deposits, excluding CDs, are included in the monetary aggregates. As a result, the aggregates, especially M_1, declined much less sharply in the second half of 1969 than the estimating equation predicts.

The reverse situation occurred in the second half of 1970 when the equations overestimated the increase in total non-CD deposits. Because of the elimination of the Regulation Q ceilings on short-term CDs in June 1970, commercial banks were able to double their volume of CDs in less than six months. These additional CDs absorbed a great volume of reserves which could not be used to support other types of deposits. As a result, non-CD deposits grew more slowly in the second half of 1970 than in the first, even though the Federal Reserve System provided a larger volume of RPDs.

Large errors also occurred during periods of rapidly changing market rates. When money-market rates are either increasing or declining rapidly, a change in deposit mix is induced at commercial banks. In the first half of 1971, for example, rates on short-term securities declined rapidly while deposit rates at commercial banks remained fairly stable. As a result, the commercial banking industry had a rapid inflow of savings and non-CD time deposits. These deposits have a relatively low average reserve requirement which enabled commercial banks to obtain a phenomenal increase in their total deposits, even though the Federal Reserve System provided a much smaller increase in RPDs. The reverse of this situation occurred in the latter half of 1971.

Chart 1

THE RATIO OF M_1 AND M_2 TO RPDs

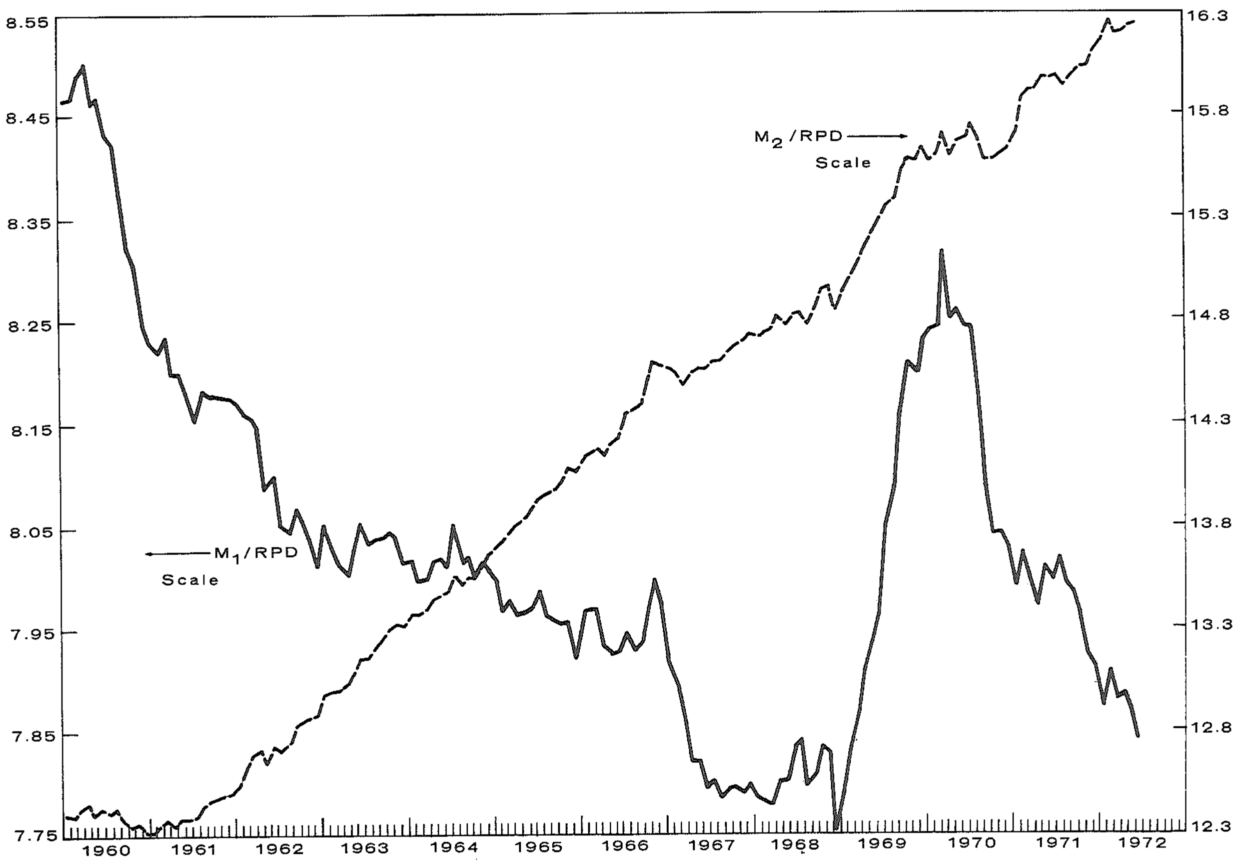


Chart 2

CHANGE IN M_1: 3-MO. MOVING AVERAGE, ACTUAL & ESTIMATED

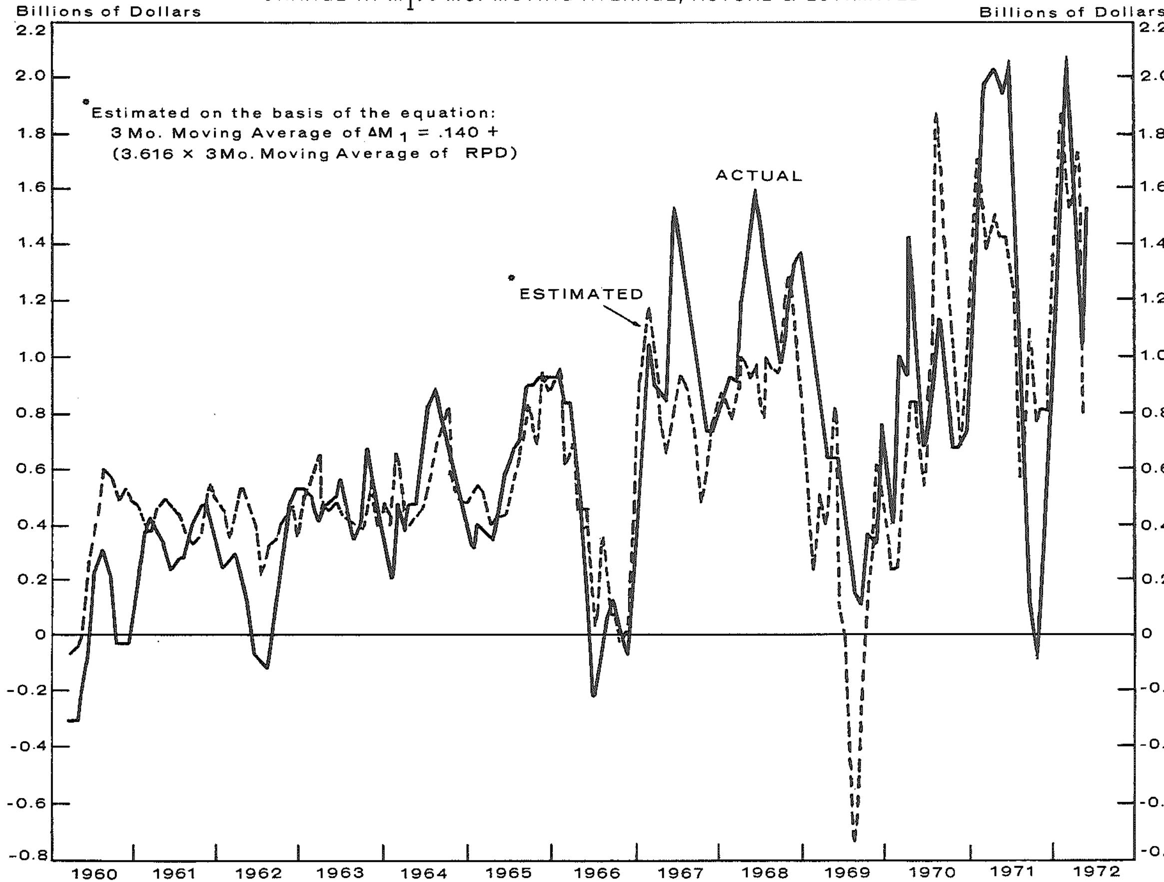
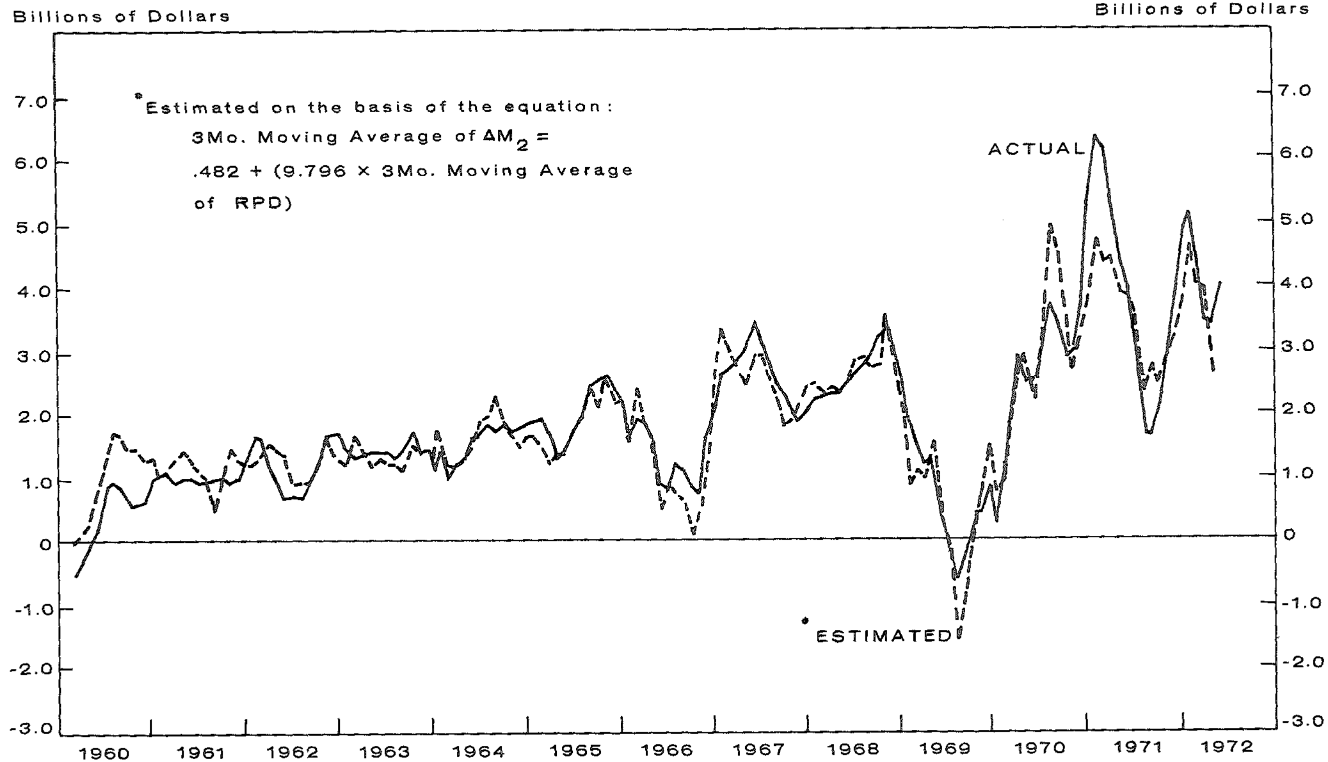


Chart 3

CHANGE IN M_2: 3-MO. MOVING AVERAGE, ACTUAL & ESTIMATED



DISCUSSION

DEANE C. CARSON*

I am pleased to be here this morning to discuss Frank Morris' thoughtful paper on monetary aggregates. Since Frank is also wearing the hat of host to this conference, I would first like to express my appreciation for the contributions that these meetings have had over the past several years. The various Conference Reports have constituted a valuable addition to the literature of monetary economics, and those of us who have used them in our classes and otherwise congratulate you, Frank, for giving this new and significant direction to the research program of the Boston Federal Reserve Bank.

Frank Morris' avowal that he is a non-monetarist, neo-Keynesian advocate of reserve-aggregate targets reminds me of an incident that occurred approximately eight years ago today when a conference similar to this one was scheduled for Lafayette, Indiana. The sponsor of the conference had chartered two planes to deliver the participants from O'Hare in Chicago to the meeting and it just so happened that all of the neo-Keynesians (except one) were aboard one plane and all the monetarists on the other. As the "monetarist" plane flew over the hot fields of Indiana, it began to pitch and yaw, giving both discomfort and apprehension to its passengers. After a few moments of this, Karl Brunner broke the white-knuckle silence with an apparently rhetorical question: "It would be interesting to speculate on what would be the impact on the future of monetary economics if this plane were to crash and kill us all". After a few further moments of silence, the lone neo-Keynesian leaned across the aisle. "Karl," he said, "I have finished my speculation and I want you to know that I'm prepared to make the supreme sacrifice."

Not many of us feel that strongly about the monetary debate, I am sure. Frank Morris has taken a very interesting middleground approach to the policy implications of the monetarist controversy by apparently adopting a monetarist prognosis. He is prepared, for

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reasons with which all monetarists can agree, to argue that monetary aggregates are preferable to money-market conditions as policy targets, but he specifically disassociates himself from the monetarist objective of providing a stable monetary growth path, which he finds to be "economically unpersuasive and politically naive".

With regard to the economics of the question, we have presumably read the same evidence and thus have apparently irreconcilable differences of interpretation, since I find the evidence to be overwhelmingly persuasive in favor of adopting a stable monetary-growth path as the least economically destabilizing monetary policy that the Federal Reserve can adopt.

I do not propose to review this evidence this morning, since that is not the burden of my assignment. Nevertheless, I note that Frank's principal example of a policy mistake, that of 1968, was not *essentially* due to the fact that the Federal Reserve was using money-market conditions as an indicator of the impact of then current policy, but rather to the belief that a much faster rate of growth in the money supply was necessary and desirable to prevent fiscal overkill following the tax increase of that year. This discretionary decision was based, as you will recall, on the mistaken notion that the tax surcharge would have a substantial impact on spending without a significant lag. To compensate for these anticipated effects of the tax increase, the rate of growth of the money stock was accelerated, and this policy led to an acceleration of inflationary forces. The point that I wish to make is that the mere adoption of a reserve-aggregate target is not going to improve things much if the Federal Reserve continues in the future either to initiate or permit wide fluctuations in the money-supply growth rate.

I take Frank Morris' assertion that the adoption of a stable monetary growth path would be politically naive to mean that it would threaten the political independence of the Federal Reserve System. This is a much more compelling argument which monetarists have not been inclined to face. It is a realistic assumption that, *if* nominal interest rates were to fluctuate widely as a result of stable monetary growth, and particularly *if* they were to rise rapidly at times, Congressional wrath and Administration frustration could easily, almost surely, lead to attacks on the System from these sources, and it is extremely doubtful that the authorities could hold fast against them.

Interest Rate Stability

But it is not at all certain that interest rates would behave in an erratic fashion, once the stable monetary growth policy had been in force for a reasonable period of time. Indeed, there are many reasons to believe that such a policy would lead to greater interest-rate stability rather than less, not the least of which is the expectation that it would prevent the kind of price level and business fluctuations that partially account for nominal erratic interest-rate movements. As I interpret the evidence, the rapid increases in nominal rates that were experienced in the 1960s were caused by monetary forces and policies designed to keep interest rates under control and to "protect" the politically-sensitive areas of housing and financial intermediaries that serve the housing market. Moreover, the policies that led to these unfortunate results were based upon a neo-Keynesian theory of money and interest rates, and what I consider the really naive view that "easy money" leads to a lower rate of interest – period. In this light, the Fed has perhaps unwittingly generated the political pressures it so ardently seeks to avoid.

Nevertheless, there is a real case in which the monetary authorities would find that interest rates were rising rapidly even in the face of a stable growth rate of money. This would occur if the expenditures and deficit of the Federal Government were rising very rapidly, placing great pressure on the credit markets. In this case it is likely that Congress and the Administration would blame the rise on the monetary authorities, rather than on themselves, in the best political tradition. Thus, great pressure would be exerted to force the Fed off the stable monetary-growth path, and in precisely the wrong direction.

Turning to the substance of the paper, I note that Frank has taken the view that a reserve-aggregate policy target is preferable to interest-rate targets, and that he does not seem to feel strongly one way or the other with regard to which of several alternative aggregates is actually adopted. My inference in this respect is based upon his frequent use of the generic term "reserve aggregate" in place of the more specific "RPDs". This suggests that he would let the choice of aggregate rest on the evidence as to (1) which aggregate is the most easily controlled by the monetary authorities, and (2) the comparative performance of alternative aggregates with regard to predicting the money supply.

On the first criterion, RPDs are inferior to the Net Source Base, since their precise control depends on the ability of the manager of the Open Market Account to predict the values of Government deposits, interbank deposits, member-bank borrowings, cash holdings of the public and non-member banks, and float, while the information required to track the Net Source Base is derived from the daily accounts of the Federal Reserve and the Treasury. RPDs, thus, are known with less certainty; their required estimate introduces a source of possible errors and difficulty in keeping the reserve aggregate on track.

With regard to the second criterion, a predictable relation between changes in the reserve aggregate and the money supply, Burger's evidence given this morning indicates a slight advantage for the Net Source Base which, when added to the considerations of (1) above, would argue for the latter's adoption by the Federal Reserve. It may turn out in practice, of course, that the difficulties in predicting RPDs are less considerable than the apparent magnitude of the task suggests, in which case there would be little, if any, need for a shift in the target; nevertheless, it does seem reasonable, other things equal, to adopt the target that involves the least amount of estimation.

Control of Rates

Frank has argued that a reserve aggregate would be superior to an interest-rate target in achieving a *desired* path of both the money supply and the interest rate itself. With regard to the latter, this is not crystal-clear, however. If the Federal Reserve knows what the desired path of interest rates should be, it would seem that the authorities could *directly* control the path of interest rates by open-market operations designed to peg the rate at the desired level, a policy that does not require the estimation of the required level of RPDs or any other reserve aggregate. Indeed, if the Fed follows the above strategy it cannot simultaneously choose the path of the reserve aggregate and the money supply. Frank partially clarifies this point in suggesting that by giving attention to the reserve aggregates the Fed will be forced to make an "assessment of the quantitative trade-off between interest rates and reserve growth". If this can be taken to mean that the trade-offs between interest rates and the *money supply* are more clearly assessed, his point is well taken. Nevertheless, when the Fed was clearly emphasizing money-market conditions in the 1960s, it was also clearly not unconscious of the money-supply effects of its policies. This suggests that it is even more important to make a wise assessment of the trade-offs than to adopt the correct target.

Both papers this morning give evidence that the control of reserve aggregates can achieve a reasonable degree of control of the money supply. The Federal Reserve Board staff has additional evidence that there is a predictable relationship between the Federal funds rate and the money stock. Thus, the ability to control the money supply seems to be widely agreed to and may properly be considered an issue that is no longer controversial. Our attention can now be focussed on the more important issues of how the Fed will use this power and under what circumstances money-supply control will be abandoned in favor of achieving interest-rate objectives. Frank's paper sheds little light on this question. Aside from several references to the possibility that such circumstances will arise, as well as to the considerable distance between Boston and St. Louis, the paper does not provide us with either clues or guideposts in this regard. Whether this is due to natural central-banker reticence or to the fact that the Fed has not yet developed these guideposts in its own deliberations is an important question, but not one that will likely be answered today.

In this regard, one suspects, as an outsider, that the shift to a reserve-aggregate target is more a change in emphasis than a clear indication that the monetarist view has infected the Federal Reserve body. And while we might expect that the shift will tend to bring about somewhat greater stability in the rate of growth of the money supply, Frank's Keynesianism and pragmatism, which seem to be the norm for the present authorities, would indicate that interest-rate control is far from being abandoned. The test of Federal Reserve intentions should come in 1973, when rising aggregate demand, resumption of accelerating inflation, and a huge Federal deficit will conspire to bring about a sharp rise in interest rates, if the current forecasts are correct.

Structural Changes

In his next to concluding remarks, Frank has enumerated several structural changes that would improve the Fed's control over M_1. In general, these involve measures that would tend to reduce the potential instability of the money multiplier – the link between reserves and the supply of M_1. These changes are widely recognized as desirable by economists of several schools. One should note that recently-proposed changes in reserve-requirement regulation seem to work at cross-purposes in this regard. On the one hand the Fed proposes to make size rather than location the means of discriminating among banks, while on the other the Fed has imposed reserve requirements on non-deposit sources of funds. The latter is a retrogressive step, while the former is an ambiguous one. It is perhaps too early to tell what effect the substitution of size for geographical location as the criterion for reserve-requirement discrimination will have on the stability of the reserve multiplier; it is also unclear what effect this will have on arresting the decline in Federal Reserve membership.

In the latter regard, my proposal to abolish reserve requirements would almost certainly increase the instability of the multiplier and make control of the money supply more difficult. This cost must be weighed against the costs of inefficient bank portfolios that reserve requirements impose. As a possible compromise one might advocate uniform reserve requirements for all banks at a low level, say 7 percent of demand deposits. This would remove the reserve requirement differential as a source of instability, require a smaller monetary base, and improve the efficiency of bank portfolios.

I am delighted to note that this paper does not dwell inordinately on the alleged and real horrors that the Fed faces in measuring the money supply. It seems to me that, with all of the resources that the Fed has at its disposal, much more accuracy could be achieved. Why for example, has the Fed not pushed harder for uniform reporting by all banks? Why, moreover, are banks allowed to get away with their reporting errors? And why should there be any ambiguity about the "M_1-ness" of Massachusetts savings deposits subject to checking simply because the Massachusetts Supreme Court has declared them to be legally distinguishable from demand deposits? Frank has correctly concluded that the concept of money should be determined on economic grounds.

In conclusion, while I welcome this paper as a strong argument for reserve aggregates as the target of monetary control, I am apprehensive about many of its details. I find myself as much in the dark about the intermediate goals of monetary policy now as I was before I read the paper. In this regard, Dr. Morris, you have carried on one of the great traditions of central banking.

Nevertheless, I find the analysis of the technical superiority of reserve aggregates over money-market conditions one of great insight and remarkable clarity. Moreover, your paper demonstrates (with a few exceptions) a laudable willingness to accept evidence even in conflict with ideology, from which a lesson should be apparent to us all. On that basis, I hope someday to have you join me in BARK, which is the acronym for the Benevolent Association of Recycled Keynesians.

Money Stock Control

ALBERT E. BURGER*

The Federal Reserve stated in 1960, when it began publishing a separate and distinct money stock series, that:

> The amount of money in existence and changes in this amount influence the course of economic developments. . . .
> The Federal Reserve System has primary responsibility for regulating the total volume of money available to meet the public's demands.[1]

Over the next 10 years a major controversy developed over whether the Federal Reserve recognized or placed enough emphasis on its responsibility for controlling the growth of the money stock. The related question of which operating strategy to follow in controlling the money stock was pushed to the background.

Economists can argue at great lengths over the extent to which the Federal Reserve tried to control money in the past. However, one thing is clear: since early 1970, the Federal Open Market Committee (FOMC) has moved in several stages to a position of placing more emphasis on controlling the money stock, relative to other objectives, than had previously been the case. Along with this move, there have been increased scrutiny of the current operating strategy and an analysis of the problems involved in controlling growth rates of monetary aggregates.

In the spring of 1969 Chairman Martin appointed a subcommittee within the Federal Reserve under the leadership of Governor Sherman Maisel to study means of improving open market operations. The Maisel Committee focused on the problem that, if money market conditions are the primary target of open market operations, then the FOMC has no clear and definite way of giving instructions to the Manager of the System Open Market Account. The Committee's primary concern was more with improving the performance

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[1]"A New Measure of the Money Supply," Federal Reserve *Bulletin* (October 1960), p. 1102.

of open market operations to accomplish the FOMC's goals, rather than with the technical aspects of open market operations.[2] One of these studies, "Short-Run Targets for Open Market Operations," prepared by Richard G. Davis, dealt primarily with the short-run operating procedures. The series of studies prepared for the Maisel Committee was published by the Federal Reserve in 1971.[3] Since that time there has been considerable additional research and discussion within the Federal Reserve System on the problem of controlling monetary aggregates.

In this paper, the control of one monetary aggregate, the money stock, is considered. It is assumed that the Federal Open Market Committee has chosen a growth path for the money stock it expects to be consistent with its policy objectives for output, employment, and prices. All the problems relating to how the growth path was chosen are ignored. The control problem is to use open market operations to achieve that growth path for money. This involves predicting the effects of open market operations on the money stock. Because of information lags and random weekly fluctuations in money, the Federal Reserve does not aim open market operations directly at the money stock, but picks an operating target intermediate between open market operations and the money stock. The two main candidates for this operating target have been the Federal funds rate and some reserve aggregate.

A general reserve aggregate-multiplier approach is used to derive a control procedure the FOMC could use to achieve a desired growth path for money. The connecting link between the reserve aggregate, be it total reserves, nonborrowed reserves, the monetary base, or some variant of these, and the money stock is called a multiplier. The money stock control procedure involves predicting the effect on the money stock of setting the reserve aggregate at a given value. The form of the control procedure developed in this article is quite general and could also be applied to the problem of controlling other aggregates such as M_2 or bank credit.

This is not the only approach that could be taken to the problem of controlling the money stock. Other economists within the Federal Reserve have attacked the problem from a different approach. The

[2] Andrew F. Brimmer, "The Political Economy of Money: Evolution and Impact of Monetarism in the Federal Reserve System," *American Economic Review* (May 1972), p. 350.

[3] *Open Market Policies and Operating Procedures – Staff Studies* (Washington, D.C.: Board of Governors of the Federal Reserve System, 1971).

method developed in this paper, however, provides a framework within which several aspects of money stock control can be analyzed, and perhaps, most importantly, provides a minimum standard of control against which other proposed methods can be compared.[4]

The determination of the money stock is summarized in a multiplier-base expression of the following form:[5]

$$M_1 = mB$$

where "M_1" is the money stock (demand deposits plus currency held by the nonbank public), "B" is the net source base, and "m" is the money multiplier. The net source base (B) can be controlled by Federal Reserve open market operations. Sometimes this base concept is referred to as the nonborrowed base to denote that member bank borrowings are excluded. *The net source base is taken as the control variable in the procedure set forth in this article.* In its day-to-day operations this would be the variable toward which the Desk would primarily direct its open market operations.[6] It is assumed that, using open market operations, the Desk can set the net source base at the value it desires for a monthly period.

On a daily basis, the Federal Reserve has information on the value of the previous day's net source base. This information comes from totaling the sources of the base, as shown in Table I. Special care

[4]James Pierce and Thomas Thomson have also studied the problem, with their monthly money market model using the Federal funds rate as the control variable. Richard Davis has used a reduced form relationship that takes the demand deposit component of the money stock as the variable to be explained. His reduced form equation includes nonborrowed reserves (or alternatively the Federal funds rate), business sales, Government deposits and a variable to capture the effects of Regulation Q. See James L. Pierce and Thomas D. Thomson, "Some Issues in Controlling the Stock of Money," pp. 115-136 in this volume.

[5]The specific procedure presented in this paper is designed within the framework of a non-linear money supply hypothesis developed by Karl Brunner and Allan Meltzer:

$$m = \frac{1+k}{(r-b)(1+t+d)+k}$$

where k, t, and d, respectively, are the ratios of currency held by the public, time deposits, and U.S. Government demand deposits at commercial banks to the demand deposit component of the money stock.

The variables r and b, respectively, are the ratios of bank reserves and member bank borrowings to commercial bank deposit liabilities (excluding interbank deposits). See Karl Brunner and Allan H. Meltzer, "Liquidity Traps for Money, Bank Credit, and Interest Rates," *Journal of Political Economy* (January/February 1968), pp. 1-37, and Albert E. Burger, *The Money Supply Process* (Belmont, California: Wadsworth, 1971).

[6]The Manager of the System Open Market Account may be referred to as the "Account Manager" or the "Desk," meaning the Trading Desk of the New York Federal Reserve Bank.

TABLE I

SOURCES AND USES OF THE NET SOURCE BASE, THE SOURCE BASE, AND THE MONETARY BASE, JANUARY 1970*

(millions of dollars)

Sources

Federal Reserve holdings of Government securities	$56,346
Federal Reserve float	3,442
Gold stock plus special drawing rights	11,296
Treasury currency outstanding	6,856
Other Federal Reserve assets	2,114
Less:	
Treasury cash holdings	655
Treasury deposits at Federal Reserve Banks	1,206
Foreign deposits at Federal Reserve Banks	170
Other deposits at Federal Reserve plus Federal Reserve liabilities and capital	2,686
Equals:	
NET SOURCE BASE	$75,337
Plus:	
Federal Reserve discounts and advances	965
Equals:	
Source base	$76,302
Plus:	
Reserve adjustment	3,172
Equals:	
Monetary base	$79,474

Uses

Member bank deposits at Federal Reserve Banks less discounts and advances	$22,615
Currency held by banks	6,622
Currency held by the public	46,100
Equals:	
NET SOURCE BASE	$75,337
Plus:	
Federal Reserve discounts and advances	965
Equals:	
Source base	$76,302
Plus:	
Reserve adjustment	3,172
Equals:	
Monetary base	$79,474

*Data are not seasonally adjusted.

should be taken to distinguish between the sources and uses of the base. To get its bearings on the base, the Desk does not have to estimate excess reserves and currency. This would be the case only if the Manager of the System Open Market Account had to rely solely on information about the uses of the base. By collecting the data on the sources of the base, which come from the books of the Federal Reserve and the Treasury, a closer estimate can be obtained on a short-run basis.

The money multiplier (m) is the connecting link between the net source base and money stock. Changes in the multiplier reflect portfolio decisions by banks and the public, Treasury actions, and Federal Reserve policy actions such as changes in reserve requirements and the discount rate. The multiplier is not constant. Therefore, under this proposed procedure, the Federal Reserve must estimate the multiplier to determine how much base to supply to achieve a desired path for the money stock.

Forecasting the Money Multiplier

The procedure used to forecast the money multiplier was set up to require a minimum amount of forecasted information. If some of the inputs into the multiplier forecasting process must be predicted, additional sources of error are added. The procedure used in this paper takes as inputs only those variables that the Federal Reserve could be assumed to know without error. In essence, this is a very mechanical method that does not attempt to incorporate any information the Federal Reserve might have about expected movements of key factors such as Treasury deposits in the forecast month. Therefore, the results of the procedure should not be viewed as an indication of the best control the Federal Reserve could attain. Instead, they provide a standard against which other procedures could be evaluated. Any alternative procedure should be able to perform at least as well as this simple, mechanical method.

A not seasonally adjusted M_1 multiplier is forecast. The regression equation used to forecast the money multiplier uses the lagged 3-month moving average of past values of the multiplier $(m_{t-1} + m_{t-2} + m_{t-3})/3$, the lagged percentage change in the market yield on 3-month Treasury bills $[TB_{t-1} - TB_{t-2}]/TB_{t-2}$, and seasonal dummy variables.

The coefficients used to forecast each month's multiplier are estimated by least squares using the previous 36 months' observations. Each month the coefficients are re-estimated by adding the most recent month and dropping the first month of the previous 36 observations. In making the forecasts ρu_{t-1} term is added, where u_{t-1} is the lagged value of the error in the estimate of the money multiplier and ρ is the correlation coefficient for consecutive error terms in the equation during the sample period.[7] This procedure is an extension of the procedure used in an article co-authored with Lionel Kalish and Christopher Babb.[8] The major modification is to remove the reserve adjustment magnitude and include the lagged percentage change in the Treasury bill rate.

Variables that may have an important influence on the value of the multiplier are excluded by the criterion used to restrict the set of eligible regressors. The influences of these variables are impounded in the error term, and the question may arise as to whether their exclusion is likely to seriously bias the estimated coefficients of the included variables. One important excluded effect is contemporaneous changes in interest rates. The method for forecasting the money multiplier takes into account only the lagged effects of changes in interest rates on the multiplier. Open market operations in the current month influence interest rates in the current month, and this impact effect on the multiplier is not included in the forecasting procedure. If the impact or current month interest rate effects of open market operations on the multiplier are substantial, then an improvement in forecasting might result from including projections of interest rates in the forecasted month. However, since these impact interest rate effects on the money multiplier appear to be small, and projecting interest rates involves an unknown error, only lagged interest rate effects were included.[9]

[7] Rho is estimated as $1-\frac{DW}{2}$, where DW is the Durbin-Watson statistic. The absolute mean value of ρ over the 1964-71 period was .47, no value of ρ exceeds .75 and only 27 of the 96 values of ρ exceed .60.

[8] Albert E. Burger, Lionel Kalish III and Christopher T. Babb, "Money Stock Control and Its Implications for Monetary Policy," Federal Reserve Bank of St. Louis *Review* (October 1971), pp. 6-22, available as Reprint # 72.

[9] Robert H. Rasche has surveyed the empirical evidence on interest sensitivity of the money multiplier, beginning with studies by Teigen, DeLeeuw, Goldfeld and Kane, and Brunner and Meltzer and ending with recent evidence provided by the Federal Reserve—M.I.T.—Pennsylvania econometric model and a financial market model by Thomson and Pierce. Rasche concludes that the accumulated empirical evidence indicates that the interest elasticity of the money supply relationship during the sample period of these studies appears to be extremely low, with the impact elasticity in the range of 0.10 to 0.15. Hence the short-run feedback effects through interest rate changes which would be generated by policy changes in reserve aggregates are weak and should cause little difficulty for controlling the money stock through control of a reserve aggregate. See Robert H. Rasche, "A Review of Empirical Studies of the Money Supply Mechanism," Federal Reserve Bank of St. Louis *Review* (July 1972), pp. 11-19.

Two other effects are changes in Treasury deposits in the current month and reserve requirement changes. Changes in Treasury balances are primarily determined by current tax receipts and expenditures of the Government and are probably uncorrelated with the regressors used to estimate the multiplier. Reserve requirement changes are infrequent and it is unlikely there is significant correlation between them and the regressors. One excluded variable that could bias the coefficients is Regulation Q ceiling rates. There could be a sizeable correlation between a variable capturing the effect of Regulation Q and the lagged 3-month average of the multiplier when the ceiling rate is effective. The basic problem is the appropriate means of specifying the effect of Regulation Q. A varied selection of candidates was tried in the research for this paper, but at present no satisfactory proxy has been developed.

Simulating the Control Procedure

The results of simulating this procedure over the 8-year period 1964-71 are presented in Table V at the end of the article. Since no forecasting errors are involved in the independent variables, the results of these simulations indicate how well the procedure would have worked over the 1964-71 period. When comparing these results with results from other methods, care must be taken to determine whether any of the variables used in the alternative procedures must be forecast. For example, an alternative which stresses the demand for money might include income or some proxy such as business sales in the forecasting period as an independent variable. If simulations of this type of procedure use actual values for income or its proxy, the errors will be biased downward to the extent that forecasting errors for income have not been taken into consideration.

The results in Table V were generated in the following manner: the forecasted not seasonally adjusted money multiplier was multiplied by the actual not seasonally adjusted net source base to obtain not seasonally adjusted money (NSAM).[10] Then NSAM was multiplied by the implicit seasonal factor for that month to obtain the

[10]In the previous article, Burger, Kalish, Babb, "Money Stock Control and Its Implications for Monetary Policy," a desired growth path for M_1 was chosen. Then, the money multiplier was forecast and the net source base was set to achieve the desired M_1. The controlled M_1 was computed by multiplying the actual (historical) multiplier by the controlled value of the net source base. Errors were computed by comparing controlled and desired M_1. In this article the net source base is set at its actual (historical) values. The money stock the FOMC would have expected, given the forecasts of the money multiplier, is computed by multiplying the forecasted multiplier by the actual net source base. Errors are computed by comparing this projected value of M_1 with actual (historical) M_1.

seasonally adjusted money stock. The regression equation used to forecast the multiplier was estimated using not seasonally adjusted data, and the implicit seasonal factor was computed by dividing actual seasonally adjusted money by actual not seasonally adjusted money. There is a different regression equation used to obtain the coefficients to forecast each month, hence, 96 regression equations. Therefore, the results of these equations are not reported. The results for January 1970 are reported in Table II to illustrate the procedure and to aid in reproducing the results.[11]

The example in Table II may be analyzed in the following manner. Using the forecasting procedure, the Federal Reserve would have forecast the January 1970 money multiplier to be 2.80095. Hence, if they had set the NSA net source base at $75.337 billion, then they would have expected seasonally adjusted money to equal $205.126 billion. The NSA net source base was $75.337 (see Table I) and actual money was $205.500 billion. Therefore, using this procedure would have resulted in underestimating the effect of their actions by $374 million.

There are several ways of evaluating the simulation results reported in Table V. One approach is to look at the monthly errors and compute the mean square forecasting error, root mean-square forecasting error, and mean and absolute mean forecasting errors. As shown at the end of Table V, the root mean square monthly forecasting error over the whole period is $1.07 billion, the absolute mean percent forecasting error is 0.45 percent.[12] The mean forecasting error is $140 million and the mean percent forecasting error is 0.1 percent, which indicate that the procedure, on average, does not substantially over-or underestimate the money stock associated with a set value of the net source base.

A sharp distinction must be made between forecasting money one month in advance and controlling money. The evaluation of the performance of a money stock control procedure should not be based solely on monthly errors. For example, a half a percent error in one month, converted to an annual rate becomes a 6 percent error.

[11]The mean value of the coefficient on the lagged 3-month moving average of the multiplier is .8867, and is significant in all regressions as indicated by a range of t-values of approximately 5 to 15. The coefficient on the lagged percent change in the Treasury bill rate is generally insignificant in the first 4½ years of the sample period and generally significant in regressions used to estimate coefficients for forecasting the last 3½ years, this final period having a mean value of .1128.

[12]The percent forecasting error for each month is forecasted minus actual money divided by actual multiplied by 100.

TABLE II

EXAMPLE OF THE PROCEDURE USED TO FORECAST THE MONEY STOCK

Period: January 1970

Regression equation based on 36 months ended December 1969: [1]

$$m = 0.79566 + \underset{(5.06)}{0.72002\,MAV} + \underset{(2.70)}{0.11888\,TB} + .00932\,D_j \qquad R^2 = .87 \quad SE = .01170$$

MAV = lagged 3-month moving average of the money multiplier
TB = lagged percent change in Treasury bill rate
D_j = seasonal dummy for January

Data used to forecast January 1970 multiplier:

MAV = 2.77206 = average of October-December, 1969
TB = 0.07873
ρ = 0.4836
ρu_{t-1} = −0.00933

Forecast of the multiplier:

$$2.80095 = 0.79566 + (0.72002)(2.77206) + (0.11888)(0.07873) + 0.00932 - 0.00933$$

Forecast of seasonally adjusted money:

Actual net source base (NSA) for January 1970 = $75.337
Forecasted not seasonally adjusted money = ($75.337) (2.80095) = $211.015

$$\text{Seasonal factor} = \frac{\text{Actual SA Money}}{\text{Actual NSA Money}} = \frac{205.500}{211.400} = 0.97209$$

Forecasted seasonally adjusted money = ($211.015) (0.97209) = $205.126

Forecasted minus actual seasonally adjusted money = $205.126 − $205.500 = $−.374

[1] The equation was estimated by least squares using not seasonally adjusted data. Numbers in parentheses are t-values.

This does not necessarily imply that using this method would result in that magnitude of error over a relevant control period. Errors do not tend to accumulate, and positive errors are offset by negative ones. Computing consecutive 3-month moving averages of forecasted and actual money over the 1964-71 period results in a mean percent error of .07 percent and an absolute mean percent error of .31

percent. A comparison of errors for 3-month moving averages with monthly errors is presented in Figure I. Only 12 percent of the total errors for 3-month moving averages are greater in absolute value than 0.5 percent, compared to 28 percent of the monthly errors. These results also support the conjecture that over a relevant control period this simple control procedure would result in relatively close control over the money stock. In other words, if the desired level of the money stock can be expressed as an average for a 3-month period the procedure should permit its achievement with only small errors.

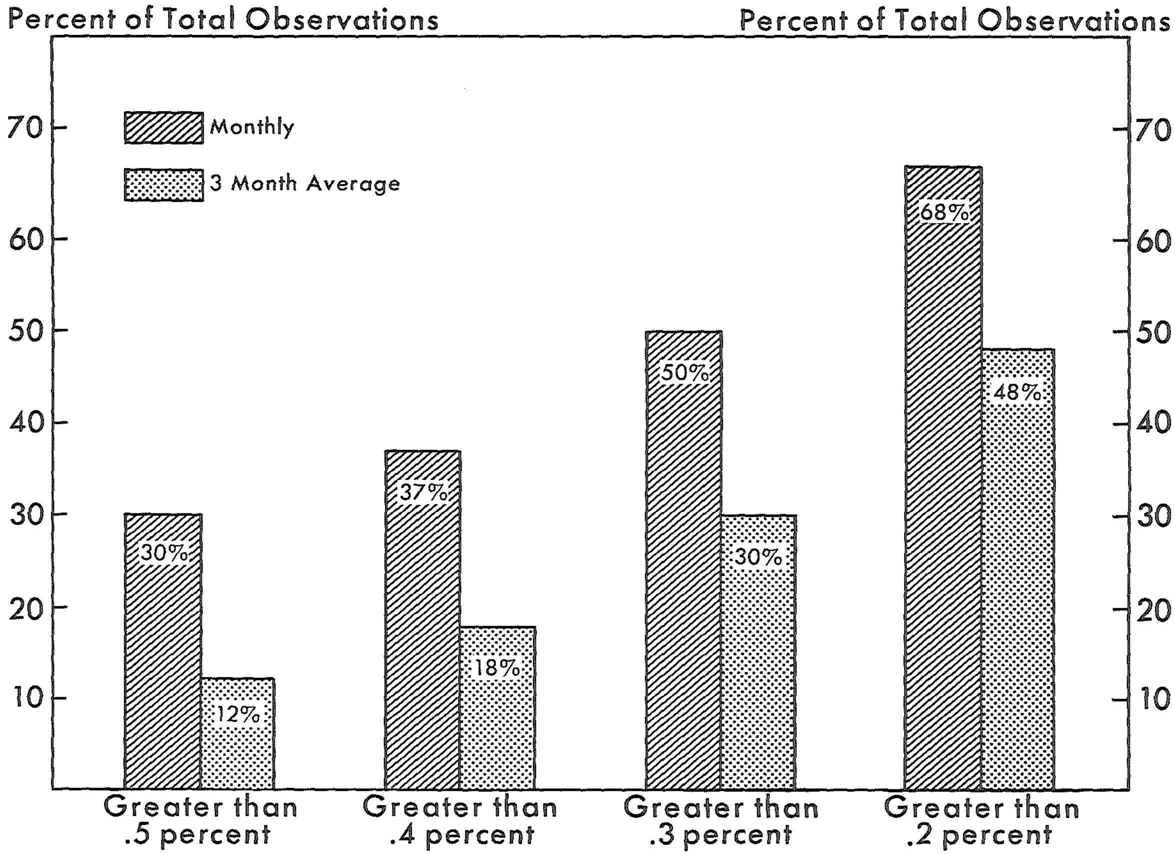
Another means of analyzing the effectiveness of the control procedure is to compare the expected growth rates of the money stock resulting from simulating the control procedure with actual growth rates of the money stock. The simulated monthly values of the money stock are what the FOMC would have expected from setting the net source base at its historical values if it had been using this procedure to forecast the money multiplier.

In this way, an analysis can be made of the effectiveness of the control procedure at times when there were marked reversals in the growth rate of the money stock. During the period 1964-71 there were at least 6 marked changes in the growth rate of the money stock. Table III presents a comparison of actual growth rates of money and the growth rates that the FOMC would have expected if it had been using the control procedure over these periods.

For example, beginning in mid-1966 the growth rate of money slowed markedly. By setting the net source base at its historical values, the FOMC would have expected, given the forecasts of the money multiplier, that the money stock would have grown at a 1.1 percent annual rate from the average of 3 months ended May 1966 to the average of 3 months ended December 1966. The actual growth rate of the money stock over this same period was 0.2 percent. In early 1967 the FOMC moved to a much more expansionary policy. Simulating the control procedure results in an expected growth rate of the money stock of 7.1 percent from the average of 3 months ended December 1966 to the average of 3 months ended January 1969. The actual growth rate of money associated with setting the net source base at its historical values was 7.2 percent over this period.

Figure I

Distribution of Forecasting Errors



Federal Reserve Induced Impediments to Money Stock Control

The 1964-71 period presented an especially difficult period for money stock control. A significant part of this difficulty was introduced by Federal Reserve actions. During this 8-year period there were several major reversals in the direction of the influence of Federal Reserve policy actions on the money stock.[13] In addition, reserve requirements were changed 7 times and lagged reserve requirements were introduced in this period. The Federal Reserve also permitted Regulation Q ceiling rates to frequently restrain banks from responding in a competitive manner to changes in market rates.[14]

The money stock control procedure developed in this article is not designed to capture the *initial* effects of these actions by the Federal Reserve. Because a lagged 3-month moving average of the multiplier is used, a sharp reversal of policy may cause a change in the money multiplier that is not immediately captured by the procedure used to forecast the multiplier. For example, at times of sharp reversals in the growth rate of the money stock relatively larger forecasting errors occur. After mid-1966 the forecasting procedure substantially overestimates the multiplier, and the opposite occurs in early 1967. Also, a similar tendency seems to have been in effect in 1971 as errors tended to be negative in the first half of the year and positive in the second half. The exact size and direction of this effect depends upon a number of factors; however, given the characteristics of the procedure used to forecast the multiplier, it does seem likely that a substantial change in the thrust of open market policy on the money stock will introduce additional problems for accurately predicting the initial influence of open market actions on the money stock.

The results shown in Table III and discussed at the end of the previous section, however, show that the FOMC could quite accurately engineer sharp changes in the growth path of money over a

[13]Policy actions resulted in an acceleration of the base from late 1965 through mid-1966 followed by a deceleration of the base through the end of 1966. This was followed by a renewed acceleration during 1967-68, followed by a deceleration in 1969, then a more rapid growth in 1970. A rapid acceleration in the growth rate of the base over the first half of 1971 again was followed by a rapid deceleration in the second half of 1971.

[14]The secondary market yield on large 6-month CDs exceeded the Regulation Q ceiling rate in the 8-month period from June 1966 through January 1967, the 9-month period from November 1967 through July 1968, and the 24-month period from November 1968 through October 1970.

TABLE III
ACTUAL COMPARED TO EXPECTED RATES OF MONEY GROWTH[1]

Period	Actual Growth Rate of Money[2]	Growth Rate of Money Expected Using the Control Procedure[3]
3 months ended 5/66 to 3 months ended 12/66	0.2%	1.1%
3 months ended 12/66 to 3 months ended 1/69	7.2	7.1
3 months ended 1/69 to 3 months ended 2/70	3.4	3.7
3 months ended 2/70 to 3 months ended 12/70	5.4	5.0
3 months ended 12/70 to 3 months ended 7/71	9.4	9.5
3 months ended 7/71 to 3 months ended 12/71	2.4	3.2

[1]Periods were chosen on the basis of a significant change in the growth rate of the money stock.

[2]Simple annual rates.

[3]Computed by comparing 3-month average of actual money in the initial period to 3-month average of forecasted money in the terminal period.

longer period of time. The same results point out that, in the initial stages of a marked change in the desired growth path of money, the FOMC should not abandon the procedure just because initially it results in larger than average monthly errors. However, given that policymakers are also concerned with the possibility of large movements in short-term interest rates, large monthly errors may make the task of returning to the desired money stock path more difficult. The author conjectures that most methods for predicting the influence of open market operations on the money stock would tend to show relatively larger errors at times when the target growth of money is markedly changed. Again, the point should be emphasized that it is the performance of the procedure over a period of several months that is crucial.

With regard to reserve requirements, there is clear evidence that reserve requirement changes create substantial difficulties for predicting the growth path of money with this technique. The root mean square forecasting error for months when reserve requirements were changed and the following month[15] is about 63 percent larger than for the whole sample period, $1.74 billion compared to $1.07 billion.

If reserve requirements are raised the money multiplier is decreased and hence the money stock resulting from simulating this procedure would be expected to exceed actual money, resulting in positive errors. In July and September 1966 reserve requirements were raised and the period July–October 1966 encompasses some of the largest positive forecasting errors of the sample period. Likewise, large positive forecasting errors occur following the raising of reserve requirements in mid-January 1968 and in mid-April 1969. Several of the largest negative forecasting errors followed lowering of reserve requirements in March 1967 and in October 1970.

Although the exact magnitude of the influence of Regulation Q ceilings is difficult to isolate empirically, it can be conjectured from theoretical analysis that this regulatory policy added to errors in money stock control. For example, as market interest rates rise above Regulation Q ceiling rates, this results in a marked reversal in the growth of time deposits, hence reducing the amount of reserves absorbed by time deposits and therefore influencing the growth of the money stock.

Comparison of RPDs and the Net Source Base as Operating Targets

Prior to 1972, a key element of open market strategy had been use of a configuration of measures of money market conditions as an operating guide for the Manager of the System Open Market Account. At the start of 1972 the Federal Open Market Committee began a series of steps that moved open market operating strategy decidedly closer to a reserve aggregate approach. At the January 11 FOMC meeting, it was decided that:

> In the interest of assuring the provision of reserves needed for adequate growth in monetary aggregates, the Committee decided that in the

[15] Most reserve requirement changes occurred in the middle of a month. Hence, their potential influence carried over to the following month. The dates of reserve requirement changes and the amount of reserves released or absorbed are as follows: July 1966 ($420 million), September 1966 ($445 million), March 1967 (–$850 million), January 1968 ($550 million), April 1969 ($660 million), October 1969 – introduction of a 10 percent marginal reserve requirement on certain foreign borrowings by banks ($400 million), October 1970 (–$500 million).

> period until its next meeting open market operations, while continuing to take appropriate account of conditions in the money market, should be guided more by the course of total reserves than had been customary in the past.[16]

At the February 15 meeting, the FOMC modified its reserve aggregate target from total member bank reserves to reserves available to support private nonbank deposits (RPDs) – defined specifically as total member bank reserves less those required to support Government and net interbank deposits.[17] "This measure was considered preferable to total reserves because short-run fluctuations in Government and interbank deposits are sometimes large and difficult to predict and usually are not of major significance for policy. It was deemed appropriate for System open market operations normally to accommodate such changes in Government and interbank deposits."[18]

The move toward guiding open market operations more by an RPD target than an interest rate target is a major constructive development, especially to those individuals who emphasize the System's role in controlling the growth of the money stock. However, RPDs are only one among several reserve aggregates that might serve the same purpose. In choosing a reserve aggregate as an operating target for controlling money it seems desirable to pick one that (1) has the most predictable relationships to money stock and (2) is easiest for the Desk to track in its day-to-day operations. The first criterion concerns picking the target path for the reserve aggregate. The second criterion concerns how well the Desk can stay on that path.[19]

[16] "Record of Policy Actions of the Federal Open Market Committee," Federal Reserve *Bulletin* (April 1972), p. 394.

[17] Deposits subject to reserve requirements include all time and savings deposits, and net demand deposits which are defined as total demand deposits less cash items in process of collection and demand balances due from domestic commercial banks. Net interbank demand deposits include all demand deposits due to domestic and foreign commercial banks and due to mutual savings banks, less demand balances due from domestic commercial banks. In the April 1972 revision of the reserve series, net interbank deposits were revised to reflect the netting of a portion of cash items in process of collection against interbank deposits. Formerly, all cash items were netted against other private demand deposits.

[18] "Record of Policy Actions of the Federal Open Market Committee," Federal Reserve *Bulletin* (May 1972), p. 459.

[19] See Charlotte E. Ruebling, "RPDs and Other Reserve Operating Targets," Federal Reserve Bank of St. Louis *Review* (August 1972), pp. 2–7.

Choosing the Growth Path for an Operating Target — Although the Federal Reserve has not made public the method used in selecting the RPD path, there are at least two ways this path could be chosen. One approach would be to predict the RPD-money stock multiplier, a procedure very similar to the one discussed in this paper. The simulation of this money stock control procedure was repeated wherein an RPD-money multiplier was predicted in the same manner as a base-money multiplier. Not seasonally adjusted RPDs were used as the control variable instead of not seasonally adjusted net source base. The results with RPDs were substantially worse. For example, the root mean square forecasting error for money over the 1964-71 period was \$1.60 billion using RPDs, compared to \$1.07 billion with the net source base as the control variable.[20]

An alternative procedure stresses that RPDs are reserves used to support private member bank deposits, one component of which, member bank private demand deposits, is a part of the money stock. This alternative first takes a projected value for GNP over the forecasting horizon. It then assumes that the effect of alternative growth rates of money on financial conditions could be worked out without any effects on GNP during the forecasting period. A relationship between M_1 and interest rates is then developed, and this relationship, along with other factors, is used to project a pattern of member bank time, demand, government, and interbank deposits.[21] From these results a growth path for RPDs could then be developed.

RPDs can be expressed:

$$\text{RPDs} = \text{TR} - \text{r}D^G - \text{r}D^{IB} = \text{rD} + r^tT + \text{ER}$$

where TR = total member bank reserves

D^G = member bank U.S. Government demand deposits

D^{IB} = member bank net interbank demand deposits

[20] The root mean square forecasting error and absolute mean forecasting error respectively using not seasonally adjusted RPDs as the control variable for selected periods are: 1964-71 (\$1.60, \$1.16), 1966-71 (\$3.30, \$1.39), 1969-71 (\$3.45, \$1.44), 1970-71 (\$2.13, \$1.20). These results may be compared to the results reported at the end of Table V.

[21] For a discussion of this type of procedure see Stephen H. Axilrod and Darwin L. Beck, "Role of Projections and Data Evaluation with Monetary Aggregates as Policy Targets," in this volume.

D = member bank private demand deposits

T = member bank time deposits

ER = excess reserves

r = reserve requirement against D^G, D, D^{IB}

r^t = reserve requirement against time deposits

Therefore, to select a path for RPDs consistent with the member bank demand deposit component of the money stock (D), which, given the projected paths of the currency and nonmember bank deposit components of the money stock, would result in the desired money stock growth, requires that the Federal Reserve estimate the path of time deposits (T) and member bank excess reserves (ER). At present there is no means to evaluate how accurately the Federal Reserve can make forecasts of the currency, nonmember bank deposit component of the money stock, member bank time deposits and excess reserves.

Predicting the relationship between any reserve aggregate and the money stock involves explicitly or implicitly predicting a multiplier relationship. Therefore, some evidence on the stability of the overall relationship between RPDs, other reserve aggregates and money can be obtained by comparing the stability of the multiplier relationships. In Table IV regressions using the appropriate reserve aggregate multiplier as the dependent variable and the 3-month moving average of past values of the multiplier and the lagged percent change in the Treasury bill rate as independent variables are presented. Since RPDs, nonborrowed reserves, and total reserves include only member bank reserves and exclude currency, these multipliers were computed on the basis of the member bank deposit component of the money stock.[22] The base-money multipliers were computed on the basis of the total money stock.

All equations were run with seasonally adjusted data. The dependent variables in the regression equations are not the same, hence the R^2 cannot be used to compare the relative performance of the equations. Therefore, the coefficient of variation – the ratio of the

[22]Other private member bank demand deposits were used for the member bank component of the money stock. Other private member bank demand deposits are defined as member bank demand deposits subject to reserve requirements less member bank demand deposits due to the U.S. Government and net interbank demand deposits.

TABLE IV

COMPARISON OF THE PREDICTABILITY OF RESERVE AGGREGATE MULTIPLIERS: MONTHLY DATA 1966–1971*

Multiplier	Equation	Statistics	Coefficient of Variation
Demand Deposits/RPD:	0.32393 + 0.93034 MAV + 0.01002 TB (25.18) (.13)	R^2 = .90 SE = .04141 mean = 4.846	.00855
Demand Deposits/ Nonborrowed Reserves:	0.36433 + 0.91707 MAV + 0.20899 TB (18.51) (2.26)	R^2 = .84 SE = .04977 mean = 4.542	.01096
Demand Deposits/ Total Member Bank Reserves:	0.46849 + 0.89213 MAV + 0.03163 TB (17.39) (.36)	R^2 = .81 SE = .04753 mean = 4.436	.01071
M_1/Net Source Base:	0.23630 + 0.91301 MAV + 0.08248 TB (20.55) (3.16)	R^2 = .87 SE = .01367 mean = 2.762	.00495
M_1/Source Base:	0.28572 + 0.89438 MAV + 0.04446 TB (18.25) (1.66)	R^2 = .84 SE = .01393 mean = 2.738	.00509
M_1/Monetary Base:	0.28481 + 0.88936 MAV + 0.06311 TB (14.66) (3.42)	R^2 = .77 SE = .00996 mean = 2.582	.00386

*Demand deposits used in the reserve multipliers are the member bank demand deposit component of the money stock. All seasonally adjusted data are used. Numbers in parentheses are t-values. TB is the lagged percent change in the Treasury bill rate, MAV is the lagged 3-month moving average of the multiplier. The coefficient of variation was computed by dividing the standard error by the mean of the dependent variable.

TABLE V

RESULTS OF SIMULATING THE MONEY STOCK CONTROL PROCEDURE 1964–1971

Date		Forecasted NSA Multiplier	Actual NSA Multiplier	Forecasted SA Money	Actual SA Money	Forecasted Minus Actual	Percent Forecasting Error[1]
				(billions of dollars)			
1964	J	2.949	2.943	$154.409	$154.100	$.309	0.2%
	F	2.924	2.906	155.470	154.500	.970	0.6
	M	2.885	2.871	155.772	155.000	.772	0.5
	A	2.906	2.896	155.714	155.200	.514	0.3
	M	2.851	2.836	156.708	155.900	.808	0.5
	J	2.835	2.823	157.055	156.400	.655	0.4
	J	2.816	2.832	156.573	157.500	–.927	–0.6
	A	2.828	2.834	158.072	158.400	–.328	–0.2
	S	2.850	2.850	159.096	159.100	–.004	0
	O	2.873	2.871	159.851	159.700	.151	0.1
	N	2.896	2.873	161.573	160.300	1.273	0.8
	D	2.885	2.879	160.829	160.500	.329	0.2
1965	J	2.925	2.921	161.113	160.900	.213	0.1
	F	2.888	2.869	162.308	161.200	1.108	0.7
	M	2.848	2.852	161.473	161.700	–.227	–0.1
	A	2.878	2.882	161.759	162.000	–.241	–0.1
	M	2.822	2.807	163.111	162.200	.911	0.6
	J	2.801	2.813	162.403	163.100	–.697	–0.4
	J	2.805	2.805	163.663	163.700	–.037	0
	A	2.802	2.803	164.149	164.200	–.051	0
	S	2.816	2.836	164.001	165.200	–1.199	–0.7
	O	2.847	2.848	166.326	166.400	–.074	0
	N	2.866	2.848	167.919	166.900	1.019	0.6
	D	2.865	2.861	168.217	168.000	.217	0.1
1966	J	2.902	2.903	169.122	169.200	–.078	0
	F	2.861	2.850	170.374	169.700	.674	0.4
	M	2.834	2.850	169.544	170.500	–.956	–0.6
	A	2.866	2.886	170.520	171.700	–1.180	–0.7
	M	2.813	2.805	172.023	171.500	.523	0.3
	J	2.812	2.819	171.245	171.700	–.455	–0.3
	J	2.814	2.763	174.146	171.000	3.146	1.8
	A	2.802	2.765	173.405	171.100	2.305	1.3
	S	2.804	2.779	173.421	171.900	1.521	0.9
	O	2.792	2.778	172.215	171.400	.815	0.5
	N	2.807	2.769	173.502	171.200	2.302	1.3
	D	2.774	2.782	171.210	171.700	–.490	–0.3
1967	J	2.816	2.785	173.290	171.400	1.890	1.1
	F	2.727	2.734	172.748	173.200	–.452	–0.3
	M	2.703	2.753	171.626	174.800	–3.174	–1.8
	A	2.745	2.774	172.289	174.100	–1.811	–1.0
	M	2.687	2.726	173.301	175.800	–2.499	–1.4
	J	2.718	2.753	175.085	177.300	–2.215	–1.2
	J	2.717	2.741	177.084	178.700	–1.616	–0.9
	A	2.738	2.746	179.222	179.800	–.578	–0.3
	S	2.772	2.763	181.488	180.900	.588	0.3
	O	2.779	2.771	182.198	181.700	.498	0.3
	N	2.777	2.774	182.593	182.400	.193	0.1
	D	2.790	2.793	182.872	183.100	–.228	–0.1

TABLE V (cont'd)

Date		Forecasted NSA Multiplier	Actual NSA Multiplier	Forecasted SA Money (billions of dollars)	Actual SA Money (billions of dollars)	Forecasted Minus Actual (billions of dollars)	Percent Forecasting Error[1]
1968	J	2.826	2.811	$184.870	$183.900	$ .970	0.5%
	F	2.767	2.746	186.351	184.900	1.451	0.8
	M	2.757	2.755	186.003	185.900	.103	0.1
	A	2.787	2.794	186.089	186.600	–.511	–0.3
	M	2.725	2.749	186.888	188.500	–1.612	–0.9
	J	2.764	2.766	189.922	190.100	–.178	–0.1
	J	2.737	2.752	190.322	191.400	–1.078	–0.6
	A	2.746	2.740	192.960	192.500	.460	0.2
	S	2.769	2.764	193.727	193.400	.327	0.2
	O	2.779	2.762	195.518	194.300	1.218	0.6
	N	2.771	2.781	195.289	196.000	–.711	–0.4
	D	2.797	2.812	196.383	197.400	–1.017	–0.5
1969	J	2.841	2.833	198.937	198.400	.537	0.3
	F	2.783	2.784	199.432	199.500	–.068	0
	M	2.797	2.802	199.909	200.300	–.391	–0.2
	A	2.832	2.834	200.867	201.000	–.133	–0.1
	M	2.783	2.749	203.870	201.400	2.470	1.2
	J	2.776	2.783	201.692	202.200	–.508	–0.3
	J	2.767	2.784	201.666	202.900	–1.234	–0.6
	A	2.760	2.753	202.933	202.400	.533	0.3
	S	2.774	2.774	202.746	202.700	.046	0
	O	2.773	2.776	203.022	203.200	–.178	–0.1
	N	2.773	2.764	204.133	203.500	.633	0.3
	D	2.794	2.776	204.991	203.700	1.291	0.6
1970	J	2.801	2.806	205.126	205.500	–.374	–0.2
	F	2.745	2.736	205.371	204.700	.671	0.3
	M	2.748	2.757	206.048	206.700	–.652	–0.3
	A	2.787	2.777	209.043	208.300	.743	0.4
	M	2.725	2.715	209.750	209.000	.750	0.4
	J	2.755	2.736	210.799	209.400	1.399	0.7
	J	2.728	2.732	210.027	210.300	–.273	–0.1
	A	2.709	2.700	212.295	211.600	.695	0.3
	S	2.734	2.709	214.761	212.800	1.961	0.9
	O	2.714	2.725	212.179	213.100	–.921	–0.4
	N	2.722	2.732	212.852	213.600	–.748	–0.4
	D	2.741	2.744	214.553	214.800	–.247	–0.1
1971	J	2.765	2.741	217.184	215.300	1.884	0.9
	F	2.687	2.690	217.425	217.700	–.275	–0.1
	M	2.696	2.705	218.929	219.700	–.771	–0.4
	A	2.730	2.732	221.044	221.200	–.156	–0.1
	M	2.690	2.679	224.688	223.800	.888	0.4
	J	2.705	2.718	224.401	225.500	–1.099	–0.5
	J	2.722	2.714	228.057	227.400	.657	0.3
	A	2.699	2.703	227.683	228.000	–.317	–0.1
	S	2.707	2.697	228.426	227.600	.826	0.4
	O	2.711	2.699	228.705	227.700	1.005	0.4
	N	2.710	2.700	228.505	227.700	.805	0.4
	D	2.720	2.715	228.624	228.200	.424	0.2

[1] Forecasted minus actual ÷ actual x 100.

TABLE V (cont'd)

SUMMARY RESULTS

	1964	1965	1966	1967	1968	1969	1970	1971
Mean Square Forecasting Error	$.4747	$.4359	$2.2479	$2.6592	$.8710	$.8942	$.8299	$.7744
Root Mean Square Forecasting Error	.6890	.6602	1.4993	1.6307	.9333	.9456	.9110	.8800

SUMMARY RESULTS FOR SELECTED PERIODS

Levels	1964-1971	1966-1971	1969-1971	1970-1971
Mean Square Forecasting Error	$1.1483	$1.3795	$.8328	$.8021
Root Mean Square Forecasting Error	1.0716	1.1745	.9126	.8956
Mean Error	.1404	.1114	.2743	.2865
Absolute Mean Error	.8273	.9220	.7379	.7725

Percent Forecasting Error	1964-1971	1966-1971	1969-1971	1970-1971
Mean Error	.0760%	.0514%	.1306%	.1375%
Absolute Mean Error	.4469	.4876	.3528	.3625

standard error to the mean of the dependent variable – is reported for each equation. The results in Table IV do not provide any basis for a conjecture that past data provide evidence for a more stable relation between RPDs and money stock than between the net source base and money stock. The coefficients of variation show that the standard error of estimate is much larger relative to the mean of the RPD-member bank demand deposit multiplier than for the net source base-money stock multiplier.[23] Also, using RPDs to control money would require estimating the currency and nonmember bank component of the money stock, which would add additional errors to the process of picking the appropriate RPD path. The t-values on the coefficients of the lagged 3-month moving averages of the multipliers indicates that the net source base-money stock multiplier is approximately as stable relative to its 3-month moving average as the RPD-member bank demand deposit multiplier.

These results are not conclusive evidence on the relative predictability of base-money relationships versus RPD-money relationships. There may exist a method of relative RPDs to money which past evidence indicates would have permitted the Federal Reserve to have more accurately predicted the effect of an RPD target on money than the results in this paper indicate for a base target. Also, there may be other money stock control procedures in which both the net source base and RPDs perform better.

Tracking the Operating Target – The second criterion concerns the information required by the Desk to track its reserve aggregate on a daily basis. RPDs require information that would appear to be considerably more difficult to project than the net source base data. Referring back to the formula for RPDs on page 48, it can be seen that the following have to be estimated to track RPDs: Government demand deposits, interbank demand deposits, member bank borrowings, currency demands of the public and nonmember banks, and float.[24] Referring back to Table I, it can be seen that all the data for

[23]These results are not specific to the 1966-71 period. An analysis of the 1964-71 period and 3-year subperiods within the 1966-71 period show that consistently the coefficient of variation for the RPD multiplier is about twice as great as that for the net source base multiplier.

[24]Richard G. Davis discusses the characteristics of short-run operating targets in "Short-Run Targets for Open Market Operations," *Open Market Policies and Operating Procedures – Staff Studies* (Washington, D.C.: Board of Governors of the Federal Reserve System, 1971) pp. 37-69. He points out additional difficulties that may arise when, in addition to the operating transactions, behavior of factors such as Treasury deposits at commercial banks must be forecast and other factors such as member bank borrowing and excess reserves, which are functionally related to open market operations, must be forecast.

tracking the net source base comes from the daily records of the Federal Reserve and the Treasury. The most troublesome component on a daily basis, which is common both to RPDs and net source base, would be Federal Reserve float.[25]

Conclusions

A simple procedure for determining the effect on the money stock of setting the net source base at a given value was presented. This proposed method was not intended to be the definitive answer to the money stock control problem. It does, however, provide a useful framework within which several aspects of money stock control can be analyzed.

The results of simulating the procedure over an 8-year period suggest that, using a method for forecasting the net source base-money multiplier which relies only on past, known data, the Federal Open Market Committee could exercise close control over the growth of the money stock. The simulation results indicate that errors resulting from using this method to determine the effect on the money stock of setting the net source base at a given value do not tend to accumulate, signifying that use of this procedure would not result in "loss of control over money" for a prolonged period. An analysis of errors for 3-month moving averages and periods of marked shifts in policy support the conclusion that the growth of the money stock could be set at about the rate desired by the Federal Open Market Committee.

[25]Proposed changes in the Federal Reserve's check collection procedures are expected to reduce substantially the average level of Federal Reserve float, from about $3 billion to around $1 billion. The only sizeable component that would remain would be transportation float. One would expect that even this component would be predictable, within limits, by monitoring such factors as weather conditions and rail or truck strikes. For a discussion of this change, see "Recent Regulatory Changes in Reserve Requirements and Check Collection," Federal Reserve *Bulletin* (July 1972), pp. 626-630.

DISCUSSION

JAMES S. DUESENBERRY*

When one comes upon a paper like this, one always has a basic decision to make. This is essentially a statistical exercise, and one must decide whether to go for statistical nit-picking or for the big picture. When I was Mr. Burger's age, I went in enthusiastically for the nit-picking, but as age overcomes me, I become more and more of a big-picture man and more and more vague. I remember John Williams, whom some of you know, made a great reputation for wisdom with one line. Whatever anybody ever said, he always responded, "It's more complicated than that." That will be my message.

Burger's Forecasting Formula

One statistical point, I think, is worth mentioning. Mr. Burger's paper begins with the calculation of a familiar formula about the relationship between M_1 and his net source base. This involves the ratio of currency to demand deposits, the ratio of time deposits to demand deposits, and the average demand deposit reserve ratio. The last ratio turns out, of course, to depend on the member-bank share of deposits and the composition of deposits by class of bank. Finally he has to include the ratio of borrowings to deposits. One rather anticipates, after he has put that formula down, that the procedure for predicting the money supply or the money multiplier will be to analyze the determinants of each one of those ratios and then put them all together. And just a glance at that formula will show that that would be a very, very complicated kind of operation. Instead of

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that, Mr. Burger proceeds with a formula which is much simpler, in which there is very little direct connection between any of those ratios which appear in the multiplier formula and the outcome. We have to think a bit about what exactly he has done here from a statistical point of view. It is, of course, another reduced form. He has created a forecasting formula which is not an attempt to analyze the structure of the underlying system but rather to exploit – I think quite ingeniously – the statistical properties of the underlying world. His formula is one which is arranged so that it can pick up trends in the money multiplier, and do so in such a way that the trend can be stronger or weaker or even, in principle, change direction. I do not know if it ever did change direction in the historical period covered. The trend depends very largely on the difference between the constant term and some number multiplied by the lag multiplier and that difference can be either positive or negative depending on the relative magnitudes of those two variables. So first, he can have a lot of flexibility in reflecting on the trend over the last three years, which helps considerably. Secondly, he has an interest-rate variable and thereby picks up net effects of interest-rate movements on this whole constellation of ratios. For example, the interest rate is presumably associated with the time deposit/demand deposit ratio. Instead of trying to estimate the interest-rate effects on the ratios one at a time and put them back together, he just boils them into a single item. Finally, he has a correction for the fact that there would be error runs if he did not have an auto-regressive corrector. But he includes a term to eliminate that. This means the formula will work to the extent that the structure changes slowly and retains the statistical properties which it had in the past.

I think that is a very ingenious way to put together a practical forecasting formula. One might think that going at it structurally would be better and that is true, in principle. If you know exactly what the right structure is – just which variables come in in just which way, then you would always do better to use the structural approach. But if you make one mistake in specifying that structure, it may turn out that you will do better with this kind of forecasting formula than you would with an apparently more analytical approach. I think it is all to the good and really very important for us to use these approaches in parallel; that is, to get the best dirty forecasting formula that we can, and at the same time to be working on the analytical structure so that we make sure that we have all the relevant variables somewhere represented in that forecast. These are not competitive, but complementary, approaches.

Randomness

Now the real message from this paper is partly about the power of averaging and partly about the statistical properties of the changes in the multiplier. What the paper really says is that the "randomness" in the system partly has serial correlation; a random error in one direction will be there partly the next time and you can take advantage of that. It also says that the random error which is not taken into account in that way is fairly large in terms of one-month observations which when multiplied by 12 may look rather frightening. But the second part of the message is that if you are content to average over six months, or even three months, then even a rather simple prediction formula will produce fairly modest errors.

The significance of that observation, of course, depends on the significance of short-run movements in the monetary variables. You might live in a world where every month's movement was terribly significant and would cause a quick action someplace else; or you might live in a world where the response to changes in monetary variables occurred with some rather long distributed lags so it really did not make any difference whether you had a big number this month and a small one next month. Most of that will wash away. The little experiment in the Pierce paper seems to show that if you take a St. Louis point of view – and some people do – good control over a six-month period will probably yield good enough control over GNP and other economic variables. I think if you performed exactly the same type of experiment with almost any other model – say the FRB-MIT model – you would come out with a very similar result. Almost all models and almost all the underlying series suggest that you can have varying inputs bouncing around from month to month but that will have very little significance as long as you have control over, say, the growth of the three-month average from the fourth quarter to the following second quarter. I think if we were to reach agreement on that, we would conclude that if M_1 is the thing we want to control, then we can probably control it well enough for all practical purposes.

RPDs

That opens up, of course, the question of what we should be controlling, but I will close that up quickly since I don't really want to do all that over again. Also, I am going to come back to it in a slightly different form because the last bit of Mr. Burger's paper is on

RPDs and, I have a few thoughts about RPDs. When I read Mr. Burger's paper, it reminded me of a story about the Frenchman who visited New York. His American guide showed him the various New York phenomena. He showed him the George Washington Bridge and said, "What do you think of that?" And the Frenchman said, "It makes me think of sex." He said, "Why?" The visitor replied, "Everything makes me think of sex." Well, when I read Mr. Burger's paper, it got to RPDs, and it turned out that RPDs made him think of M_1. The point of that is that I don't really think that the argument in favor of using RPDs as the basis for the directive is the efficiency of RPDs as a predictor of M_1. They might, since they are related to net source base and monetary base and so on, be a good predictor, but that is not the basis on which I would have selected them. And I don't think it is the basis on which they were selected.

Multiple Policy Objectives

I think the real argument is in the peculiar flexibility of the RPD formulation. It seems to me it meets two basic facts. One is that multiple objectives of policy are inevitable – for reasons I will come to in a minute – and the second is that you can't really tell the Trading Desk to achieve multiple objectives. If you do, you put a lot of responsibility on the Trading Desk to select the mix of objectives. Now I don't want to spend a lot of time on this, but it does seem to me that it is pretty clear that many people on the FOMC and in and out of the System think that the world is pretty complicated, like John Williams always said, and that it is changing. Policy has to respond to a whole constellation of data coming in and you have to decide what you want to do in the light of some compromise on a great number of variables that have to be considered. You have to give some weight to M_1, M_2, various interest rates, and a lot of other things. If that is the case, you need to try to find a form of instruction to the Desk which will specify how it is to respond to the directive to influence a variety of different objectives.

Secondly, even among those who know there is only one objective, it turns out that each one of them knows a different thing. Some of them know that M_1 is the right thing; some of them know that M_2 is the right thing. Some of them are like the man who took up the cello. He started practicing the cello, and after a while his wife said, "You know, I've been watching you play and since you took this up I've taken an interest and have watched other people play. I've noticed that other people keep moving the bow around in different places, and they move their fingers up and down the board. You keep your fingers in the same place on the finger board, and you keep your bow on the same string all the time. How come?" He responded, "Those other people are looking for the note; I have found it." Well, in our little orchestra, there are several people who have found the notes, but different ones. It produces a certain amount of dissonance. So I think that the real beauty of the RPD formula is that each member can make his own compromise. That is, for any given value of the RPD directive, he can ask himself, "What constellation of M_1, M_2, bill rate, and what-not will emerge?", apply his own weights to those and make his own compromise as to what he thinks would be the best value for that controllable variable. The other fellows can do the same. Then they have to compromise with one another. But then what the desk gets is a fairly definite instruction rather than one telling it that it somehow has to compromise between several different, conflicting – and possibly inconsistent – objectives. I think that is a very useful step forward.

This suggests to me some further lines of research, because, if indeed the FOMC members are going to be stuck with the task which I ran through so briskly – of saying, for a given value of RPDs in the next three weeks, what to expect in terms of this whole constellation of variables – they need some light on what they can expect. Perhaps we ought to be directing our research somewhat to assess the risks and uncertainties that are involved. I think one can select a target in terms of RPDs only by knowing both what you expect to be the outcome in terms of that whole combination of interesting variables and also what you think would be the errors in each of them. And I think maybe we have to advance now from finding the relationship between "something or other" and M to finding the relationship between RPDs and quite a variety of things. Maybe in a few years we will be reporting on the pragmatic treatment of RPDs.

The Problems of the Open Market Manager

ALAN R. HOLMES*

The purpose of this paper is to describe the procedures used by the Trading Desk in implementing the Federal Open Market Committee's directive and to enumerate some of the problems we have run into now that more weight is being given to the aggregates, particularly to reserves against private deposits. I use the term "greater weight" with some deliberation because there is no suggestion that the Federal Reserve System has finally hit on a magic formula which, if rigidly adhered to, would provide the precise growth rates of money and credit that would lead to the desired national economic performance. Recently-published policy records make it quite clear that while the primary focus is on RPDs, due consideration is given to the behavior of the key monetary and credit measures, to the state of the domestic money and capital markets, and to international financial markets as well. Thus, the current status of the directive reflects a continuing evolutionary process in the thinking of the members of the Committee and the Committee staff – not a radical departure from past procedures. No revolution has taken place at the Trading Desk – although it is quite obvious that RPDs now get daily attention, but not to the exclusion of everything else.

Arriving at an RPD Target

It might be worthwhile at the outset to review very briefly how the Committee arrives at an RPD target – or target range –that it associates with any given directive to the New York Reserve Bank as a guide to day-to-day open market operations. As you know, the Committee staff prepares an economic forecast for several quarters

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ahead, and provides the FOMC with projections of growth rates of money and credit – and of interest-rate levels – they believe to be consistent with the GNP forecast. Individual members of the Committee may or may not like the GNP forecast or agree with the staff estimates of the linkages between GNP and the monetary and credit aggregates which serve as intermediate target goals. Nonetheless the Committee does start with a proximate notion of an appropriate long-term growth rate for money and credit linked to a desired growth rate for real output and associated levels of unemployment and prices.

Next, the staff prepares each week monthly forecasts of the monetary and credit aggregates for the next quarter or two, and weekly forecasts for a shorter time span. While these are consistent with a given long-run growth rate – or at least thought to be – there may be substantial month-to-month deviations since we know from experience that the course of money growth is seldom smooth, particularly in the short run. Incidentally, I wish we knew more about the reasons for the substantial month-to-month deviations in M_1 growth. Why did M_1 grow at only a 4-5 percent annual rate in April-June and then suddenly accelerate to a 14 percent rate in July, with no real change in underlying economic conditions? Is our seasonal adjustment all wrong? Are there wide random swings in the demand for money? Or is there some hitherto undetected aberration in our statistical measurement of the money supply?

Once the staff has prepared its aggregate forecasts – which members of the FOMC may or may not find to be reasonable – it is relatively easy to derive a consistent RPD growth rate on a monthly or quarterly basis. In choosing an RPD target range the FOMC is essentially reflecting a longer-range growth rate for money and credit aggregates, providing the staff forecasts are reasonably accurate and the assumed linkages reasonably correct. Thus, as the policy records I believe have made clear, an RPD target is not an end in itself but an operating target or handle that the Committee uses to reach a monetary and credit objective which in turn is expected to be consistent with the Committee's fundamental objectives – that is, basic national economic goals.

The Committee's RPD target is expressed, as you know, as a range, typically with a 4-percentage-point spread on an annual-rate basis, and generally covering a two-month period. Thus for February-March the target range for RPDs was a 6-10 percent annual rate, and for May-June 7.5-11.5 percent. Two observations about the target range may be in order at this time. First is a warning not to interpret a change in the target range as necessarily signifying a change in the Committee's policy stance. A raising or lowering of the range may well be merely a reflection of an anticipated temporary short-run deviation from a longer-run steady growth rate for money. Second, some people have felt that the extent of the range – 4 percentage points – is so wide that there is really no target at all. It should be pointed out that 4 percentage points on an annual rate basis is equivalent to only $100 million a month in actual RPDs – quite a narrow range when measured against an RPD base of $30 billion.

The RPD target is expressed, of course, in seasonally-adjusted terms. Since the Trading Desk lives in a seasonally-unadjusted world, and since on a day-to-day basis we know only total-reserve figures – with a break between borrowed and nonborrowed reserves, of course – it is necessary to convert the Committee's RPD target into a total-reserve target in order to have a practical operational guide. Hence, the staff deseasonalizes the RPD target, breaks it into statement weeks, and adds in allowances for reserves required to support Treasury and interbank deposits and "normal" excess reserves. This provides a reserve measure that can be compared day-by-day with the reserves actually available in the banking system.

Problems of Implementing a Reserve Target

I shall return to the use of the RPD target in day-to-day open-market operations later on. But first some of the problems that will ever be present in attempting to implement a reserve target, or for that matter any short-run target designated by the FOMC, should be enumerated.

First of all is the obvious fact that the System does not provide the only influence on bank reserves. Market factors, such as float, currency in circulation, vault cash, the Treasury balance, etc. vary substantially from week-to-week with the average weekly variance last year (1971) amounting to over $450 million. This is, of course, very large compared with a $35 million weekly reserve growth implied by a 6 percent annual rate of RPD growth. Our ability to hit a reserve target with reasonable precision depends importantly on how well we can forecast the factors affecting reserves that are outside our control.

Unfortunately, despite heroic work by our staffs, the results are something less than perfect. Last year, for example, the New York bank's forecast on the first day of the statement week missed the final outcome by $280 million on average. Of course, new estimates are made daily, but even as late as Tuesday – the sixth day of the statement week – the average miss in projecting weekly average-reserve factors was about $100 million. This means that at any given point in time there is considerable uncertainty as to where we really stand in relation to the reserve target. Revisions in the deposit data and as-of adjustments to bank reserve positions also cause operational problems from time to time.

Incidentally, our projectors are looking forward with interest to the revision of Regulation J that is scheduled to be introduced later this month. This speed-up of the check collection mechanism is expected to reduce float by about $2 billion. Whether or not it will reduce the weekly fluctuation in float is less certain, but it may well mean that past patterns will be even less helpful than at present in forecasting float during an extended transition period.

Lagged reserve requirements are pointed to by some Fed watchers as an obstacle to appropriate monetary management. It is certainly true that in any given reserve statement week the level of required reserves is fixed, determined by deposit levels two weeks earlier. There is nothing the banking system can do to change that level, and if reserves are not supplied by open-market operations or through the movement of other reserve factors, banks must have recourse to the discount window. The Federal Reserve can, of course, keep relatively close control over the supply of nonborrowed reserves, and if the monetary aggregates are turning in a stronger performance than the Committee desires, open-market operations can become a reluctant supplier of nonborrowed reserves, forcing the banks into the discount window. This process will, over time, bring about administrative action by the discount officers at the Reserve banks, and eventually a change in the lending and investment activities of the commercial banks. With lagged-reserve accounting, an RPD target presents something more of a problem in ensuring a prompt monetary response than was the case when the Committee was operating directly on a monetary or credit target. Thus we find that we often have to look through the RPD handle to money and credit growth directly. If money growth is lagging behind the Committee's desires, the Desk steps up the supply of nonborrowed reserves, or if money and credit are growing more rapidly than the Committee's desires, the Desk reduces the supply.

The use of an RPD target is not only tempered by what is happening to key measures of money and credit, but also by money-market conditions themselves. The greater weight placed on a reserve target has of course meant less weight being placed on money market conditions. But in instructing the Desk on the conduct of operations the Committee has made it clear that it does not want to have wild gyrations in money-market conditions, as typified particularly by the Federal funds rate. It is interesting to note that in the first six months of operations under a reserve target the variance in the Federal funds rate between Committee meetings was no different than in the two previous years. Part of this performance was due, perhaps, to the relative stability of credit demand over that particular period. Certainly putting greater weight on reserves should mean that over time there will be greater variation in interest rates. The important point, however, is that while the Committee has increased its emphasis on the monetary and credit aggregates, it continues to demonstrate a lively concern over the state of the money and capital markets.

Importance of Federal Funds Rate

The Federal funds rate – the cornerstone of the money market – is of particular concern to the Trading Desk for purely practical reasons as well. Since it represents the price at which banks are willing to trade reserves and is very sensitive to supply and demand factors, it frequently provides a better measure of actual reserve availability than do our projections. Thus a dip in the funds rate from its recent average level may indicate a greater availability of reserves – perhaps from a bulge in float – than had been anticipated. The Federal funds rate – in the very short run – serves as a most useful corrector of faulty reserve projections. It is not an infallible measure, however, reflecting in the main the fact that commercial banks have as much trouble keeping track of their own reserve positions as we do forecasting reserves for the banking system as a whole. Sometimes banks with reserve deficiencies are very slow to cover them, giving a false sense of ease in the money market. At other times banks with large excesses hold them off the Federal funds market, perhaps in hopes of higher rates later on, lending a false sense of an overall shortfall in reserve availability. Indeed, at times the major money- market banks have accumulated gross excesses or deficiencies of $2 to $3 billion over a weekend, leading to strong pressure or ease in the funds market towards the close of a statement week. Thus it is important to interpret movements in the Federal funds rate in light of our knowledge of the day-to-day reserve position of the banking system, and of how the major money-market banks are currently managing their cash positions.

Daily Check of Current Reserves

In working with an RPD target, a daily check is made of current reserve availability relative to the target and what the position will be in the weeks ahead, if our reserve projections turn out to be right. If we find that reserves are deviating from the target, or getting uncomfortably close to either end of the range, we need to know more about why the deviation is taking place. Is there a fundamental departure in reserve growth from the Committee's desires, or is there only a temporary quirk in the weekly number? In making this assessment we are acutely conscious that the drawing up of a target path – particularly on a weekly basis – is far from an exact science. There is always the possibility that the path has been badly constructed and that a different combination of weekly figures than assumed will still give the desired longer-run growth pattern. Statistics are constantly being revised, and it frequently happens that the base month on which the target range has been constructed is changed after a Committee meeting – indicating that a different growth rate would be required in order to reach a given target level for reserves. This has to be taken into account in determining what the performance actually is.

RPD Multiplier

Since RPDs are not an end in themselves, but a means to achieving longer-run monetary and credit goals, the multiplier linking RPDs to these intermediate goals is a crucial factor. The multiplier assumed in the target path can be off – sometimes significantly – because of a shift in deposit mix between time and demand deposits, or because of a division of deposits as between reserve city and country banks other than the one assumed at the time the target was drawn up. Thus in reviewing reserve performance there must be a continuous review of how the multiplier is actually performing relative to its assumed performance.

The RPD target contains an allowance for excess reserves in the banking system. While the allowance has generally been realistic if a number of statement weeks are averaged, it can be far off the mark in any given week. Given the massive flow of funds through the banking system, banks are not always able to keep their reserve positions precisely where they want them to be. Thus there may be an unexpected bulge in excess reserves in any statement week. This is apt to be followed by a sharp drop in excess reserves in the following week as banks carry over excess reserves into that week. Hence an alternating weekly pattern of high and then low excess reserves tends to develop. These swings are large relative to our RPD target range and can force us off target in any single statement week. Since they are largely self-correcting and of little basic significance, we tend to ignore short-run deviations from an RPD target if they are caused by an excess-reserve swing.

Appropriate Time Span for Meeting a Target

Some of the more basic problems of working with reserve or aggregative targets are discussed in other papers presented to this seminar. One of the more interesting ones is the appropriate time span for establishing and meeting an aggregative target. There appears to be reasonable agreement that a week or month and possibly even a quarter is not long enough. Working against a longer-run target raises questions of assessing at any given point in time how well on target one may be. Since the target period includes the future as well as the present and past, one has to look to the projections of money and credit growth for some guidance as to the outlook in ensuing months.

Are these projections good enough to weight them heavily in making this assessment? Unfortunately, despite excellent staff work at both the Board and the New York bank, the answer has to be no. They are useful, and absolutely necessary, for obtaining some notion of the future direction of movement of the aggregates, but not yet good enough to put much faith in them. The following example of progressive estimates for a recent month's annual growth rate of M_1 will illustrate the point. Early in the preceding month the Board staff estimate was for M_1 growth of 6.5 percent in the following month, a reasonable enough figure. It was somewhat marred, however, by a New York bank forecast of over 12 percent. By the end of that prior month the Board estimate had moved to 8 percent and New York to 15 percent. In the first week of the month itself the forecasts at 10-11 percent had come quite close together. A week later, however, the forecasts dropped to 5-7 percent, and by the end of the month to 1.5-3 percent. After a number of revisions in later weeks, M_1 growth wound up at about 3.5 percent. I think this illustrates the pitfalls of treating a forecast as a known fact. The point is not that the forecasts are so volatile as to be useless. They are both useful and necessary, but placing great weight on them would lead to some rather startling reversals of open-market operations as the numbers just cited would imply.

In addition to a need to improve our forecasting ability, there is still endless work to do on the linkages between reserves, the monetary and credit aggregates and interest rates, and the linkages between the monetary world and the real world. Some of the work underway on these linkages and on the lag between monetary policy actions and monetary response has been presented at these conferences. But I suspect that this is a never-ending task, and not even the most sophisticated econometric analysis will ever replace the need for judgment in the formulation of monetary policy. Better analysis will foster better judgments. But if, as might be suspected, the lag between action and response is variable and the linkages between the aggregates and interest rates are subject to variation over time as financial markets develop, the payments process becomes more efficient, and since public and market psychology vary, there will never be a final conclusive answer.

For some years now, the FOMC has been giving greater emphasis to the monetary and credit aggregates and, more recently, to RPDs in its policy deliberations. But it has continued to watch developments in interest rates and financial markets and has tempered its emphasis on reserves to cope with international financial distrubances, to deal directly with domestic financial crises, and to avoid severe wrenches to market and public psychology. While money matters, so do interest rates, the condition of the markets and the state of public confidence in our financial system. And so the Federal Reserve, like every central bank, is faced with the perennial need to effectuate a trade-off between desired and desirable monetary and credit growth rates and interest-rate movements. In making that trade-off, the type of economic research and analysis that has been under discussion here has a major role to play, but it can never replace the reasoned judgment of the policy makers.

DISCUSSION

JACK M. GUTTENTAG*

The Account Manager has two broad types of problems: those he acknowledges and talks about, and those he doesn't. I shall assume that my role is to discuss the second.

Ten or twelve years ago a major unacknowledged problem of the Account Manager was to defend his actions to the Federal Open Market Committee. This was necessary because the Committee's instructions to him were often hopelessly vague and ambiguous.

Since 1961 there has been a clear tendency toward greater clarity and rigour in the instructions given to the Account Manager. Indeed, to an important degree, instructions have been quantified. This, of course, places new and heavy burdens on the Manager. I think we would all agree, however, that it is much healthier for the Account Manager to expend his efforts trying to do what the Committee wants him to do than in trying to convince the Committee that what he did was what they really wanted.

The major unacknowledged problem of the Account Manager today is that he works within an open-market strategy that incorporates a risk that he will preside over a financial crisis without being able to stop it.

I. Evolution of Open-Market Strategy

With that provocative lead-in, I want to back off and take a longer view of open-market strategy. I have already mentioned a trend toward greater explicitness in instructions given to the Manager. A second major trend has been the increasing weight given to reserves and other monetary aggregates as targets in open-market strategy, and the decreasing weight given to money-market conditions. We can trace the first (very tentative) steps in this evolution to 1960 when

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the Manager first began to report changes in total reserves and non-borrowed reserves to the FOMC (prior to that time the Manager only reported free reserves). In 1960 also the Board first began to collect daily-average money-supply data which became indispensable to later steps in the evolutionary process (see below). In 1961 oblique references to desired growth in reserves began to appear in FOMC policy directives. In 1963 and 1964 the Committee's desires about reserve aggregates were expressed in the "while" clause.

> "System open market operations shall be conducted with a view to maintaining about the same conditions in the money market as have prevailed in recent weeks, *while* accommodating moderate expansion in aggregate bank reserves" (FOMC meeting of June 17, 1964, my italics).

The "while" clause was used until late in 1964 when it was scrapped – perhaps because of its ambiguity. Then in mid-1966 the "proviso" clause was adopted.

> "System open market operations. . . shall be conducted with a view to attaining somewhat firmer conditions in the money market; *provided,* however, that operations shall be further modified if bank credit appears to be expanding more rapidly than is currently projected" (FOMC meeting of March 5, 1968, my italics).

The "proviso" clause was used until early in 1970. A stock-taking at that point would have led to the conclusion that the aggregates had inched up in the scale of priorities over a ten-year period but remained clearly subordinate to money-market conditions in open-market strategy. We might well have agreed with Frank Morris that "the proviso clause had only marginal significance, in part because the limits on the growth of the proxy were never sufficiently quantified to give it teeth."[1]

In 1970 a change was made in open-market strategy that clearly had important operational implications. The Committee adopted monetary aggregates as explicit open-market targets. These aggregates, as is well known, consisted of M_1, M_2 and the bank credit proxy, with M_1 the more important of the triumvirate. To be sure, these were long-run targets. Money market conditions, especially the

[1] Frank E. Morris, *RPDs as the Target.*

Federal funds rate, continued to be the daily and weekly targets. Yet within a given policy stance the short-run targets could be (and were) adjusted if the aggregates moved away persistently from weekly paths considered consistent with their long-run target values.

In my view, the evolution in open-market procedures should have stopped there. The strategy that was adopted early in 1970 was an eminently sensible one. As a consequence, I was quite surprised when early in 1972 I read about the introduction of RPDs. I was also concerned that the pendulum had swung too far.

Every step in the evolution of open-market procedures reduced in some degree the relative importance of money-market conditions as an objective of open-market operations. (While the early steps perhaps had little operational significance, this cannot be said for the changes that occurred in 1970 and 1972). This evolution in procedures was a response mainly to intellectual developments, particularly the rise of monetarism. The changes that occurred in the financial system would not have called for decreasing emphasis on money market conditions. Increasingly over the period, financial institutions and non-financial corporations came to depend upon the efficient functioning of financial markets for their liquidity. Hence, the Federal Reserve should have been increasingly concerned about the viability of financial markets in connection with its "last resort" responsibilities to prevent financial panic.

Without great exaggeration it might be said that during the 1950s, when liquidity positions were generally strong and financial panic was more or less impossible (barring gross policy mistakes), the Federal Reserve used a "money market strategy" that had optimal panic prevention properties.[2] As liquidity positions became increasingly fragile during the 1960s and financial panic an increasing possibility, open-market strategy gradually came to de-emphasize money market conditions.

I don't want to over-stress the paradoxical elements in this. Clearly, money market conditions were over-emphasized in open-market strategy earlier while control over monetary aggregates was inadequate. Furthermore, a good open-market strategy will permit adequate control over aggregates *and* have strong panic-prevention properties as well.

[2]This generalization does not hold to the extent that the money-market strategy used free reserves, as opposed to market interest rates, as an open-market target. For a further discussion see my "The Strategy of Open Market Operations," *The Quarterly Journal of Economics,* Feb., 1966.

Indeed, I felt that the FOMC had a satisfactory strategy in 1970, with the Federal funds rate serving as a short-run target and monetary aggregates as long-run targets.[3] Why then the adoption of RPDs?

II. Why RPDs?

First we must be clear with regard to the precise role of RPDs in open-market strategy. While he does not say so explicitly, Frank Morris evidently views RPDs as a replacement for the monetary aggregates as long-run targets. We can draw this inference by noting the four arguments in favor of RPDs that Frank advances. All of these arguments imply a comparison with the monetary aggregates – none of them involves a comparison with the Federal funds rate.

In contrast, a close reading of Alan Holmes' paper[4] indicates that RPDs have replaced the Federal funds rate as the weekly target of open-market operations; that the Federal funds rate is now a short-run constraint; and that the monetary aggregates remain in the strategy as long-run targets. On this issue we must accept Alan's view. Clearly the role of RPDs in open-market strategy is what the Account Manager understands it to be.

Why this change? A good place to look for the answer is the article on open-market operations in 1971 written by Alan Holmes and Paul Meek,[5] which is the most detailed and forthright report on open-market strategy ever published by the Federal Reserve. The report stresses, among other things, the considerable difficulty experienced in 1971 of controlling the monetary aggregates, especially M_1. It is clear that in some sense M_1 grew too fast in the first half of the year and too slow in the second half. This was a source of concern to the monetarists especially. This raises the possibility that the FOMC introduced RPDs as the short-run target so as to assure closer control of the monetary aggregates.

[3] While I was satisfied with the strategy, I have never been convinced that the monetary aggregates singly or in combination were superior as long-run targets to a long-term interest rate or combination of such rates.

[4] Alan R. Holmes, *The Problems of the Open Market Manager.*

[5] "Open Market Operations and the Monetary and Credit Aggregates in 1971," *Monthly Review,* Federal Reserve Bank of New York, April, 1972.

The relevant question, however, is not whether a different behavior pattern for M_1 *considered in isolation* would have been preferred. Rather, it is whether a different *trade-off* between the behavior pattern of M_1 and the behavior pattern of other variables, particularly market interest rates, would have been preferred.

While there are some ambiguities in the record[6] one gets the distinct impression that the answer to this question is negative. While the FOMC would have preferred greater stability in M_1 over the year, it was not prepared to pay the price in the form of greater instability in interest rates. In this significant sense, there was no lack of control of the monetary aggregates.

It is interesting that while Frank Morris says that the use of RPDs would have changed the outcome of open-market operations in 1959-60 and in 1968, he does not think that open-market operations would have been significantly affected during 1971.

The 1971 experience thus does not support the view that an open-market strategy consisting of monetary aggregates as long-run targets and the Federal funds rate as the short-run target provides insufficient control over the aggregates. Rather, it suggests that this strategy forced the FOMC to bear the pain of choosing its preferred trade-off between the behavior of M_1 and the behavior of interest rates. This is exactly what an open-market strategy should do.

One is led inexorably to the conclusion that the FOMC introduced RPDs as a means of constraining its own freedom of action. The Committee in other words chose to prevent itself from doing what it knows it is otherwise disposed to do, namely, to limit short-run fluctuations in interest rates to a relatively narrow range.

From the standpoint of the monetarists, this is a wholly sensible step. Their view is that the Committee's revealed trade-off in 1971 between changes in M_1 and changes in market interest rates was much too constrained by the fear of swings in rates. In this view the new strategy hopefully will lock the Committee into a "better" trade-off; with RPDs the main target the burden of proof would be on those who want to prevent interest rates from changing too much.

Yet the Committee as a whole clearly is not dominated by monetarist thinking.[7] Why should it constrain its own freedom? No

[6]Some sizeable errors in forecasting occurred during the year. Forecasting errors always make it difficult to know whether any given outcome was intended.

[7]On this point, see Andrew F. Brimmer, "The Political Economy of Money: Evolution and Impact of Monetarism in the Federal Reserve System," *The American Economic Review,* May 1972.

one can deny that the freedom to choose imposes a heavy burden, and this is as true of institutions as it is of individuals.[8] Perhaps the Committee is trying to "escape" this burden. Or perhaps we can view the change in strategy as a rational attempt by the FOMC to curb its own irrationality. Whatever the explanation, the change in strategy adds a new risk at a bad time, as we shall now see.

III. RPDs versus the Federal Funds Rate

In general, there seem to be four criteria for assessing a short-run open-market target. Two, mentioned by Frank Morris, can be dismissed quickly. These are *controllability* – the ability of the Account manager to control the variable – and *information lags*. The Federal funds rate ranks slightly higher than RPDs on both of these criteria although RPDs also rank fairly high.[9]

The third criterion of an open-market target is its utility in controlling longer-run targets. The interesting paper by Pierce and Thomson[10] shows the complexity of the problem of discriminating between short-run targets on these grounds, and gives no *a priori* reason for believing that RPDs are better than the Federal funds rate.[11]

The fourth criterion is central and will occupy the remainder of my remarks. A short-run target should cause the Manager to respond appropriately to disturbances that had not been anticipated when the Committee gave him his last instruction. In comparing the Federal funds rate and RPDs on this criterion, we must distinguish a number of different types of disturbances, and in each case we must ask, "How important is it if the Manager responds inappropriately?"

[8] See Erich Fromm, *Escape from Freedom*, Rinehart, 1941.

[9] The problem of information lags can of course be subsumed under the problem of controllability. For an extensive discussion of the controllability problem, see Richard G. Davis, "Short-run Targets for Open Market Operations," in *Open Market Policies and Operating Procedures – Staff Studies*, Board of Governors of the Federal Reserve System, July 1971.

[10] James L. Pierce and Thomas D. Thomson, *Some Issues in Controlling the Stock of Money*.

[11] The same point may be made with regard to that hoary relic of the money-market strategy, free reserves.

Consider an unanticipated change in operating transactions – an unusually large rise in Federal Reserve float, for example. Since this disturbance will tend both to lower the funds rate and to increase RPDs, the Manager will respond appropriately by withdrawing reserves, using either a Federal funds rate or an RPD target. On the other hand, in the face of a change in deposit mix that affects the average reserve requirement, and therefore excess reserves, the Manager will respond appropriately if he is using the Federal funds rate but *not* if he is using RPDs (since RPDs are not affected by this disturbance). I don't consider either of these two types of disturbances very important and they will not be considered further.[12]

There are three types of disturbances which I believe are most important in evaluating the relative merits of the Federal funds rate and RPDs as short-run open-market targets. The first is a change in the demand for money associated with unexpected strength or weakness in economic activity. If we take a simple-minded equation where the demand for money is equal to some coefficient times GNP, then demand will be higher when GNP is higher. The appropriate response to such a change generally is not to accommodate it. The Manager would not accommodate the change in demand if he were using RPDs whereas he would accommodate it if he were using the Federal funds rate. In this case, therefore, RPDs provide better control over the monetary aggregates than the Federal funds rate. The consequences of an inappropriate response, however, are trivial so long as the strategy includes monetary aggregates as long-run targets. All that happens is that the monetary aggregates go off their target path for a few weeks, until the Federal funds rate is adjusted to get them back. Pierce and Thomson suggest that the money supply can wander off path for up to two quarters without doing any significant damage.

The last two disturbances, which have different implications, are, first, an unexpected change in the demand for money from sources other than changes in economic activity (the coefficient changes in my simple-minded equation); and unexpected changes in the banks' desired level of free reserves (banks wish to hold more excess reserves or have lower borrowings from the Federal Reserve at prevailing interest rates). Both types of disturbance should be and are accommodated using the Federal funds rate; they are not accommodated using RPDs.

[12]Another disturbance that will not be considered in this paper is a change in U.S. Government deposits. This turns out to be a very complicated disturbance to analyze, but my preliminary thinking suggests that the Federal funds rate will not come off second best when compared to RPDs.

How important is the failure to accommodate these two types of disturbances using RPDs? In most cases very unimportant. Interest rates in the typical case will rise or fall more than expected but the disturbances will typically reverse themselves in a short time and no harm will be done. However, I don't think we can take this harmless sequence any longer for granted. There is another possible scenario — a scenario that leads to financial panic.

IV. Thinking the Unthinkable

Basically, panics are a general loss of faith in the capacity of financial institutions to deliver on their promises, and a consequent rush by those to whom the promises have been made to convert them quickly, before others do so, and before the institutions' resources are exhausted.

What sort of promises? Before the Federal Reserve Act it was the promise of commercial banks to convert their deposit or note obligations into gold, silver or other "lawful money." It was this promise that was under attack also in the great depression of the 1930s. Today, however, bank promises to convert their deposits are not subject to question. The two important promises that are subject to question today are the promise of securities dealers to make markets in major debt instruments; and bank promises to make loans, particularly to large corporate customers with established lines of credit.

The backdrop conditions for an emerging financial crisis are the fragile liquidity positions referred to earlier, an investment boom generating strong credit demands, and a tight-money policy adopted by the Federal Reserve. Suppose that under these conditions an unusually large disturbance hits the market — an increase either in the demand for money or in the banks' demand for free reserves. Since the Manager is following RPDs, the disturbance is not neutralized. Interest rates rise much more rapidly than anyone is accustomed to. As a result, dealers become apprehensive that further increases of unspecified magnitude may be impending, they refuse to take any more securities into position, and they may even attempt to go short. At this point the financial markets stop functioning effectively and a cumulative process — a scramble for liquidity — could begin and move with extraordinary rapidity.

(a) Suddenly, as it is realized that markets are undependable, the liquidity of "liquid assets" evaporates.

(b) As a result, a secondary wave of loan demands hits the banks just when the banks find that because of the markets' collapse they also are unable to raise the funds they need by selling assets or CDs. This leads bank loan commitments to come into question for the first time. The panic is on.

(c) As a result, a third wave of anticipatory loan demands hits the banks. The new borrowers want to stockpile against future needs and against the possibility that if they don't get theirs now the supply may be exhausted. Since the bargaining position of these borrowers will in many cases be stronger than that of borrowers who have pressing current needs, the distribution of available loans takes a turn for the worse. The same cash-hoarding tendencies quickly come to pervade the pattern of intra-firm trade credit. Everyone wants longer credits and quicker collections.

(d) The inevitable maldistribution of cash resulting from the spread of the hoarding psychology leads to inability of some otherwise solvent firms to meet their debts, and bankruptcies begin to mount. This causes lenders to reevaluate the credit-worthiness of customers, and yield and availability differences between "high grade" and "low grade" borrowers widen markedly.

(e) And so on. . .

There are several types of rejoinder to my fear-mongering on which I wish to comment. The first is that if the Federal Reserve stabilized monetary aggregates, disturbances of the type I have described would be small.[13] This argument has always seemed to me to be a piece of monetarist theology for which there is no evidence. That major disturbances in the past (particularly in the 1930s) may have resulted principally from the Federal Reserve's own actions does not at all imply that the market cannot generate major disturbances. During the period when the Federal Reserve followed a money-market strategy the money stock fluctuated markedly on a week-to-week basis. Since the money-market strategy was basically accomodative, this testifies to instability in the demand for money. Whether this instability is of sufficient magnitude, under the type of conditions I have posited, to generate a crisis I don't know and neither do the monetarists.

A second rejoinder is that the market will adjust to the new conditions generated by the revised open-market strategy, in such manner as to dampen the tendency for wider rate fluctuations. Davis notes that "institutions could be expected to learn to respond more flexibly to take advantage of rate fluctuations – thus increasing the

[13] For an example of this viewpoint, see Richard T. Selden, "Liquidity Crises and Monetary Policy," *The Morgan Guaranty Survey,* September, 1970.

supply elasticity and thereby dampening the fluctuations themselves."[14] Such adaptations, however, are costly and they will be adopted only to the extent needed to deal with the general run of disturbances that occur week-in-and-week-out under the new regime. Financial institutions will not stand the cost of preparing themselves to cope with a major disturbance without a marked shift in psychology and confidence that is likely to occur only as a result of a crisis. Indeed, our long history of bank crises indicates that even crisis-induced adaptations are likely to be short-lived.[15]

The third rejoinder, and the only one to be taken seriously, is that the new open-market strategy does not throw the market to the wolves. Alan Holmes has indicated that "the Committee. . . continues to demonstrate a lively concern over the state of the money and capital markets."

In general I believe this rejoinder is well taken. In all probability if a disturbance occurred which the Manager could not accommodate without driving RPDs far off the target, he would go back to the Committee and get special authority to do what had to be done. Nevertheless, I believe that there is an uncomfortable probability that the Committee would not take effective action. Let me give you the reasons for that judgment.

Although the current Federal Open Market Committee is better informed and perhaps more competent than any prior Committee, there is good evidence to suggest that it is also more prepared to take risks. At the same time Committee members could easily disagree on whether or not a critical stage had been reached – "everybody knows that those guys in New York always want to coddle the market."

Once a panic begins to develop momentum, furthermore, the resources needed to turn it back may be massive relative to the magnitude to which policy-makers have become accustomed. At that point courage and boldness are needed as well as intelligence. These are rarer qualities and it is hard to predict whether or not they will be forthcoming. Certainly, I am not reassured by the decision-making machinery involved. A committee of twelve members does not lend itself to bold actions on an unprecedented scale. In the past the FOMC has been chronically disposed to move in small steps, partly

[14] Davis, p. 58.

[15] For a general discussion see George R. Morrison, *Liquidity Preferences of Commercial Banks,* University of Chicago, 1966.

because moderation and compromise are a natural outgrowth of conflicting viewpoints.

None of these points will cause you, I am sure, to take my warnings seriously. Inevitably, the dangers will appear less threatening to an insider than to an outsider. The insider generally has more confidence that the responsible persons in the Federal Reserve will take the right action at the right time. The outsider is more impressed with the need for procedural safeguards that make it difficult for those in authority to make serious errors. You should not sell this view short.

In a post-mortem on the 1966 "crunch" Governor Brimmer expressed surprise that anyone could believe that the Federal Reserve would have allowed market developments to get out of hand; yet he conceded that "this impression did take root in the minds of a number of market participants and serious observers of the financial scene." It seems to me that the nervous nellies in 1966 had the logic of history on their side. Governor Brimmer was naive in expecting the financial community to have complete confidence in the ability of the Federal Reserve to dance around the brink. The System will earn this confidence when they can point to procedures which assure that they will not fall off the end.

Role of Projections and Data Evaluation with Monetary Aggregates as Policy Targets

STEPHEN H. AXILROD and DARWIN L. BECK*

The Federal Reserve has in recent years placed more stress on monetary aggregates in the formulation and execution of monetary policy. This is abundantly clear from published documents. Among the monetary aggregates, money supply narrowly defined (M_1) to include currency held by the nonbank public and demand deposits other than U.S. Government deposits has played an important role. Other aggregates involved in policy formulation include money more broadly defined to include time deposits other than large negotiable CDs (M_2), bank credit, and various measures of reserves.

Without arguing the question of whether money is best defined narrowly or broadly, or of how much weight money should be given in policy formulation and execution, we will focus in this paper on some of the problems in measuring M_1 and in projecting relationships among M_1 and other financial variables that serve as intermediate and/or day-to-day operating objectives of monetary policy. The projection problem can be thought of in a number of ways. One, of course, is to attempt to determine what M_1 (and related financial conditions) will produce the best chance of attaining desired ultimate goals for the nation's economy, as expressed in terms of economic activity, prices, etc. We will not deal in any detail with that aspect of the question. Instead we will concentrate on the shorter-run operational questions that involve projected relationships among a particular M_1 growth rate, if that is taken as a target, other monetary aggregates, bank reserves, day-to-day money market conditions and interest rates more generally.

The ability to carry out a policy that includes monetary aggregates as objectives evidently requires — in addition to a method by which the objectives can be achieved — reasonably accurate data to gauge

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whether the aggregates are in practice on path. This may seem a mundane problem. And if data reliability and speed of availability is a problem, the obvious answer is to improve the figures. Improvement of figures does involve an assessment of benefits and costs, though. And such an assessment would require knowledge of the range of error in figures as they are published.

In a later section of this paper, we will attempt to show how much revision there has been in M_1 figures, comparing them with, for example, revisions in GNP. Revisions in money supply figures represent only a partial measure of error. They show the extent to which first published figures for M_1 deviate from final published figures, but they do not indicate the extent to which final figures deviate from "true" figures, given the Federal Reserve definition of M_1. There still may be errors which have not been uncovered between first publication and final revision. At best, though, we may be able to see to what extent past revisions may or may not have made M_1 an uncertain target, to the extent it was a target.

Targets and Projections

It is probably useful first to distinguish between targets and projections. In discussing projections, we basically mean a projection of a set of relationships. That is, what is being projected is the relationship to be expected among various monetary aggregates – including bank reserves – and interest rates, taking gross national product as given for purposes of making short-run projections, of about a quarter or less, of financial relationships.

A projected relationship is not, of course, a policy target. Whether monetary policy takes as a target either an interest rate or an aggregate depends on much broader and more important considerations than projected financial relationships a quarter ahead. Decisions as to the particular policy targets chosen depend on the whole set of considerations involved in deciding whether money or interest rates as a target link more dependably to ultimate economic objectives. And the dimensions of the intermediate money or interest-rate targets, or the relative emphasis among them, depend on assessment of the future strength of demands for goods and services, trade-offs, if any, among various domestic ultimate objectives and between domestic and international goals, estimates as to lags in effect between current policy targets and ultimate goals, and how uncertainties about demands for money are weighed against uncertainties about demands for goods and services.

While monetary policy can choose a particular target, say M_1, and also ignore what is happening to all other variables, in practice it is unlikely that monetary policy would ever take the single-minded course of adhering to one target, regardless of its consequences for other financial variables. Since policy makers – given their uncertainties about future economic developments and as to how interest rates or money interact with these developments – will tend to have trade-offs between what they would like to see happen to monetary aggregates and what they would like to see happen to interest rates, projected financial relationships are of interest as a means of setting reasonable bounds within which policy operations might be carried out over the short run.

Nevertheless, projected relationships should not be thought of as determinants of policy. For discussion purposes, a relationship between M_1 and the Federal funds rate can be taken as indexing a whole set of financial relationships. If monetary policy were to decide to strive for a, say, 6 percent annual rate of growth for M_1, it might be willing in practice to attain such a growth rate provided the Federal funds rate did not rise by a substantial amount from what were prevailing levels. Such a decision, though, would not depend on projected relationships between M_1 and the Federal funds rate; it would depend on an analysis of economic conditions and on the weight policy makers assign to the relationship between M_1 and GNP as compared to the relationship between the funds rate, or interest rates more broadly, to GNP.

If projections were to indicate that the Federal funds rate would have to rise substantially for a 6 percent increase in M_1, this need not necessarily stop policy from choosing that M_1 growth as its desired target. In the first place, the projected relationship may be wrong, and it may prove possible to attain the desired M_1 growth without an undesired rise in the Federal funds rate. This may occur because GNP does not turn out to be as strong as expected or because demands for money at a given GNP were not as intense as expected.

If the projected relationship does turn out to be right, policy might in the end countenance a higher M_1 growth than initially desired because of unwillingness to see the Federal funds rate rise. In the latter case, of course, monetary policy would be giving up on a particular M_1 target, at least over a short run, but would be doing so in the belief that it was more important at the particular time for interest rates not to rise as much as they otherwise would either because of uncertainties as to the future strength of GNP, because of short-run market problems, or because of evidence that money demand is stronger for a given GNP than expected.

It is not our purpose in this paper to discuss the rightness or wrongness of an approach in which policy tends to bounce between money supply and interest rates as targets. What we want to point out particularly is that policy decisions about how much to stress monetary aggregates relative to interest rates are separable from technical estimates of relationships likely to be expected between money supply and the Federal funds rate.

But as suggested above, there are reasons for policy to give weight both to aggregates and interest rates. For one, there is always a good deal of uncertainty as to the demand for money for a given desired growth in income. If M_1 is tending to grow more rapidly than was initially thought to be consistent with income, policy makers may conclude – after examining all the available evidence such as may be obtainable from deposit ownership figures, from other domestic and international financial developments, and from appraising the trend in economic activity – that the original estimate of the demand for money was too low. Or, they might conclude that there are short-run reasons for money growth to be higher than expected, and that over the long run it can be expected to move back to target.

The Best Means to Achieve the Target

If policy were to take M_1 as a target, though perhaps not an absolute target to be achieved irrespective of other financial developments, there is still the question of what is technically the best means of achieving the target. The answer to this is complicated, but in brief might be said to depend on whether one is more certain of the relationship between bank reserves and M_1 or of the relationship between money market conditions and M_1. This is basically an empirical question, and one in which results do not yet appear to be conclusive. For our purposes, though, it may be relevant to point out that the Federal Open Market Committee has recently adopted a concept of reserves available to support private nonbank deposits (RPDs) as one of its day-to-day operating guides. This measure may be thought of as a handle through which desired M_1 is obtained, although we do not mean to suggest that the FOMC necessarily has taken so narrow a view. One of the advantages of an RPD target, as compared with total reserves, is that it permits day-to-day operations to be completely accommodative of the highly volatile short-run swings in U.S. Government deposits.

The next section of this paper will discuss how one can go about estimating likely relationships among the various monetary aggregates, bank reserves, and interest rates for operating purposes.

Projected Relationships

The method of projecting short-run financial relationships with which we are most familiar is a combination of judgment and use of econometric models. One approach utilizing M_1 as an important target variable might be along the following lines. Suppose for the moment that you are at the beginning of a quarter and want to estimate relationships that are likely to obtain over the quarter as a whole. For these purposes, the rate of growth in Gross National Product can be taken as given, as noted earlier. The expansion in GNP would be projected on the basis of past monetary policy, fiscal policy, and current tendencies in spending by key economic sectors.

As an aspect of the assumption of given GNP, the effect of alternative rates of growth in M_1 on financial conditions during the quarter could be worked out without assuming any feedback effects on GNP in the course of the quarter. This seems a reasonable enough assumption for one quarter – given what we know about the lag structure of the economy – but the assumption would become more and more unreasonable, of course, as the time period lengthens. In this paper we will concentrate mainly on projections one quarter ahead and for monthly periods within the one-quarter time horizon.

One key input to projecting short-run relationships among money and other potential variables is the summary of past historical relationships contained in econometric models. James Pierce and Thomas Thomson of the Board of Governors staff have worked out a monthly money-market model which helps provide some basis for projections. This model is being continuously improved, and is not, of course, the sole basis of making projections. But out of the model – which takes account of lagged relationships between interest rates and money demand – one can derive estimates of what is likely to happen to the Federal funds rate in the quarter ahead if M_1 were to grow at, say, a 6 percent annual rate. Alternative estimates of the Federal funds rate can be made for growth rates of M_1 on either side of 6 percent.

Model results can then be compared with and modified by judgmental projections based on long experience working with these relationships and utilizing in part estimating equations for particular aspects of the projected relationships. In addition, special factors that may not be contained in a model – such as effects on money demand from a new wage-price program or a foreign exchange crisis – can also be taken into account judgmentally. Finally, very sharp changes in U.S. Government deposits can affect the money stock held by the public at least for periods of a week or a month, even though basic money demands over a quarter or more may not be affected.

Once a basic M_1 – Federal funds rate relationship is established through combining judgment with model results, a projection can be made of the behavior of the three-month Treasury bill rate. This rate can be taken as indicative of the whole structure of short-term rates, although clearly there can be differences in rate spreads from time to time between the three-month bill rate and longer-term bill rates and between bill rates and private rates, such as the commercial paper rate.

A given Federal funds rate will tend to exert a strong pull on the three-month bill rate, but the rate spread will vary depending on Treasury debt-management practices and cash borrowing needs and on expectational forces in the market. The expectational forces come into play, of course, because the three-month bill rate permits more scope for attitudinal shifts than does the one-day Federal funds rate.

Given the three-month bill rate, estimates can then be made of likely public demand for time deposits. For estimating purposes, time deposits might be divided into two types: large negotiable time certificates of deposit acquired mostly by business corporations and savings and other time deposits, principally interest-bearing deposits of consumers. Recent trends and an evaluation of consumer behavior in past periods when market rates had roughly the same relationship to interest rates offered by banks for consumer-type time deposits provide a basis for making a specific estimate of the likely increase in such deposits. In that process, of course, account would also have to be taken of the likelihood that banks will adjust their offering rate on these deposits, assuming they are not constrained by Regulation Q ceilings. Banks typically adjust such offering rates sluggishly, however, and thus to an important degree play a passive role in the short run in relation to flows of consumer-type time deposits.

Banks are much more likely to adjust frequently offering rates on large negotiable CDs as market interest rates move. Partly, this is because prospective holders of large CDs are considerably more responsive to interest-rate differentials than are typical holders of time and savings deposits. And, because of the responsiveness of CD investors, banks tend to view large CDs as a readily-available adjustment mechanism. For instance, when business loan demands are strong or when there is a sharp shift toward expectations of lower long-term interest rates, banks may quickly increase their issuance of large CDs by raising their offering rates, to the extent it is possible under Regulation Q ceilings, in order to accommodate business customers or to invest in longer-term U.S. Government or municipal securities. Similarly, when loan demands are weak, banks are likely to reduce offering rates relative to market rates because they have no need for the funds to satisfy customer relationships.

In this context, key elements in trying to estimate likely bank demand for CD funds would be the expected state of business loan demand and bank attitudes toward long-term interest rates. In addition, banks would tend to use large CD funds as a means of offsetting flows of funds over which they have little immediate control. Thus, if demand deposits or consumer-type time deposits are not growing as much as a bank wants, it may attempt to take up the slack by issuing more large CDs into the market.

Banks also can obtain funds by borrowing abroad or through issuance of commercial paper. Over the past year or so, these have not been very important sources of funds, partly because domestic CD funds have been readily available and partly because of regulatory measures which have reduced the relative value to banks of issuing commercial paper or borrowing abroad through their branches.

One source of funds over which a bank has practically no control is U.S. Government deposits. The fluctuations in these deposits are, of course, the combined result of the current Treasury budgetary position and its cash and debt management practices. In projecting financial relationships, estimates can be made of the month-to-month and quarter-to-quarter fluctuations in U.S. Government deposits. The extent to which these fluctuations might be reflected in changes in money supply and/or in bank credit have to be predicted.

Short-run variations in U.S. Government deposits often appear to have been reflected in bank credit, given interest rates. As banks obtain an increase in Government deposits generated by, say, a surplus of Treasury tax receipts relative to outlays, bank credit rises as banks invest the funds, with the counterpart of this purchase of securities being the net sale of securities by businesses or high-income individuals who may be paying taxes, net, to the Treasury on a current basis. Similarly, when there is a sharp drop in Government deposits from an excess of outlays relative to tax receipts, this is reflected in a smaller increase in bank credit as those who are net receivers of Government funds invest them, at least temporarily, in short-term securities; the counterpart would be the sale of such securities by banks.

When banks acquire Government deposits at a time when the Treasury is a net issuer of debt, there is a positive effect on bank credit as expansion in bank investments and a rise in Treasury deposits occur concurrently as part of the same transaction. As these deposits are drawn down, there is a negative effect on bank credit as banks in effect sell the securities to the public, who can be conceived of as investing the funds dispensed by the Treasury.

It does not seem as though Government deposit variations are solely reflected in bank credit variations, however. Evidence is not clear, but there does seem to be some degree of substitutability at least in the very short run between Government deposits and private demand deposits. Private demand deposits in that case are temporarily reduced below or raised above desired levels as individuals and businesses receive net payments from, or make net payments to, the Treasury. It is difficult on *a priori* grounds to see why a change in Government deposits should effect a permanent change in the public's willingness to hold cash, given interest rates, though. And a one-or-two week rise in private demand deposits associated with a drop in U.S. Government deposits is likely to prove transitory unless the monetary authorities permit a substantial decline in interest rates.

When all these elements affecting bank balance sheets are put together, estimates are obtained of M_1, M_2, and bank credit for given Federal funds rates and Treasury bill rates. There is no reason, in view of the history of economic forecasting, to be very certain about the relationships that are established. As a result, it is best to think of relationships as ranges. Thus, one might expect, for a given rate of increase in M_1, the Federal funds rate might vary within a range that could be put as 1 or 2 percentage points around a central tendency.

A range for the Federal funds rate can be considered as a range of uncertainty with respect to projected relationships. On the other hand, policy makers may take a range for the Federal funds rate as representing the boundaries beyond which, for one policy reason or another, they do not wish the Federal funds rate to fluctuate during a specified interval of time. The technical range of the funds rate and the policy boundary range need not coincide, of course.

Alternative projected financial relationships can be readily developed using the same approach outlined above. Given the GNP, one can judge what Federal funds rate is likely to develop from a different M_1 growth, and then make estimates of alternative specifications for other monetary aggregates and interest rates.

When a quarterly pattern is set, for operating purposes it is desirable also to have monthly patterns, so as to provide bench-marks by which to determine whether current policy operations, as they are carried out, are on track of a desired longer-run path, assuming an aggregate objective. Monthly and also weekly levels of M_1 within a quarterly pattern can be projected using the best judgment possible. An infinite variety of weekly and monthly patterns can be consistent with a desired quarterly growth rate. One method for choosing a particular pattern would be to take the one that appears to minimize day-to-day instabilities in the money market and the credit market generally.

Fluctuations in Treasury deposits would be one factor influencing short-run projections of M_1. Information about special factors that might be influencing very recent tendencies in M_1, such as stock market fails or international currency crises, would also be taken into account in working out a projected weekly or monthly pattern of M_1 performance. Since projections can be undertaken on a seasonally adjusted basis, past seasonal variations are already taken into account in the forecast.

When a pattern of growth is established not only for M_1, but also for other deposits at banks that is consistent with a longer-run target for M_1, the required reserves needed to support such deposits can be determined for, say, the month ahead. (This also, of course, requires knowledge of breakdowns of deposits by city vs. country banks under the old reserve system and by banks by deposit size under the new reserve system.) The total required reserves can then be broken down between those behind so-called RPD-type deposits and those behind all deposits. RPDs represent reserves behind all deposits or other liabilities requiring reserves except U.S. Government deposits and net interbank deposits. The measure of RPD would include such required reserves plus excess reserves of banks. Thus, the projected relationships would have to include an estimate of the excess reserves banks are likely to want to hold at the interest rates likely, given a set of monetary aggregates indexed by a particular rate of growth in M_1.

With an estimate of excess reserves and a projection of short-run deposit behavior, an RPD target can be established which will serve as a short-run operating guide for purposes of achieving desired M_1 growth. One would not expect, of course, that all of any increase in RPDs would necessarily be supplied through the effect of open-market operations on nonborrowed reserves but that some might be provided through reserves borrowed from the discount window, depending on the relation between market rates and the discount rate.

As operations proceed, a different weekly or monthly pattern of M_1 and related reserves may develop and prove consistent with longer-run growth rates since very short-run propensities to hold cash on the part of the public are notoriously unstable and unpredictable. This would, of course, make for a certain amount of suspense in carrying out operations to achieve a longer-run M_1 growth rate.

It is not the purpose of this paper to discuss, once all financial relationships are projected, whether it is then best to operate monetary policy on the basis of a particular reserve measure thought consistent with all the relationships – such as RPDs, nonborrowed RPDs, total reserves, etc. – or a particular Federal funds rate. As is known, in recent months the Federal Reserve has been giving increasing attention to RPDs as an operating device to attain its financial objectives.

It is of some interest to know, however, whether such a complicated set of financial relationships would or would not provide information for policy that is more misleading than helpful. Some information on projected relationships has been published in the FOMC policy records. The following section takes information from the policy records, showing expected relationships between the Federal funds rate and M_1, and compares them with actual developments.

Projections and Results

The policy records published by the Federal Open Market Committee contain estimates of expected quarterly relationships between M_1 and the Federal funds rate – expressed with varying degrees of clarity – beginning in early 1970. Such estimates do not appear after the late summer of 1971. If we assume the Federal Reserve goes through a projection procedure somewhat as described in preceding sections, the published projected relationships can be compared with actual results to obtain a rough idea of the "success" of such a procedure.

We mean "success" in the narrow, technical sense of accuracy in projected relationships. We do not mean to be judging the success of particular monetary policies followed, however one might choose to define policy. To restate, projected relationships should not be confused with policy. The success of policy does not depend on whether initial expectations of an M_1 – Federal funds rate relationship are realized but depends rather on whether the actual financial impacts of monetary policy operations contribute in some optimal sense to attainment of the nation's economic goals.

If a particular rate of M_1 growth were optimal, then it would not matter if the projected M_1 – funds rate relationship were wrong so long as policy permitted the funds rate to vary while attaining M_1. If a particular funds rate were optimal, it would also not matter if the projected relationship were wrong so long as policy permitted M_1 to vary. As suggested earlier, policy for what may be good reason probably varies its emphasis on monetary aggregates relative to interest rates depending on economic and financial circumstances.

The table on the following page compares projected relationships from the policy record with actual results for seven quarters from the first quarter of 1970 through the third quarter of 1971. For most of that period only one set of relationships was shown in the policy record, but at times more than one was indicated. When there was a choice, we have chosen the one which contains the Federal funds rate closest to that which actually prevailed.

Some judgment had to be used in interpreting the policy record. The degree of specificity in the policy records does not permit a very accurate assessment of the Federal funds rate projected to be associated with a particular M_1. The record normally refers to money market conditions, and notes that for a given M_1 future money market conditions (presumably over the interval between meetings) are expected to be about prevailing, or a little tighter, or a little easier. We have used the recent Federal funds rate at the time of a meeting as a measure of prevailing money market conditions, and have indicated by sign whether it was expected to be greater or less than that. Examination of normal variation in the funds rate would seem to indicate that easing or tightening of the money market would mean a change in the funds rate of generally about ½ percentage point or less in an inter-meeting period – though sometimes the change was larger, as much as 1 percentage point.

Differences between projected and actual annual rates of change in M_1, assuming no significant difference between projected and actual Federal funds rates, are summarized in the text table below. There were, in fact, minor differences from time to time between the actual and projected Federal funds rate, and these can account for some of the differences between the actual and projected rate of change in M_1. There were no doubt also differences between projections of the rate of increase in nominal GNP for a quarter and the actual results. This would, of course, contribute to differences between projected M_1 – Federal funds rate relationships and actual results. However,

PROJECTED RELATIONSHIPS AND ACTUAL RESULTS
(ΔM_1 REPRESENTS SEASONALLY ADJUSTED ANNUAL RATE OF CHANGE; r_f REPRESENTS FEDERAL FUNDS RATE)

	1970								1971					
	I		II		III		IV		I		II		III	
Policy Record	ΔM_1	r_f	ΔM_1	r_f	ΔM_1	r_f	ΔM_1	r_f	ΔM_1	r_f	ΔM_1	r_f	ΔM_1	r_f
Last month of preceding quarter	—	—	3	<8.5	5	<8	5	<6.5	>3.4	5–5.5	>8.9	3.5	9–10[2]	>4.75
First month of quarter	0	9	3	7.25–8	5	7–7.625	5	6.125	7.5	<4.5	>8.9	3.75–4	9	>5.125
Second month of quarter	3–4	9	4	8–8.5	5	<6.5	4	<5.75	6	3.75	8.5	4.5	9	5.5
Third month of quarter	2	<8.5	7[1]	8	4.5	6.5	5	5–5.5	7	3.5	12.0	4.5–4.75	<9	>5.5
Actual														
First published	3.8	8.5	4.2	7.875	5.1	6.75	3.4	5.5	8.9	3.875	11.3	4.5	3.0	5.25
Latest revised	(5.9)		(5.2)		(6.5)		(3.8)		(9.1)		(10.6)		(3.7)	

[1] Meeting of May 26

[2] Meeting of June 8

the FOMC policy records do not contain specific enough information on GNP projections to permit a comparison of actual and projected GNP.

SUMMARY OF DIFFERENCES BETWEEN M_1 PROJECTIONS (GIVEN FUNDS RATE) AND ACTUALS (DIFFERENCE IS AVERAGE OF ACTUAL ANNUAL RATE OF CHANGE AND PROJECTED RATES OF CHANGE FOR THE QUARTERS 1970 I THROUGH 1971 III)

	As 1st Published		As of Latest Revision	
	Without regard to sign	With regard to sign	Without regard to sign	With regard to sign
Last mo. of preceding qtr.	2.4	−1.7	2.7	−.8
First mo. of qtr.	2.4	− .2	3.0	+.8
Second mo. of qtr.	1.8	−.04	2.3	+.7
Third mo. of qtr.	1.6	− .1	2.1	+.6

Under the circumstances, the differences shown in the summary table at best serve as only very crude indications of success in projecting relationships. And it must be remembered that differences are expressed as annual percentage rates of change, which tend to magnify the extent of error on the level of M_1. For a quarter, for example, an error of 2 percentage points at an annual rate would represent an error of ½ of 1 percent, or about $1 billion, on the level of M_1. The level of M_1 varied from $205 billion in early 1970 to over $225 billion by the end of summer 1971.

As may be seen from the first column of the text table, the average miss in M_1 was almost 2.4 percentage points at an annual rate at the beginning of a quarter and generally improved as the quarter progressed. In the middle of a quarter the average was 1.8 percentage points at an annual rate. The misses tended to be offsetting, and the second column shows virtually insignificant misses when "plus" misses are averaged against "minus" misses. This might be interpreted as indicating the absence of bias in the projections; one is just as likely to miss in one direction or another. It might also be interpreted as suggesting that a projected relationship will prove out over a longer run than a quarter.

The third and fourth columns of the text table show results after the annual revision for bench mark and other corrections had been made. This increases the degree of error to a modest extent. The increased error is mainly a result of the special circumstances of 1970, however, when there was an unusually large correction in M_1

figures. In that year new figures were obtained to adjust for a downward bias in M_1 growth that occurred because of increasing check clearing activity through New York banks during the year for agencies and branches of foreign banks and Edge corporations.[1]

It is a little difficult to know what to make of the result that FOMC records indicate that for a given Federal funds rate M_1 growth was predicted with an error (without regard to sign) of around 2 percentage points at an annual rate. If the FOMC had been adhering to a Federal funds rate rigidly as a day-to-day operating guide, and if a particular M_1 initially associated with the funds rate were an objective, the objective would not have been attained in a particular quarter.

But there is no need to believe that a Federal funds rate is a rigidly held operating target, nor is there reason to believe that objectives have to be attained within one quarter – an M_1 objective could average out over two quarters for instance. And to the degree that M_1 were an objective, the funds rate would not be rigidly held. The increased emphasis on reserves in recent months would in itself appear to suggest more day-to-day flexibility for the funds rate. If and when data become available, it would be interesting, of course, to test out the projected relationship between RPDs and M_1.

Whatever was in fact the emphasis on a particular M_1 as a target, the results suggest that projections of financial relationships over a period of a quarter had their deficiencies, but probably not so great as to throw policy very far out of kilter. In the current state of economic knowledge, it would be hard to argue that we know what M_1 should be obtained for a desired GNP within a range of precision that is represented by 2 percentage points at an annual rate for a particular quarter. In any event, a 2 percentage point miss, at an annual rate for a quarter, is not very large since it can fairly readily be made up in a subsequent quarter and adjustments in that direction can be set in train during a current quarter. Moreover, there is no evidence that we know of which suggests that a moderate M_1 miss for a quarter, or even two quarters, relative to a desired trend, has significant impacts on GNP. Thus, the projected relationships do not seem so bad that they are capable of throwing the FOMC off a desired M_1 path, if there were such a path and if that path were construed as of at least six months in duration.

[1] See "Revision of the Money Stock", *Federal Reserve Bulletin,* Dec. 1970.

One cannot really know, though, to what extent projected relationships affected the extent to which M_1 was taken as a target, or what rate of growth in M_1 was desired, or acceptable, to the extent it was a target. One would suspect that relationships between financial variables and desired future GNP would be more important in conditioning an M_1 target or an interest rate target, depending on the degree to which FOMC members had more faith in an M_1 to GNP relationship or in an interest rate to GNP relationship.

Whether one does or does not believe that an effort to have an M_1 target for policy requires estimates of demand relationships among M_1, other monetary aggregates, and interest rates, it does seem clear that an M_1 target requires reliable and timely statistics to measure money supply. The money supply statistics, in particular the extent to which they have been revised, are discussed in the succeeding section.

Money Supply Statistics and Revisions

The daily average money supply series published by the Board is a constructed series based on member bank deposit data, weekly condition reports of large commercial banks, Federal Reserve Bank balance sheets, call reports and items of information collected from Edge Act Corporations and agencies and branches of foreign commercial banks.[2] This series is published weekly with an eight-day lag; that is, the first estimate published for a statement week ending Wednesday comes out a week from the subsequent Thursday. These estimates are usually revised to a degree over the weeks immediately following publication, as new or revised figures dribble in. These revisions are usually small before being "finalized" in about three weeks; over the past year and a half, for example, revisions have been $100 million or less 50 percent of the time and $300 million or less 80 percent of the time. A major annual bench mark[3] and seasonal factor revision is undertaken, however, in the fall of the year, and this usually accounts for the bulk of revisions.

[2] For explanation of the series, see "A New Measure of the Money Supply," *Federal Reserve Bulletin,* October 1960, and "Revision of the Money Stock," *Federal Reserve Bulletin,* December 1969 and October 1970.

[3] Roughly 25 percent of the M_1 series is estimated on the basis of call report relationships; call report data are available for the end of June and at the end of December with about a two- or three-month lag.

Revisions aside for the moment, week-to-week variations in the money supply are large and appear to reflect a considerable amount of short-run noise. Thus, a month might be taken as the minimum unit of time (and even this could be too short on economic grounds) for which it is reasonable to compare first published and revised figures. The first published seasonally adjusted annual rates of growth for a month for the years 1961 through 1971 are compared with such growth rates derived from the currently published series in the chart on the following page. Roughly 26 percent of the differences shown are no more than 1 percentage point, at an annual rate, and roughly 65 percent of the differences shown are no more than 3 percentage points, at an annual rate. Annualizing monthly rates of change – which is done for ease of comparing months, quarters, and years – tends to exaggerate differences, of course. At current levels of M_1 these annual rate percentage differences represent from \$200 to \$600 million in the monthly average level of the series. And such absolute differences represent only about one-fifth of a percentage point of the level of the series.

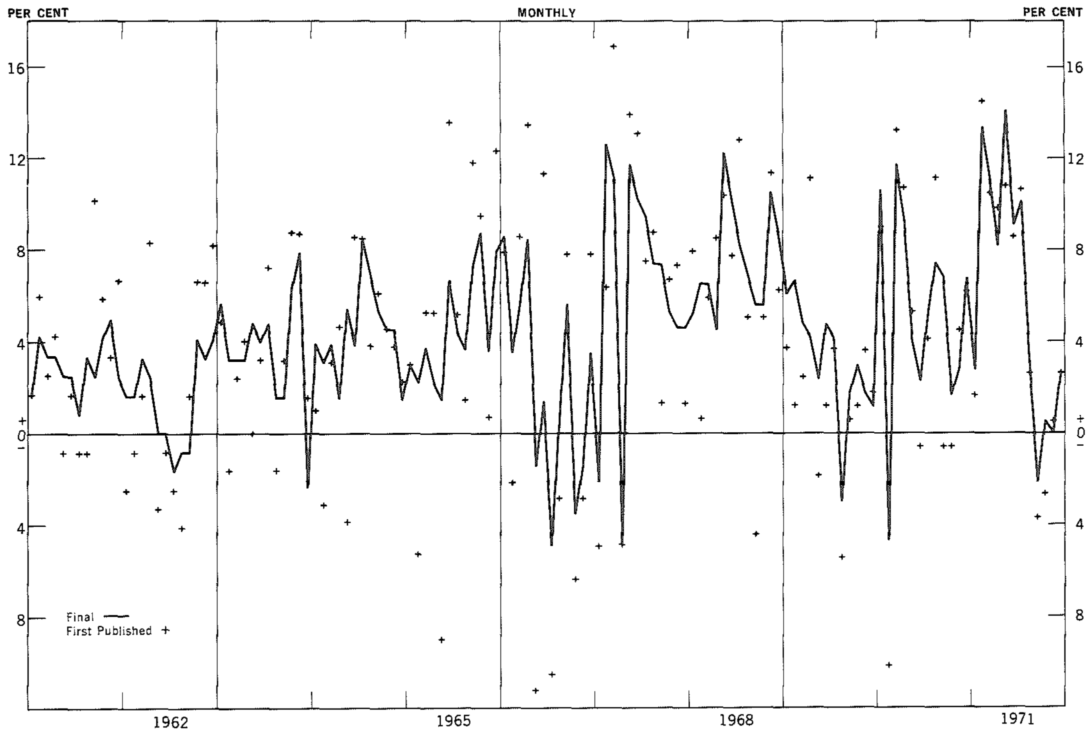
On a short-run basis the money supply is clearly subject to shifts from the time it is first published until it has completed successive bench mark and seasonal reviews and becomes "final." But these shifts primarily affect the intra-yearly movement of the money supply. Changing seasonal factors, which are the source of most of the difference between first published and final monthly (and also quarterly) growth rates have to offset within a 12-month period. Bench mark adjustments are usually small (though there were relatively sizable measurement improvements made at bench mark time in 1969 and 1970) and have little effect on monthly growth rates since these adjustments are spread throughout the 12-month period.

As a further check on the reliability of the monthly series, the correlation between the first published and current money supply monthly annual rates was calculated first for the entire period from 1961 to 1971 and for two subperiods 1961 to 1967 and 1968 to 1971.[4] The subperiods were selected to see if there was any measurable difference in the correlation before and after sizable adjustments that were made for Eurodollar float and for cash items in the process of collection that had been inappropriately deducted. The correlation coefficient for the entire period was .767. For the subperiods

[4]This analysis follows very closely that used in an earlier study. See William Poole, "Rules-of-Thumb for Policy," *Open Market Policies and Operating Procedures – Staff Studies,* Board of Governors of the Federal Reserve System, July 1971.

CHART 1

COMPARISON OF MONEY SUPPLY GROWTH RATES



1961 to 1967 and 1968 to 1971 the correlation coefficients were .740 and .832, respectively. Correlation coefficients of this magnitude may not be as high as one might hope for in a series that might be used as a guide for monetary policy purposes. Nevertheless, the monthly first published money supply figures do appear to be reliable enough to be used for policy guidance purposes. This is particularly so if it is recognized that monthly variations in M_1 growth have little economic significance as such, with much greater significance to be attached to a longer-run average annual rate of growth.

To lengthen the time horizon for checking on the reliability of first published money supply statistics, annual growth rates first published for a quarter were computed and compared to current quarterly growth rates. On a quarterly basis the coefficient of correlation for the entire 1961-71 period rose to .920. For the 1961 to 1967 subperiod R was .922 and for the 1968 to 1971 period R was .948. All of these correlation coefficients show significant improvements over the monthly relationships.

It may be of some interest to compare money supply revisions with revisions in other economic series. Almost every economic series used by policy makers and economic analysts is subject to annual bench mark and seasonal factor revisions as well as other major adjustments from time to time. We have compared revisions in the money supply with revisions in one of the series – nominal GNP – that reflects an ultimate objective of policy. Coefficients of correlation for final and first published GNP growth rates for a quarter were calculated for comparison with the quarterly money supply growth rate revisions. The correlations between first published money supply and GNP growth rates and their respective revised figures are little different for the entire 1969-71 period and for both subperiods, although in two of the three periods the final money supply growth rates correlate more closely with first published figures than do the GNP series.[5]

Another way to look at the relationship of the final to the first published growth rates is to use a simple regression equation; final growth is a function of first published growth. This simple regression equation was applied to the quarterly money supply and quarterly GNP growth rate data. The regression results are shown in the following table. When the quarterly GNP and money supply equations are

[5]For the whole period 1961-1971, the correlation for GNP was .852 as compared with a .920 for M_1. For 1961-1967, and 1968-1971, the GNP correlations were .821 and .959, respectively, compared with .922 and .948 for M_1.

compared, the fit of the money supply equation is generally better than the fit of the GNP equation. On the basis of the regression coefficients for the 1961-1971 money supply equation one can say that given a first published quarterly growth rate of 8.0 percent, the best point estimate of the final growth rate would be 7.8 percent. Further, there is about one chance in three that the final growth rate will fall outside of a 6.7 to 8.8 percent range.

In addition to being reliable, money supply figures must be timely if they are to be used as a guide for the implementation of monetary policy. The figures published weekly with an 8-day lag represent the first fairly-firm indication of the most recent tendencies of M_1. The Federal Reserve does have earlier figures, based on sample information for smaller banks and daily deposit reports of larger banks. These can be used as an interim guide, but the extent of revision in the data is considerably larger than between the first published weekly estimate and the subsequent "final" figure. Efforts are, of course, being made to speed up data reporting, and to devise methods to improve early estimates based on partial reporting (including reports from a possibly shifting sample of banks depending on which banks in a particular week turn out, for one reason or another, to report earlier than others).

Other problems relating to the construction of the money supply series are also being investigated. These include the best method of resolving the perennial seasonal adjustment problem (not excluding the question of what meaning, if any, can be attached to a seasonally adjusted M_1 series if it were assumed to be policy-determined); timelier reports from nonmember banks; investigations into biases in the level of M_1 resulting from such items as deduction of inappropriate "cash items" related to U.S. Government checks or to other bank liabilities not currently included in M_1.

In addition to improvement of the money supply as currently defined, work is also proceeding on conceptual problems of the money supply. It is not our intention to enter into that large subject, which requires a paper to itself. But we might mention issues such as the proper role of foreign deposits in U.S. banks and of U.S. individuals' or firms' deposits held abroad (as Eurodollars or otherwise); questions as to how float (checks in transit) should be treated in the calculation of money supply; and the role to be assigned time and savings deposits and other assets which to greater or lesser degrees substitute for demand deposits (and may even serve directly as a means of transactions if regulations such as those permitting savings and loan associations to make third-party transfers for certain types of transactions become more widely used or more broadly applicable).

SIMPLE REGRESSION EQUATIONS OF FINAL MONEY SUPPLY AND GNP GROWTH RATES ON FIRST PUBLISHED MONEY SUPPLY AND GNP GROWTH RATES
(Quarterly Average Data)

	Constant	Regression Coefficient	R^2	S.E.
1961-1971				
M_1	.933 (3.68)	.845 (15.20)	.846	1.026
GNP	1.696 (3.14)	.806 (10.56)	.726	1.394
1961-1967				
M_1	.882 (3.14)	.768 (12.16)	.850	.881
GNP	2.527 (3.78)	.706 (7.32)	.673	1.494
1968-1971				
M_1	1.555 (3.65)	.870 (11.20)	.900	.897
GNP	−0.767 (−1.20)	1.112 (12.65)	.920	.833

NOTE: t-values in parentheses

Concluding Comment

We would first like to note again that this paper did not concern itself with the critical economic question of whether money, somehow defined, interest rates, or both in some mixture, should be the immediate target(s) of monetary policy. The paper was a much more limited effort to determine how projected relationships between M_1 and other financial variables and how data revisions in M_1 might affect the possibilities of achieving an M_1 target.

The material we have reviewed does not suggest that the rate of change in M_1 under present circumstances technically cannot be taken as an immediate target of monetary policy, provided that it is not important to hit a pre-determined target weekly, monthly, or possibly even quarterly. The length of time over which it is important to be able to achieve an M_1, or any other immediate, policy target is an empirical question. The work we have seen, particularly that of Messrs. Pierce and Thomson of the Board staff,[6] suggests that if an M_1 growth rate can be achieved over a period of three to six months, significant economic disturbances will not be caused by shorter-run deviations around the growth path.

The revisions that have occurred in M_1 growth rates have been fairly sizable for months but have been less for quarters (as would naturally be the case since much of the revision results from changing seasonal factors), although in one or two years impacts on quarterly growth rates have been noticeable. And while conclusions with respect to projections and their use are highly subjective, projected relationships between M_1 and other financial variables do not appear to have been an insuperable obstacle to achieving an M_1 objective. The Federal funds – growth in M_1 relationship would have led to misses in the rate of change of M_1 by about 2 percentage points on average in any given quarter, but if a quarterly M_1 growth rate were a rigidly-held target, the funds rate could have been permitted to vary. However, because of lagged relationships between money demand and interest rates, if the funds rate is too high or too low relative to desired growth in M_1 long enough, the funds rate variation required to achieve a particular growth rate in M_1 may be so great as to make it practically impossible to achieve the desired growth rate within a quarter. In that case, one would have to attain a target over a longer-run – say, a six-month period.

Nevertheless, the extent of revision in incoming M_1 statistics (including particularly revision of the early, pre-publication figures) makes it difficult to modify day-to-day open market operating decisions on the basis of the very current flow of M_1 data. One is likely to be conservative in adjusting operations because of the likelihood that preliminary M_1 figures will be revised substantially and in unpredictable ways. This raises the danger that needed modifications in a bank reserve or Federal funds rate operating target might not be undertaken until too late (or will be undertaken too soon) to achieve, say, a quarterly M_1 objective – given continued constraint on the degree of fluctuation permitted in money market conditions and the extent of lag, and elasticity, in the relationships between interest rates and money demand.

It seems clear, therefore, that so long as M_1 is considered an important near-term policy target, further improvements in the accuracy of the data will be required. And further research on the

[6] See their paper in this volume.

relationship between M_1 and interest rates will be needed, so as to be better able to determine what is the range for a Federal funds rate constraint, if such constraint there must be, that would be most consistent with a growth in M_1 objective, if such an objective is desirable.

DISCUSSION

KARL BRUNNER*

The Committee on Banking and Currency of the U. S. House of Representatives published in 1964 a critical study surveying Federal Reserve policymaking.[1] This study questioned both the diagnostic procedure and the established strategies. It argued that the traditional diagnosis produced serious misconceptions of monetary events. Policies were frequently characterized as "tight" when the Federal Reserve's behavior was actually expansionary, or they were described as "easy" when this behavior was actually deflationary. Systematic misinterpretation converted the downswing of 1929 into the secular disaster of the Great Depression. The same misinterpretation also explains repeated experiences of apparent failure of monetary policy. The appearance of failure or impotence was created by the negative association between rhetoric and action conditioned by a persistent misinterpretation of monetary policy and monetary events.

The Committee study also argued at the time that the Federal Reserve's strategy was usually centered on one form or another of money-market conditions. Changes in the Federal Reserve's portfolio of securities and other policy actions were adjusted in response to desired and actual patterns on the money market. A money-market strategy converts rising pressures on market rates of interest into accelerations of the monetary base and eventually accelerating aggregate demand for output. Conversely, the strategy converts a faltering demand on credit markets into decelerations of the base and retardations of economic activity. This result holds quite generally and does not depend on specific monetarist hypotheses of the transmission mechanism or about the dominant impulse force driving the economy. A Neo-Keynesian view of the transmission mechanism and some Wicksellian hypothesis of the dominant impulse force yield the same implications.

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[1] U. S. Congress, House Committee on Banking and Currency, *An Analysis of Federal Reserve Monetary Policy Making*, prepared by Karl Brunner and Allan H. Meltzer, 1964.

Traditional diagnosis and strategy were conditioned by the Federal Reserve's governing conception of the money supply process expressed by the free-reserve hypothesis. This hypothesis emerged during the 1920s under Governor Strong's leadership in a special form centered on the role of bank borrowing from the Federal Reserve System. It became codified in the writings of Burgess and Riefler in the late 1920s and early 1930s. But the experience of the 1930s forced several modifications of the inherited conceptions. The Strong-Burgess-Riefler doctrine became gradually transmuted into the free-reserve conception of the 1950s and 1960s. This view assigned to the level of free-reserves and assorted money-market conditions a causal role of central significance. The rate of adjustment of the commercial banks' portfolio of earning assets and thus the supply of bank credit depended under this view on the level of free reserves and the money-market conditions. This causal link justified the frequent use of free reserves both as an indicator to guide the interpretation of monetary policy and also as a target controlling the adjustment and execution of open-market policies.

Dominance of the Free-Reserve Doctrine

The free-reserve doctrine dominated official views for many years. This view should not be imputed however to the staff members of the research division. It prevailed at the operational and policymaking levels of the Federal Reserve System. It is remarkable to observe at this date that the free-reserve conception has been fading away for several years. Some lingering traits still remain, most visibly at the Friday briefing of the Wall Street Journal on the money-market conditions. The fading of the free-reserve doctrine also affected the traditional diagnosis and strategy. Strict and unquestioned adherence to a money-market strategy has been abandoned even on the operational and policymaking levels of the Federal Reserve System. The traditional diagnosis has also waned and is not propounded with the vigorous naivite of the 1950s or earlier 1960s. We observe less frequently that rising free reserves and falling short-term rates are interpreted as symptoms of an expansionary policy, or falling free reserves combined with rising short-term rates are interpreted to indicate a more restrictive policy. This change does not mean that the Federal Reserve authorities have accepted the monetarist interpretation or concentrate on monetary growth as the optimal target guiding the FOMC's policy procedure. It essentially means that a somewhat vaguely mixed position stressing simultaneously the relevance of interest rates or money-market conditions and monetary aggregates replaced the traditional diagnosis and strategy.

These changes accompanied the gradual emergence of the money-market theory of the money-supply process. The older theory represented by the free-reserve doctrine had evolved on the operational levels of the Federal Reserve System with almost no exposure to economic analysis. The money-market theory developed on the other hand from the work of staff economists. It surfaced for the first time in a paper articulating the Federal Reserve's counter-critique prepared by Lyle Gramley and Samuel Chase for the *Federal Reserve Bulletin* of October 1965. Its structure has been incorporated into the description of the monetary system of the Fed-MIT model and it is represented also in papers recently prepared by Richard Davis and James Pierce. The money-market theory centers the description of the money-supply process on the Walrasian money market. Variations in interest rates adjust the implicit demand and supply of base money on this market. This contrasts with the credit-market theory which centers the process on a credit market. The difference between the two alternative theories is conditioned by a fundamental issue in contemporary monetary analysis, *viz.* the relevant range of substitution relations centered on money. The money-market model expresses the Keynesian view that these relations are constrained to money and some financial assets of the same risk class. The credit-market theory on the other hand is based on the denial of such restrictions and follows from an explicit assertion that money substitutes over the whole spectrum of assets. It follows that in a "Keynesian world" the public's money demand and asset supply to banks are identical, whereas they are separate and independent behavior patterns in a Non-Keynesian world. It also follows that the money-market theory assigns to the public's money demand a central position in the process. In this view the properties of money demand dominate the outcome.[2]

[2]The reader will find a detailed comparison between the "credit-market theory" and the "money-market theory" in my forthcoming paper on "Two Alternative Theories of the Money Supply Process".

Variability of Money Demand

This Keynesian money supply theory has been supplemented in many Federal Reserve discussions with a special hypothesis asserting the fragile, volatile or highly unstable nature of the public's money demand. This instability hypothesis of money demand has been particularly cultivated on the operational and policymaking levels of the Federal Reserve System. There is nothing inherently "Keynesian" about this conjecture. It satisfies on the other hand an established institution's desire for operational continuity. The money-market model supplemented with this conjecture offers support for the traditional attention to an interest target. It is, however, not a sufficient argument. William Poole has demonstrated that the variability of money demand *relative* to the variability of aggregate demand for output forms the crucial condition and not instability *per se*. Still, it remains true that an interest-target policy effectively screens economic activity from the volatile behavior of the public's money demand according to the money-market theory. Another implication of the money-market model formulated in conjunction with the hypothesis of volatile money demand and an interest-target policy bears on the interpretation of observable changes in the money stock. All changes in the money stock are attributable to the inherent instability of money demand. This implication has been used in recent years by members of the policymaking body or of the operational staff to absolve the Federal Reserve from any responsibility for the observed accelerations or decelerations in the money stock. This absolution is more impressionistic than real however. The reduction of all variations in the money stock to the variability in money demand is crucially conditioned by the empirical relevance of the money-market model and the Federal Reserve's obsession with an interest-target policy. The reduction does not hold for an alternative money-supply theory, even in the context of an interest-target policy. Moreover, the association between money stock and money demand depends, within the confines of the money-market model, on the Federal Reserve's traditional strategy. The Federal Reserve's responsibility for this strategy is thus transferred to the variability in monetary growth resulting from the variability in money demand *under this strategy*. Still, the Federal Reserve authorities can argue that its traditional strategy protects economic activity from the variability in money demand. This assertion is conditioned, however, by two questionable empirical hypotheses. The assertion depends on the relevance of the money-market theory and the postulated variability of money demand. The assertion does not hold under an alternative theory of the money-supply process which is based on the assumption that money substitutes over the whole spectrum of assets. The alternative analysis implies that a volatile money demand is transmitted to economic activity even with a rigid policy geared to an interest target.

The Federal Reserve's presumption about the character of money demand assumes thus a crucial role. It is remarkable that the weight attached by policymakers and members of the operational staff is not matched by a similar weight of evidence supporting the frequent contentions that money demand has shifted. Actually, a note prepared by Michael Hamburger and to be published in the *Journal of Money, Credit and Banking* establishes that the studies prepared by staff members of the Research Division of the Board of Governors and the Federal Reserve Bank of New York strongly disconfirm the hypothesis of a volatile money demand. These studies deny in particular that major accelerations or decelerations of the money stock observed over the past few years can be attributed to the vagaries of money demand. It would appear that the Federal Reserve should pursue the reexamination of inherited positions and views somewhat further and with deliberate vigor.

The Role of Analysis

The paper submitted to this conference by Axilrod and Beck offers some interesting material bearing on the reexamination initiated in recent years. The authors remove the target problem with an insistent agnosticism and the obvious compromise. This prudent compromise performed within the confines of a money-market model explains probably the peculiar procedures evolved by the FOMC over the past years and described in some detail by the paper. The procedure centers on some projections involving money stock and interest rates. The projections are apparently based on a money-market conception of the money-supply process. But the detail is blurred and an exact interpretation is barely possible to the uninitiated. It is not clear whether the authors project a family of money stock-interest rate *combinations* once a forecast for GNP is fixed. This family would be expressed by a *single* projected relationship. On the other hand, the reader wonders on occasion whether the projection mentioned involves a family of *relations* expressing different beliefs about money demand factors omitted in the explicit analysis, based possibly on some regressions. The ambiguity can be stated in terms of a matrix with rows representing given money stock levels and columns with levels of the Federal funds rate. The account leaves obscure whether discussions are centered on the diagonal of the matrix or the whole matrix.

The initial ambivalence is reinforced by the subsequent description. Enter now the policymakers' judgments, possibly supplemented with some unrevealed analysis. A particular point (or relation) on the projected relation (or projected family of relations) must be selected. This selection may also involve a particular association between two *ranges* of money stock and Federal funds rate. Moreover, judgment may, or may not, substantially modify the projected association of selected ranges. One wonders at this stage what happened to analysis and what the role of analysis really is. It appears to offer no more than a more-or-less definite proposal to initiate a discussion at the FOMC. This discussion is however essentially "liberated" from the drudgeries of analytical requirement. It seems anybody's guess how much of the ancient "tone, feel and color" still remains with a different vocabulary. The reader of the Axilrod-Beck paper wonders about the appropriate interpretation of the procedure. Should he infer from the freewheeling intrusion of the FOMC's judgment that the underlying analysis submitted to the FOMC is of dubious quality and marginal relevance? Or should he infer that the FOMC cannot recognize relevant analysis with potentially useful applications? The reader finds moreover no clue to the proper interpretation of the eventually-selected combinations. Should we consider them as targets imposed on monetary policy? Or should the projections be regarded as an expectation expressing a consensus? Or do they reveal the social preferences of the FOMC negotiated in policy discussions? This unresolved ambiguity explains the absence of any relevant information about the response of the Federal Reserve authorities to emerging differences between the eventually-projected combination and the actual trend. The discrepancy *may* be accepted by the monetary authorities or *may* induce some appropriate actions. But we learn nothing from the paper concerning the conditions which determine either neglect of the discrepancy or some specifiable adjustments. Should we infer that the Federal Reserve authorities randomly decide that substantial deviations from the projections do not matter or are actually desirable? If this were the case the initial choice of the FOMC would be judged irrelevant or false. Or should we suspect that old patterns of behavior persist under the camouflage of a new procedure and a new vocabulary? This would be the case if deviations are disregarded in order to maintain an implicitly desired course of the Federal funds rate. The reader also wonders about the connection between the projections prepared for a particular quarter and the GNP forecasts made for *subsequent* quarters. I confess even more curiosity about the connection between the failure of a projection for a given quarter and the forecasts already prepared for GNP in subsequent quarters. The discussion is decently obscure and sufficiently empty to preclude useful answers. One wonders therefore whether the FOMC could really provide any useful answers for these questions.

The problems of interpretation extend also to the authors' tabulation comparing projected and observed values over a sample period selected from recent years. The ambiguities of the procedure yielding the projections necessarily blur the meaning of this table. What does it really establish? Do we learn from it the relative adequacy of target achievements, or the relative ease of sacrificing established targets? Do we obtain information about the FOMC's skills in determining expected values by political consensus? Or do we acquire information concerning the closeness of negotiated social preferences and their realization? The paper offers no answers to these questions but vaguely suggests that the deviations are not too bad. But what it is that is measured more or less adequately stays a mystery. The tabulation remains for the reader essentially an empty exercise. This conclusion is reinforced by the reader's difficulty in reconstructing the table from published material. Economic analysis appears still consigned to a dubious and uncertain role in the political councils of Federal Reserve policymaking.

Two other themes of the paper reinforce the reader's doubts concerning the use of analysis in Federal Reserve procedures. The authors assert for instance that "short-run variations in U. S. government deposits often appear to have been reflected in bank credit, given interest rates". They also write that "evidence is not clear, but there does seem to be some degree of substitutability. . . between Government deposits and private demand deposits". The argument linking "bank credit" and Treasury deposits fits without strain into the old textbook chapters on the determination of the money stock and bank credit. A substantial development of money-supply theory over more than a decade seems to have completely bypassed the authors. It is also remarkable that staff members of the Federal Reserve System complain about the inadequate evidence available bearing on the impact of variations in Treasury deposits on private deposits or money stock and bank credit. Surely, this problem can be successfully examined. It appears that either the authors are poorly informed about the work of the research staff, or the FOMC has not directed the research staff to acquire some relevant information for a reliable appraisal of Treasury deposits in the money-supply process.

RPDs As The Target

The authors' discussion of the role assigned by the authorities to RPDs (i.e. volume of reserves held by banks against private deposits) touches another theme. This magnitude has recently emerged as the target variable preferred by the FOMC among the monetary aggregates. The paper outlines how the desired, preferred or expected volume of RPDs is linked with the projected combination of money stock and Federal funds rate. Once this volume is derived it is apparently used by the FOMC to track proximately the course of the money stock. The paper offers however no explanation or analytic justification for the choice of RPDs as a target variable, or whatever it is that it is used for in the Federal Reserve's procedures. Albert Burger presented in his paper an excellent critique of the RPDs which need not be repeated here. The reader wonders of course why the FOMC strained itself to construct such a measure when better and more useful measures with at least some analytic and empirical support are available. The reader also wonders why the FOMC, or the Board for that matter, did not request a detailed comparative study by the research staff in order to guide its choice of suitable measures guiding its assessments and constraining the Account Manager's actions.

In summary, the Axilrod-Beck paper is actually quite informative, in some indirect fashion, about the current state in the Federal Reserve's policymaking. So where do we stand? We certainly note some changes since the early 1960s. The free-reserve doctrine may not be dead, but it certainly faded away like a good old soldier. With it faded also the naive concentration on money-market conditions to interpret monetary events and guide monetary policy. It appears that academic and Federal Reserve economists agree that interest rates or money-market conditions are a poor target to guide monetary policy beyond the very short-run. But the ambiguities and ambivalences of the paper also reveal serious problems in our policymaking procedures. We note foremost the unresolved issue of the target or strategy problem. Some economists and probably most of the Federal Reserve staff attempt to preserve a money-market approach for shortest-run adjustment with suitable constraints producing the desired monetary growth beyond the shortest-run, say over a period of two quarters. The procedure developed in recent years and described in the present paper may be understood to form such an attempt. But this attempt remains haphazard and unreliable. Its execution also failed during 1971. The target problem is not unsolvable. James Pierce presented some studies in the first volume on *Controlling Monetary Aggregates* published by the Federal Reserve Bank of Boston which offered a potentially useful and interesting avenue. It is regrettable that such studies were discontinued; at least the outside observer sees no further evidence of such studies. The study of Albert Burger presented at this Conference also offers an interesting avenue worthy of serious exploration. It would require however a somewhat greater willingness on the part of the staff members at the Board of Governors to examine and pursue seriously ideas which do not necessarily fit their accustomed preconceptions or paradigmatic constraints. It appears particularly important to reexamine in this context the rationale of short-run stabilization of interest rates. There can be little doubt that this policy induced large variations of interest rates over cyclic phases. The cost was very high indeed over the past years. What is the social benefit, an illusion of the Account Manager? Another request addressed to the Federal Reserve's staff bears on the money-market theory of the money-supply process. It would be useful to develop an explicit awareness of the world described by this conception. It is a world which perpetuates the ancient confusion of money and credit. It assigns perturbations to money demand which more probably are assignable to the public's loan demand or willingness to hold securities. Moreover, these perturbations in loan demand or the stock demand for securities are not necessarily mirrored in the demand for money. The Federal Reserve's special hypothesis of a volatile and unstable demand for money requires of course particular attention. I challenge the Board's research staff to apply their skills to this issue and either offer evidential support for this so far purely impressionistic contention, or convince the FOMC and the staff at the Federal Reserve Bank of New York to abandon this unfounded idea. And beyond these questions we would naturally ask what the rationale of the procedure described by the authors is, and more importantly, what the procedure *really* is.

Further studies of appropriate strategies will no doubt yield proposals for substantial changes in policymaking procedures. These studies should also attend to important problems associated with the controllability of the money stock. The authors discuss one of these issues and offer some interesting comments. They examined the extent of the revisions in the money stock measures. I suggest that the measurements procedures require serious reexamination. We need at least two distinct measures, one expressing the domestically-held money stock and one the total money stock. I would argue that our current measure forms essentially a rather strange concoction with its treatment of foreign claims and liabilities of U. S. banks, or the treatment of cash items in process of collection. The seasonal adjustment of the raw data forms probably even a more serious problem. This problem has been recently discussed in an interesting paper by William Poole. It is difficult to interpret a seasonal adjustment which is arbitrarily determined by the Federal Reserve's policymaking procedures. We thus experience substantial difficulties in interpreting monetary evolutions within one year – and most particularly over a few months.

Lastly, a variety of institutional changes were introduced over the past decade. The reserve requirements were substantially complicated and the ceiling rate on time deposits became repeatedly a serious constraint. Concern with the development of an optimal strategy should be extended to investigate the nature of institutional arrangements which improve the degree of control over monetary growth exerted by the Central Bank. This problem has been quite neglected by economists and barely considered by Central Banks. I conjecture that a serious examination of this problem could yield useful proposals of substantial improvements in many countries.

My requests are addressed to the research staff of the Federal Reserve System. Ultimately, progress depends on the policymakers' willingness to use their research facilities to prepare the information required for rational policymaking. This willingness and interest on the part of the Board and the FOMC determines the research staff's ability to communicate with the policymakers. It also determines in the longer run the quality and the nature of the research pursued. But we cannot expect an established and fundamentally political institution to modify its procedures and impose systematic constraints on the free-wheeling judgment of the policymakers. Changes will at best emerge in response to persistent pressures from the outside. This seems to be the function of independent academic researchers and also the function, a very crucial function indeed, of the press and various forms of information media. The changes observed over the past ten years in major newspapers (e.g., *Wall Street Journal* and *New York Times*) concerning the mode of discussion applied to monetary or banking problems effectively contribute to maintain the necessary outside pressure on an entrenched institution.

Some Issues in Controlling the Stock of Money

JAMES L. PIERCE and THOMAS D. THOMSON*

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:

$$(4)\quad M = (a_1 b_2/(a_2+b_2))Y + (a_2 b_1/(a_2+b_2))R + (a_2/(a_2+b_2))v + (b_2/(a_2+b_2))u \;.$$

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,

$$(6)\quad M = a_1 Y - a_2 r + u \;.$$

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

$$(7)\quad M^T = \left(\frac{a_1 b_1}{a_2+b_2}\right)\hat{Y} + \left(\frac{a_2 b_1}{a_2+b_2}\right)R$$

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

$$(8)\quad M^T = a_1\hat{Y} - a_2 r \;.$$

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

$$(9)\quad (M - M^T)^R = \left(\frac{a_1 b_2}{a_2+b_2}\right)(Y - \hat{Y}) + \left(\frac{b_2}{a_2+b_2}\right)u + \left(\frac{a_2}{a_2+b_2}\right)v$$

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

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

The variance under the interest rate regime is given by

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

An evaluation of the ratio of the error variances under the two regimes will indicate which control variable is to be preferred. If $\dfrac{VAR\,(M - M^T)^R}{VAR\,(M - M^T)^r} < 1$, 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?

The Appropriate Time Frame for Controlling Monetary Aggregates: The St. Louis Evidence

LEONALL C. ANDERSEN and DENIS S. KARNOSKY*

Since the mid-1960s increasing attention has been paid to the effect of monetary actions on the pattern of economic activity. An important issue has been the role of monetary aggregates in the conduct of stabilization policy. Monetary actions, measured by changes in monetary aggregates, are now generally recognized as powerful in their effect on economic activity and are considered at least as an equal partner with fiscal actions in economic stabilization programs. For purposes of monetary policy, however, questions remain regarding the nature of the temporal response of important economic variables to monetary shocks. Knowledge of the length of the lags and whether or not the lags are variable is required in order to ascertain the appropriate time period for controlling monetary aggregates. This study investigates the effect on economic activity of one monetary aggregate, the money stock defined as currency plus private demand deposits.

The Fisherian interpretation of monetary actions affecting primarily the price level is widely accepted as descriptive of the long-run effect of changes in the stock of money. However, monetary actions are conducted primarily in the pursuit of achieving much shorter-term goals. If the long-run neutrality of money is accepted, it is important for policy purposes to investigate the nature of the intermediate adjustments to changes in the money stock. Of prime concern is the relative effect of changes in money on prices and output. Specifically, do monetary actions affect output, and thus employment in the short run and, if so, what is the time frame of this effect? These questions relate to the policy problem of the extent to which monetary authorities can secure short-run increases in output without incurring the cost of later inflation.

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This paper investigates, first, the time patterns of effect of monetary actions on several aspects of economic activity, concentrating on the response of output and the average price of output. The second section presents the implications of these results for the proper time frame for controlling money.

RESPONSES OF OUTPUT AND PRICES TO CHANGES IN THE MONEY STOCK

In order to investigate the question of the appropriate period for controlling money, it is necessary to consider the dynamics of the economic system. Among the important issues that must be considered are the magnitude of the response of various economic variables to monetary shocks, the length and variability of the lags, and the relative effect on different variables. This section, first, develops a hypothesis regarding the nature of short- and long-run responses of prices and output to a change in money. Regression analysis is then used to test the hypothesis.

Development of the Hypothesis

In the commonly accepted general equilibrium system, market trading is typically assumed to be conducted with the benefit of perfect information and behavior is assumed to adjust instantly and costlessly to changes in economic conditions as they occur. Where money is included in the system, it is often assumed to function only as a medium of exchange. Excess demand functions for non-money assets are assumed to be homogenous of degree zero in money prices, and thus autonomous changes in the stock of money result only in equiproportionate changes in the general level of prices. "Money" in this context closely resembles a simple accounting device. Variations in the amount of money outstanding have no effect on production, employment, or relative prices in the system.

Economic decisions in the real world are not made with complete knowledge of market opportunities, however, and adjustments to new or better information can generally not be made without cost. The *tatonnement* process is not representative of day-to-day trading procedures where transactions are made on the basis of expectations and trades at non-equilibrium prices are the rule.[1] Thus the implications of equilibrium analysis are indicative of long-run effects of monetary shocks. The nature and speed of adjustment in economic activity to autonomous monetary actions are important issues to be considered. What are the intermediate effects of changes in the stock of money and how long do they endure? For this study, neo-classical monetary theory is expanded to include imperfect information and adjustment costs, providing a hypothesis regarding the long- and short-run responses of prices and output to a monetary shock.

Long-Run Response

As with any exogenous force, monetary actions which change the money stock set off adjustment processes by shifting supply and demand relationships in various markets. The aggregate long-run effect of a permanent change in the stock of money can be summarized in two variables, total output and the average price level. The commonly accepted interpretation of the neo-classical monetary theory holds that money is neutral in its long-run effect on output; the long-run expansion path of output is determined by the supply of productive resources, technology and the relative efficiency of labor and capital. There is no long-run effect of a monetary shock on the factors which influence the trend growth of output. It is generally accepted that the trend growth of money, productivity, resource endowment, and money demand influence the trend rate of price increase.

Commonly drawn implications from this theory are that:

> A permanent change in the rate of growth of money has a permanent, equiproportionate effect on the equilibrium *rate of change* of prices and no effect on the equilibrium *rate of change* of output.[2]

Short-Run Responses

The nature of the short-run effect of a change in the stock of money depends on the manner in which economic units adjust their

[1] For an interesting attempt to incorporate these considerations in a general equilibrium framework see H. Grossman, "Aggregate Demand and Employment," presented at the meetings of the Western Economic Association, University of Santa Clara, August 1972.

[2] According to this statement, the implications are stated in terms of the slopes of the output expansion path and the price level time path and is not concerned with the important question of whether money shocks result in permanent displacements of the paths.

behavior to disequilibrium between actual and desired money holdings. With less than perfect information on current and future market opportunities, economic decisions are based on expectations of conditions in the various markets. These estimates are related not only to prices and quantities in markets for current consumables and producers' goods, but also for financial assets which are means to future consumption. The speed of adjustment to exogenous shocks reflects the time required to change expectations and the costs of altering behavior in response to new expectations. Legal, institutional and technological constraints often preclude adjustment without penalty, and the advantages of rapid adjustment must be traded off against these costs. Thus the effect of an autonomous shock will tend to be distributed over time and markets, first as information about the change in market conditions is disseminated and expectations are generated, and secondly as economic units adjust their behavior to new information and expectations.

Changes in the stock of money relative to its demand is an important exogenous shock. Demand for "money" is a consequence of the fundamental social service which money provides, i.e., reduced cost of trading. With imperfect information and positive costs of adjustment, society will adopt as money that asset or set of assets which is thought to minimize the amount of resources which must be devoted to exchange.[3] Thus the factors which affect the demand for money balances in a period of time include those factors which affect the demand for current and future consumables, such as current human and nonhuman wealth, estimates of market opportunities, and the pattern of time preference relative to the real rental rate on funds and the expected rate of change of prices on consumables.

Following the introduction of an excess stock of money balances into the system, economic units will attempt to divest themselves of excessive money balances, given current estimates of prices and rates of return. Demand for real and non-money financial assets will increase. As a result, businesses experience some increase in demand for goods and services, and consequently inventories will be drawn down and backlogs of orders will tend to increase.

The problem faced by business firms is one of determining whether the increased demand is permanent or temporary. There are several possible adjustments – continue to run down inventories, build up an inventory of orders, increase output, or increase prices.

[3]K. Brunner and A. Meltzer, "The Uses of Money: Money in the Theory of an Exchange Economy," *American Economic Review,* LVI, December 1971, pp. 784-805.

Each adjustment bears a cost, and miscalculations can be expensive. It is postulated that, on average, firms find it less costly to gather information about demand conditions by changing output first rather than prices, and then, in the case of a permanent change in demand, as more information becomes available, prices are changed.

The implications from the postulated short-run behavior which incorporates imperfect information and adjustment costs are that:

> The adjustment of prices to a monetary shock is not instantaneous and that temporary output effects can be expected as the economy moves to a long-run equilibrium.

Testing the Hypothesis

Testing a hypothesis involves confronting logical implications of the hypothesis with empirical evidence. If the evidence is in good agreement with all of the implications considered, the hypothesis is judged to be confirmed; if it is not, the hypothesis is rejected.

The operational form of the implications which were presented above are as follows:

1. The long-run elasticity of the price level with respect to money, $\bar{\epsilon}$ (P,M), is unity.
2. The long-run elasticity of output with respect to money, $\bar{\epsilon}$ (Q,M), is zero.
3. The short-run elasticity of output with respect to money, ϵ (Q,M), is greater than zero.
4. The short-run elasticity of the price level with respect to money, ϵ (P,M), is zero.

General Considerations

These implications are tested by means of regression analysis of data for the U.S. economy over the period from 1955/I to 1971/II. Observations on the rate of change of various price indices and measures of output are regressed against current and lagged values of the rate of change of money and other exogenous variables.

The basic specification tested is of the form:

$$(1)\ \dot{X} = F\,(\dot{M},\dot{Z})$$

where (X) is a matrix of observations on the rates of change of prices and output, ($\dot{M}$) is a matrix of contemporaneous and lagged rates of change of the money stock, (Z) is a matrix of contemporaneous and lagged rates of change of other exogenous factors which might affect (X). This relationship should be recognized as a *final* form, relating endogenous variables to exogenous variables only.[4]

In testing the hypothesis it is necesary to take into consideration initial conditions. There are two aspects to the set of initial conditions which are important in the analysis. The first aspect is the effect of current non-monetary exogenous forces. These are factors originating outside of the economic system and generally beyond the control of the monetary authorities, including fiscal actions, world trade conditions, technology, consumer time preferences, the legal framework, and random events such as strikes and weather conditions. The second aspect is the stage of adjustment of endogenous behavior to prior economic shocks. In this area are the influences of market expectations, demand for information, the costs of adjustment, and capacity utilization.

In evaluating the effect of monetary actions on economic activity, it is important to separate these two aspects. The second aspect mentioned above represents the lagged effect of prior shocks and thus should not be considered as a separate influence. The first aspect remains as an independent consideration.

Choice of the final form as the vehicle for testing the hypothesis implies that the set of initial conditions is summarized in current and lagged values of the exogenous variables. The length of the lag specified for the exogenous variables in a final form regression is a postulate describing the period over which the dependent variable adjusts to changes in the independent variable. For example, to specify

$$\dot{X} = a_0\dot{M} + a_1\dot{M}_{-1} + a_2\dot{M}_{-2}$$

is to postulate that the variable X adjusts completely in three periods to a change in M. This specification can then be interpreted as a statement about the time span over which a new equilibrium is reached.

There is no *a priori* knowledge, however, regarding the exact time period required for adjustment to a monetary shock. Thus, in testing the hypothesis, determination of the appropriate length lag becomes an important consideration. For the purpose of this study, the

[4]The form differs from the *reduced* form in that the reduced form allows the inclusion of non-contemporaneous endogenous variables.

regressions with the lag structure which produces the highest $\bar{R}^{2}$ (minimum standard error) are used to test the hypothesis. The length of the lag, at that point, is taken as the time span over which adjustment of prices and output to a monetary shock takes place. Over this period of adjustment, the signs and estimated magnitudes of the sums of the coefficients on money are used to test the long-run implications of the hypothesis. The distribution of estimated coefficients on current and lagged values of money and their level of significance within the first part of this period are used to test the short-run implications.

If the difference between the estimated coefficient and the postulated coefficient for each of the four implications is found to be not statistically significant from zero (at the 5 percent level), the hypothesis is considered confirmed. On the other hand, if the difference for any one implication is found to be statistically significant from zero, the hypothesis is rejected.

Definition of Variables

Monetary policy attempts to secure national economic goals by actions which influence behavior in the private sector of the economy, i.e., households and businesses. While total economic activity is composed of more than the actions of those sectors, the other sectors are generally beyond the control of the monetary authorities. The Federal Government, for example, engages directly in all aspects of economic activity, from production to consumption, but there is little that monetary actions can do to influence this portion of the economy. Government actions are a separate autonomous force influencing the private sector, and monetary actions should be considered in conjunction with this and other exogenous factors.

Three measures of spending are used in this study. The first one is the standard expenditure definition of gross national product (Y).

$$(1)\ Y = C + I + G + Ex - Im$$

where C = private expenditure on consumer goods and services, I = private expenditure on investment goods, G = government expenditures on goods and services, Ex = exports, or foreign expenditures on U.S. goods, and Im = imports, or domestic spending on foreign produced goods and services. As measured in the National Income Accounts, GNP is a measure of all expenditures which generate income or employment in the U.S. economy.

This measure is too broad for measuring the response of domestic spending to a monetary shock, since it includes variables essentially beyond the influence of the monetary authorities. As mentioned earlier, autonomous changes in the stock of money affect economic activity by altering private demand for real and financial assets. A money shock would produce, in part, increased demand for consumables and investment goods, both domestically and foreign produced. That is, some portion of the effect of an increase in the money stock would be on import demand and thus is not directly on domestic output and employment. Imports should be included to measure private spending, while government expenditure and exports should be eliminated.

To reflect these considerations, total private expenditures in the economy (Y_p) are defined as:

$$(2)\ Y_p = C + I = C^p + C^f + I^p + I^f$$

where superscripts refer to the sector where production originates, p = private domestic sector and f = foreign sector. The demand for domestic versus foreign output would depend on relative prices of domestic and foreign output, and the quality of the respective output.

Since this study is concerned with the response of domestic output and the corresponding price level, private expenditures on domestic output are defined as:

$$(3)\ Y_p^p = Y_p - Im = C^p + I^p\ .$$

Although this study is primarily interested in private spending on domestic output, tests of the hypothesis are made using all three of these spending concepts and the measures of output and prices related to each. These are related to total expenditure in the economy (Y), total private expenditure (Y_p), and private expenditure on domestic production (Y_p^p). Thus the matrix of prices includes the GNP deflator (P), the deflator for private consumption and investment expenditure (P_p), and the deflator for private expenditures less imports (P_p^p).[5] The associated output measures are (Q), ($Q_p = Y_p/P_p$), and ($Q_p^p = Y_p^p/P_p^p$).

[5]The price variable (P_p) is constructed as the weighted sum of the national income account deflators for private consumption expenditures and gross private domestic investment. The variable (P_p^p) is equal to (P_p) minus the weighted deflator for expenditures on imported goods and services.

Testing Long-Run Implications

The first long-run implication that the long-run elasticity of prices, $\bar{\epsilon}(P,M)$, is unity was tested by means of the following regression:[6]

$$\Delta \ln P = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \, \Delta \ln M_{-i} + \sum_{i=0}^{k} e_i \, \Delta \ln E_{-i}$$

The variables are expressed in changes in the logarithms, which for small movements approximate the percentage rate of change. The estimated coefficients can thus be interpreted as elasticities. The sum of the coefficients on the money terms, here defined as currency plus private demand deposits, is taken as evidence on $\bar{\epsilon}(P,M)$, the long-run elasticity of prices with respect to money.

The variable D_1 and D_2 are dummy variables which are nonzero in the quarter of a major labor strike and the following quarter, respectively. The variable (E) is high-employment government expenditure which is included to take account of a potentially important exogenous policy variable, but the estimated coefficients are not emphasized.[7] The constant term is the average influence of all other systematic forces influencing the rate of growth of the price level.

The estimated sum of the money coefficients for each of the price measures and for various lengths of lag on money are presented in Exhibit I.[8] The results were little affected by changes in the length of the lag on government expenditures and thus the table includes only those results for a lag of four quarters on that variable. In each case, the lag on the money terms which gives the maximum adjusted $\bar{R}^2$ also yields a sum which is not significantly different from unity, at the 5 percent level of significance. The evidence is thus in good agreement with the long-run implication that $\bar{\epsilon}(P,M) = 1.0$. The sum of the money coefficients on all three price measures are found to be

[6]The tests were run using all combinations of the Almon constraints. The criteria were not significantly affected by the degree of polynomial or the end-point constraints. Only a small portion of the results are thus presented here.

[7]The estimates for high-employment expenditures were similar to those found by Andersen-Jordan. See L.C. Andersen and J.L. Jordan, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization," *Review*, Federal Reserve Bank of St. Louis, November 1968, pp. 11-24.

[8]See footnote 9 for an explanation of the very small constant term in the price regressions reported in Exhibit I.

EXHIBIT I

1955 I – 1971 II
ALMON CONSTRAINTS: d=3, t+1≠0

$$(1)\ \Delta\ln P = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta\ln M_{-i} + \sum_{i=0}^{4} e_i \Delta\ln E_{-i}$$

n	Σm_i	Σe_i	a_o	$\bar{R}^2$	D.W.	$H_o:\Sigma m_i=1.0$
4	.324*	.048	.361*	.141	.600	
8	.559*	.043	.214*	.451	.817	
12	.686*	.012	.206*	.584	1.023	
16	.800*	.004	.163*	.652	1.232	
20	.912*	.015	.078	.704	1.429	Accept
24	1.030*	.027	–.022	.750	1.676	Accept
28	1.150*	.025	–.091	.776	1.881	Accept

$$(2)\ \Delta\ln P_p = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta\ln M_{-i} + \sum_{i=0}^{4} e_i \Delta\ln E_{-i}$$

n	Σm_i	Σe_i	a_o	$\bar{R}^2$	D.W.	$H_o:\Sigma m_i=1.0$
4	.281*	.063	.277*	.168	.666	
8	.505*	.056	.137	.456	.944	
12	.631*	.027	.127	.597	1.209	
16	.717*	.021	.094	.637	1.362	
20	.829*	.026	.021	.683	1.550	
24	.936*	.036	–.067	.720	1.732	Accept
28	1.058*	.035	–.141	.745	1.892	Accept

$$(3)\ \Delta\ln P_p^p = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta\ln M_{-i} + \sum_{i=0}^{4} e_i \Delta\ln E_{-i}$$

n	Σm_i	Σe_i	a_o	$\bar{R}^2$	D.W.	$H_o:\Sigma m_i=1.0$
4	.166	.059	.309*	.017	1.280	
8	.418*	.054	.149	.336	1.765	
12	.526*	.027	.147	.404	2.068	
16	.586*	.028	.116	.412	2.125	
20	.689*	.029	.056	.439	2.217	
24	.809*	.040	–.041	.473	2.309	Accept
28	.941*	.039	–.122	.500	2.408	Accept

*Significant at 5% level.

P = GNP deflator

P_p = Deflator for private consumption expenditure and gross domestic investment

P_p^p = Deflator for private expenditure less imports not significantly different from unity only after 20 quarters, implying the adjustment process of prices to a monetary shock takes over five years to run its course.

The second long-run implication, that $\bar{\epsilon}(Q,M) = 0$, was tested by means of the regression:

$$\Delta \ln Q = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{k} e_i \Delta \ln E_{-i}$$

The constant term is the average influence of all other systematic forces influencing the rate of growth of output.

The results of this test are presented in Exhibit II. The sums of the money coefficients are not significantly different from zero for lags longer than four quarters; the evidence is consistent with the long-run implication that $\bar{\epsilon}(Q,M) = 0$. The explanatory power of the relationship is maximized between lags of 12 to 20 quarters, implying a somewhat faster adjustment in output than in prices.

What are the implications of the lag in the output regression being shorter than in the price regression? This question may be examined with reference to changes in velocity. Consider the equation of exchange

$$MV = PQ$$

where V = expenditure velocity of money. Expressing the relationship in elasticity form gives:

$$\epsilon(P,M) + \epsilon(Q,M) - \epsilon(V,M) = 1.0$$

This shows that there need not be a close correspondence at all times between the elasticities of prices and output, as money shocks may also affect velocity. This latter effect was tested as a check on the consistency of the price and output regressions by means of the following regression:

$$\Delta \ln Y = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{k} e_i \Delta \ln E_{-i}$$

where Y is a measure of spending, Y = PQ.

EXHIBIT II

1955 I – 1971 II
ALMON CONSTRAINTS: d=3, t+1≠0

$$(1)\ \Delta \ln Q = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{4} e_i \Delta \ln E_{-i}$$

n	Σm_i	Σe_i	a_o	$\bar{R}^2$	D.W.	$H_o:\Sigma m_i=0$
4	.664*	–.085	.446	.329	1.105	
8	.149	–.085	.793*	.515	1.397	Accept
12	–.126	–.015	.798*	.586	1.649	Accept
16	–.274	–.013	.867*	.596	1.720	Accept
20	–.359	–.004	.895*	.595	1.718	Accept
24	–.462	–.007	.956*	.571	1.614	Accept
28	–.538	–.032	1.063*	.549	1.505	Accept

$$(2)\ \Delta \ln Q_p = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{4} e_i \Delta \ln E_{-i}$$

n	Σm_i	Σe_i	a_o	$\bar{R}^2$	D.W.	$H_o:\Sigma m_i=0$
4	1.054*	–.280*	.550	.411	1.240	
8	.431	–.282*	.960	.574	1.595	Accept
12	.153	–.212*	.964*	.613	1.746	Accept
16	.075	–.211*	.998*	.614	1.763	Accept
20	.036	–.170	.934*	.597	1.717	Accept
24	–.050	–.164	.958*	.554	1.560	Accept
28	.006	–.203	1.018*	.527	1.451	Accept

$$(3)\ \Delta \ln Q_p^p = a_o + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{4} e_i \Delta \ln E_{-i}$$

n	Σm_i	Σe_i	a_o	$\bar{R}^2$	D.W.	$H_o:\Sigma m_i=0$
4	1.053*	–.280*	.550	.411	1.241	
8	.430	–.282*	.960*	.574	1.596	Accept
12	.152	–.212	.964*	.614	1.747	Accept
16	.074	–.211*	.998*	.614	1.765	Accept
20	.035	–.170	.934*	.597	1,718	Accept
24	–.052	–.164	.958*	.554	1.562	Accept
28	.005	–.203	1.018	.527	1.453	Accept

*Significant at 5% level

Q = GNP at 1958 prices

Q_p = Real private consumption expenditure plus real gross private domestic investment, $Q_C + Q_I$.

Q_p^p = Real private expenditure less real imports, $Q_C^P + Q_I^P$

EXHIBIT III

1955 I – 1971 II
ALMON CONSTRAINTS: d=3, t+1≠0

$$(1)\ \Delta \ln Y = a_0 + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{4} e_i \Delta \ln E_{-i}$$

n	Σm_i	Σe_i	a_0	$\bar{R}^2$	D.W.	$H_0: \Sigma m_i = 1.0$
4	.989*	–.037	.816*	.500	1.576	Accept
8	.707*	–.042	1.007*	.547	1.692	Accept
12	.560*	–.003	1.004*	.567	1.756	
16	.526*	–.009	1.031*	.564	1.785	
20	.552*	.011	.973*	.562	1.799	Accept
24	.568*	.019	.934*	.536	1.714	Accept
28	.612	–.007	.972*	.509	1.584	

$$(2)\ \Delta \ln Y_p = a_0 + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{4} e_i \Delta \ln E_{-i}$$

n	Σm_i	Σe_i	a_0	$\bar{R}^2$	D.W.	$H_0: \Sigma m_i = 1.0$
4	1.335*	–.217*	.827*	.553	1.522	Accept
8	.936*	–.225	1.097*	.583	1.696	Accept
12	.783*	–.185	1.091*	.588	1.724	Accept
16	.792*	–.190	1.093*	.586	1.726	Accept
20	.865*	–.144	.955*	.578	1.718	Accept
24	.885*	–.128	.891*	.535	1.582	Accept
28	1.064*	–.168	.877*	.512	1.480	Accept

$$(3)\ \Delta \ln Y_p^p = a_0 + a_1 D_1 + a_2 D_2 + \sum_{i=0}^{n} m_i \Delta \ln M_{-i} + \sum_{i=0}^{4} e_i \Delta \ln E_{-i}$$

n	Σm_i	Σe_i	a_0	$\bar{R}^2$	D.W.	$H_0: \Sigma m_i = 1.0$
4	1.219*	–.221*	.860*	.501	1.793	Accept
8	.848*	–.228*	1.109*	.555	1.969	Accept
12	.678*	–.185	1.111*	.572	2.017	Accept
16	.659*	–.182	1.115*	.571	2.019	Accept
20	.724*	–.141	.990*	.564	2.004	Accept
24	.757*	–.124	.917*	.529	1.872	Accept
28	.946*	–.164	.896*	.508	1.779	Accept

*Significant at 5% level

Y = Nominal GNP

Y_p = Private consumption expenditure plus gross private domestic investment, $P_p(Q_C + Q_I)$

Y_p^p = Private expenditure less imports, $P_p^p(Q_C^P + Q_I^P)$

Since ϵ(P,M) + ϵ(Q,M) = ϵ(Y,M), this regression tests (indirectly) the effect of money shocks on velocity. The results are presented in Exhibit III.[9] The sum of the estimated coefficients is taken as evidence of $\overline{\epsilon}$(Y,M), which in turn can be considered as $\overline{\epsilon}$(P,M) + $\overline{\epsilon}$(Q,M) for all three measures of spending. In the case of the rate of change of spending, the adjustment apparently is completed after about four quarters. In terms of the sum coefficients, these results are generally consistent with those implied by the price and output regressions, i.e., $\overline{\epsilon}$(Y,M) = $\overline{\epsilon}$(P,M) = 1.0 and $\overline{\epsilon}$(Q,M) = 0.

Testing Short-Run Implications

The third and fourth implications are that in the short-run ϵ(Q,M) > 0 and ϵ(P,M) = 0. These are tested by examining the patterns and the levels of significance of individual coefficients of the regressions for the first few quarters after a change in the rate of money growth. Chart I presents the distribution of coefficients from the regressions for $\Delta \ln Q_p^p$ and $\Delta \ln P_p^p$, with 24 lagged money terms. Those variables, which relate to spending by the private sector on domestically produced output, represent the portion of aggregate demand which is probably most directly influenced by monetary actions. The responses of the other definitions of the variables are the same.

The chart shows that there is a sharp and substantial positive response of output growth for five quarters following a permanent change in the rate of increase of money, then the effect becomes negative and remains less than zero out to 19 lagged terms. The price response, however, is essentially zero for over five quarters and builds slowly from there. For the first several quarters after a change in the

[9]The exceedingly small constant in the ΔlnP equation should not be taken as an indication that only money growth influences the price level. Changes in the trend growth of money demand, productivity, and factor endowment also influence the price level.

The small constant in the ΔlnP equations reported in Exhibit I can be explained in the following manner. The constant in the ΔlnY equation can be interpreted as measuring the trend rate of change in velocity, which reflects trend movements in the demand for money. The constant in the ΔlnQ equation can be considered as the trend rate of growth of output, which reflects trend increases in productivity and factor endowment. Since $\Delta \ln P = \Delta \ln Y - \Delta \ln Q$, the constant in the ΔlnP equation equals the constant in the ΔlnY equation less the constant in the ΔlnQ equation. In the sample period, these two constant terms are approximately equal; therefore, the constant in the ΔlnP equation is very small.

rate of money growth the output coefficients are positive and statistically significant from zero and the price coefficients are not. The evidence is in good agreement with the short-run implications that $\epsilon(Q,M) > 0$ and $\epsilon(P,M) = 0$.

Conclusion From Test Results

Since the evidence in each test is consistent with the implications under consideration, the neo-classical hypothesis expanded to include imperfect information and costs of adjustment is judged to be confirmed. The conclusion to be drawn from this exercise is that a change in the trend of money growth has no permanent effect on the rate of growth of output and results instead in an equiproportionate change in the rate of increase of prices. There is, however, a substantial short-run effect of money shocks on output growth. The adjustment of output, while zero in the long-run, is extremely volatile compared to the adjustment pattern in prices. Prices show a relatively slow adjustment, which does not begin to appear, on average, until almost a year after a monetary shock. The length of the adjustment period for both prices and output to a monetary shock was found to be about 24 quarters. It should be remembered that this evidence relates only to the U.S. economy during the sample period and thus to the magnitude of changes in money growth experienced during that period.[10]

IMPLICATIONS FOR CONTROLLING MONEY

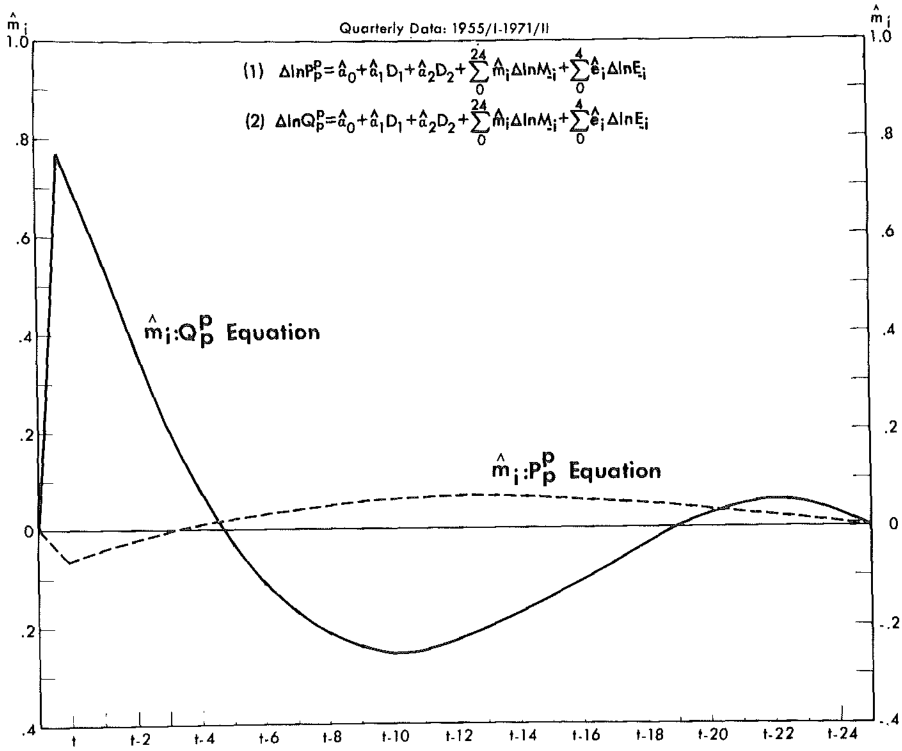
Having accepted the hypothesis regarding the responses of output and the price level to a monetary shock, the regressions of the previous section are used to develop some implications for monetary analysis and control of the money stock. In particular, problems of ascertaining the magnitude of response to a change in money growth and the length of the appropriate time period for analyzing the response are investigated.

This section, first, develops regression equations for the responses of output and the price level to a change in the rate of money growth. Next, these equations are used to simulate the time path of

[10] As with any hypothesis, that considered here is subject to scrutiny under a wide range of experience. For further confirming evidence see John L. Scadding, "The Relationship between Changes in the Stock of Money and Changes in Output and Prices: Canada 1954-1969," unpublished manuscript, Stanford University, June 1972.

Chart I

Estimated Coefficients



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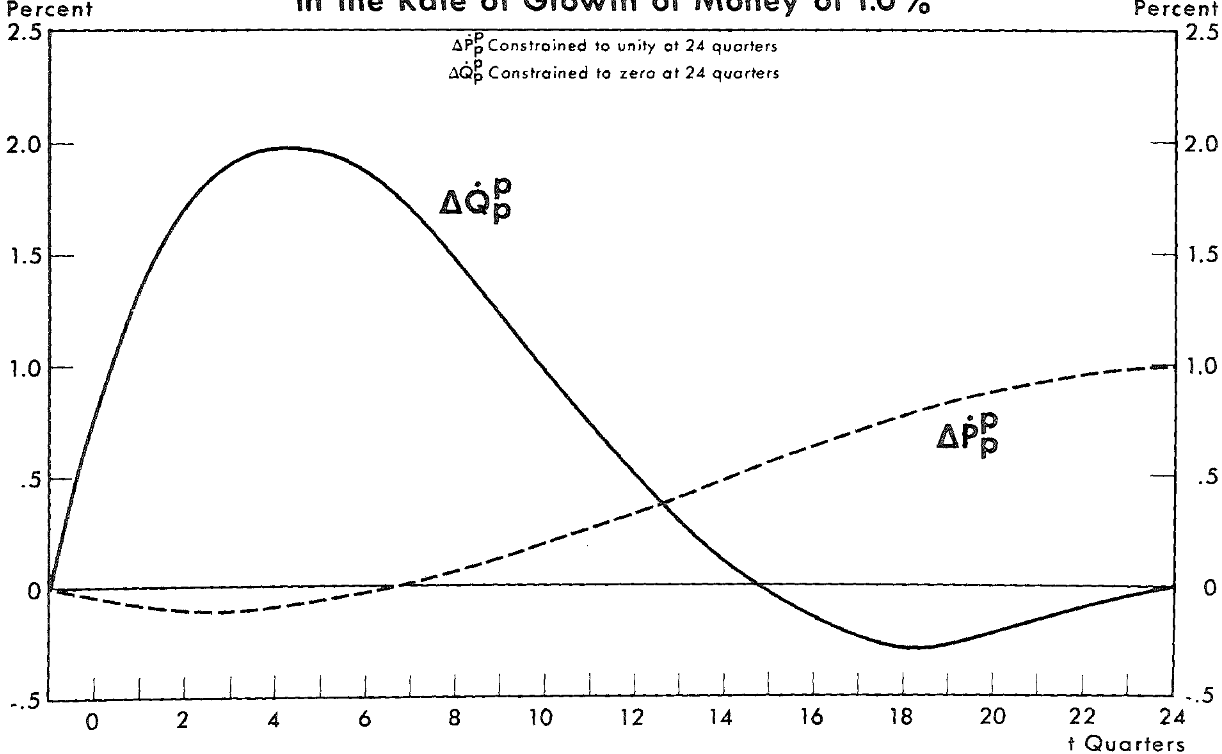
output and the price level in response to various types of monetary shocks. The simulations provide important insights into the factors which must be taken into consideration in judging the most likely responses and in determining the appropriate time period for monetary control.

General Nature of Responses

While the estimated sums of the money coefficients are not exactly equal to the implied long-run elasticities of the hypothesis, the tests reported in the preceding section showed the differences not to be statistically significant. These long-run elasticities and the patterns of response over the adjustment period are accepted as the best representation of the real world. In developing empirical measures of the responses of output and the price level to a change in the rate of money growth, the coefficients reported in Chart I are,

Chart II

Cumulative Effect of a Permanent Increase in the Rate of Growth of Money of 1.0%



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therefore, re-estimated subject to the constraint that the sum of the money coefficients in the price equation equals unity and in the output equation equals zero.[11] The responses over time are measured by cumulating the sums of the coefficients for each equation. On basis of the evidence presented in the previous section, a 24-quarter lag period is taken as an approximation of the time required for full adjustment.

The cumulative effect of a permanent increase of 1 percent in the trend of rate of money growth on the rates of output and price increase is presented in Chart II. The response of output is in the form of deviations from its trend rate of growth as measured by the constant term in that equation. The price level in the sample period was found to have no trend independent of the rate of money growth, because the constant term in the price equations is very small and not statistically significant from zero. Thus the response of the price level is measured in deviations from its rate of growth consistent with the prior trend rate of money growth.

Chart II indicates that the immediate response to accelerated money growth is a rapid and substantial increase in the rate of output for five quarters, with essentially no price response. Growth of output then ceases to accelerate and falls rapidly while the rate of price increase rises moderately. The rate of output expansion falls below its trend rate about 15 quarters after the monetary shock. Price increases continue to accelerate and reach a permanently higher trend level after 24 quarters, just as output growth returns permanently to its initial trend rate.

Simulation Experiments

Two general types of simulation experiments are performed. They are accelerations in the rate of money growth which change its trend growth rate and deviations of money growth around a constant trend. In the second set of simulations the length of time over which money growth deviates from its trend is considered. These simulations provide evidence regarding the influence of changes in one important initial condition – the stage of adjustment to prior monetary shocks – on the response of output and the price level. The

[11] Introduction of these additonal constraints into the Almon procedure did not alter the timing of the estimated distribution. The magnitude of individual coefficients was somewhat affected, however.

influence of changes in other initial conditions, such as trends of productivity, resource endowment, and money demand, is not examined.

Accelerations in Money Growth Producing Changes in its Trend

Three simulations are presented in Charts III and IV which indicate the short-run and the long-run responses of output and price to an increase in the trend growth of money. All three start from an equilibrium situation in which there has been a constant rate of increase in the money stock for an extended period. Output is growing at its trend rate, which is determined by growth of factor endowment and technological advance, and the price level is rising at the rate determined by the prior trend of money growth. The first simulation is a permanent 1 percentage point increase in the quarterly rate of money growth, exactly as reported in Chart II.[12] The second one involves a 1 percentage point increase in the quarterly money growth rate maintained for five quarters and then an additional 1 percentage point increase which is maintained thereafter. The third simulation is the same as the second except that the additional acceleration in the quarterly money growth rate occurs after 15 quarters.

These three simulations indicate the responses of output and price to a permanent acceleration of money growth with three different sets of initial conditions, stated in terms of the stage of adjustment to previous monetary shocks. In Simulation 1, a 1 percentage point increase in the rate of money growth begins at a point of full adjustment. In Simulation 2, the rate of money growth is permanently increased following five quarters of adjustment to a prior acceleration. This is the point of maximum, positive short-run adjustment of *output* to the prior shock. In Simulation 3, the second acceleration is introduced at the mid-point of the period of *price* adjustment to a prior shock.

The short-run response of output (arbitrarily set at 5 quarters) to the increase in the rate of monetary expansion varies depending on the initial conditions (Chart III). Beginning at a point of full adjustment to the prior trend rate of money growth, there is a very strong

[12] Throughout this presentation it should be remembered that the variables are defined in quarterly rates of change which can imply substantial *annual* rates of increase. A change of 1 percent in the quarterly rate of increase of a variable, for example, translates into a change of over 4 percentage points in the annual rate, i.e., from a 4 percent rate of increase to an 8 percent rate.

Chart III

Cumulative Effect on Output Growth of Permanent Increases in Rate of Growth of Money

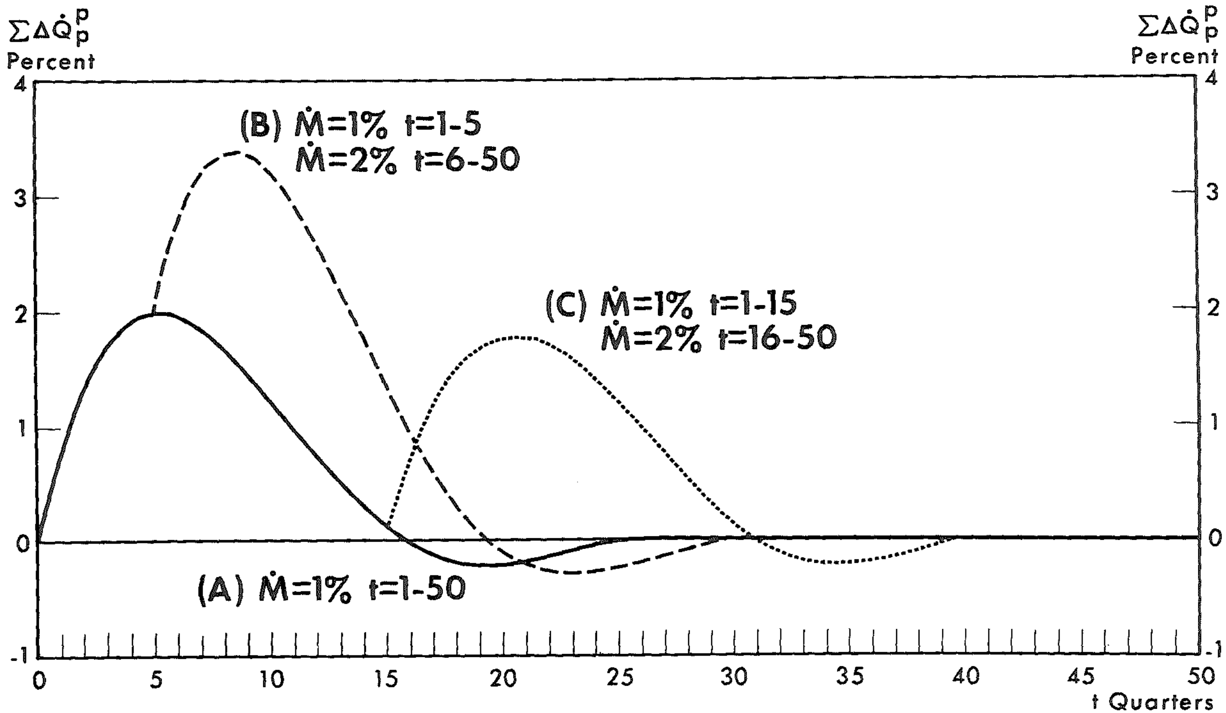

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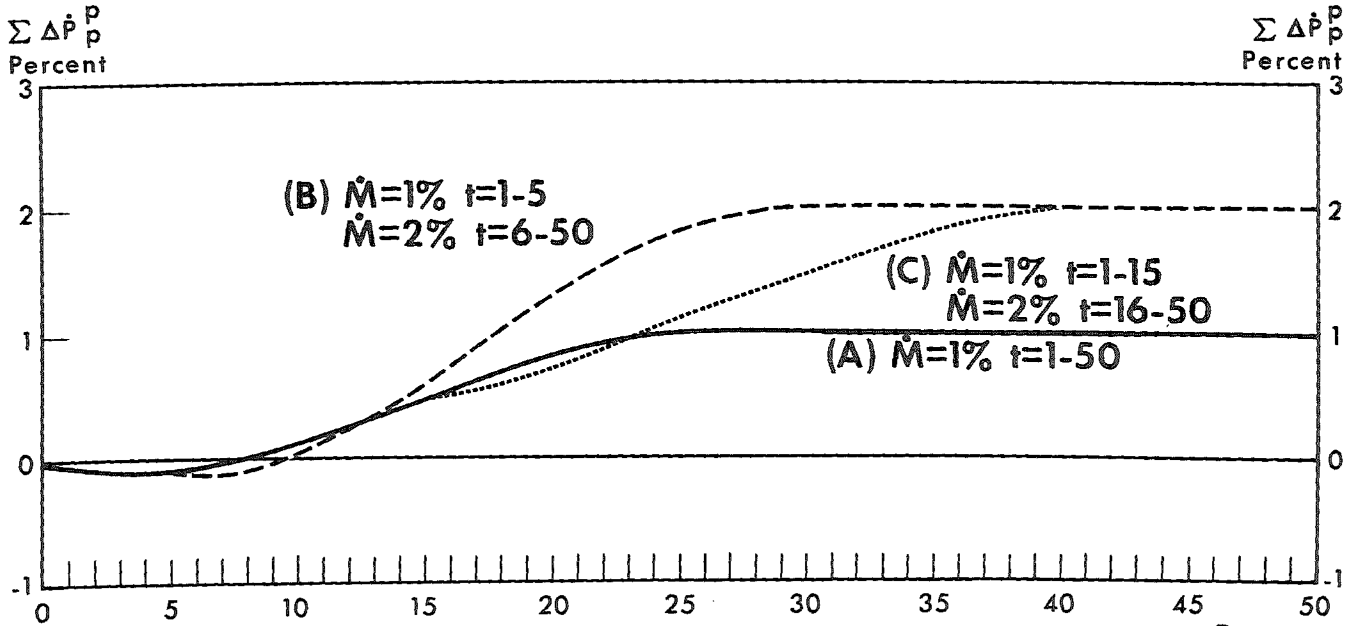
Chart IV

Cumulative Effect on Rate of Price Increase of Permanent Increase in Rate of Growth of Money



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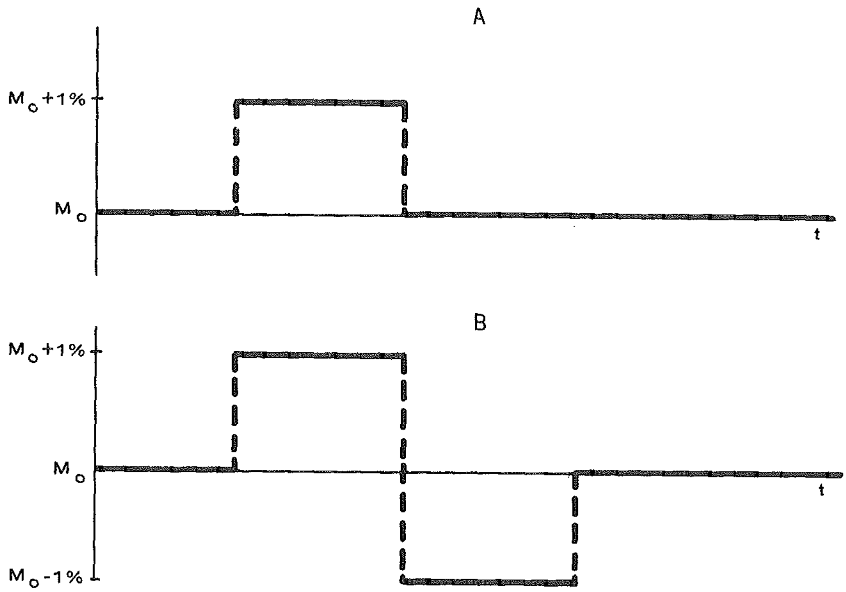
short-run response of output to the 1 percentage point increase in the rate of money growth, line (A). The rate of growth of output is almost 2 percentage points above trend after five quarters. The incremental response to the additional increase in money growth which occurs after five quarters of adjustment to the previous 1 percentage point shock is somewhat less, line (B). The rate of output expansion rises another 1.5 percentage points after five quarters, reaching 3.5 percentage points above trend 10 quarters after the initial money shock. In the case of the additional change in money growth which does not come until after 15 quarters of adjustment to the previous 1 percentage point shock, the incremental output response, line (C), lies between those of the other two cases.

Since the price level responds more slowly to the pattern of money growth over 24 quarters, its short-run response will be measured by the difference shown in Chart IV between the price change for the fifth quarter following the final acceleration in money growth and the change which prevailed at the last quarter before the final acceleration. In the first simulation (starting at full adjustment), there is virtually no short-run response in the price level. The rate of price increase after five quarters is unchanged. The second simulation (starting after five quarters of adjustment) shows a short-run response of an increase of about .5 of a percentage point from the zero beginning rate. The third simulation (starting after 15 quarters of adjustment) shows a smaller short-run response than the second one, an increase from 0.4 percent to 0.6 percent.

In all three simulations, new long-run trend rates of money growth are produced. In the first case, the trend of money growth is increased 1 percent a quarter, and in the last two cases it is increased by 2 percent a quarter. As a consequence, new trend rates of price increase are also produced. There are substantial short-run gains in output growth stemming from monetary acceleration but there is no change in the trend of output.

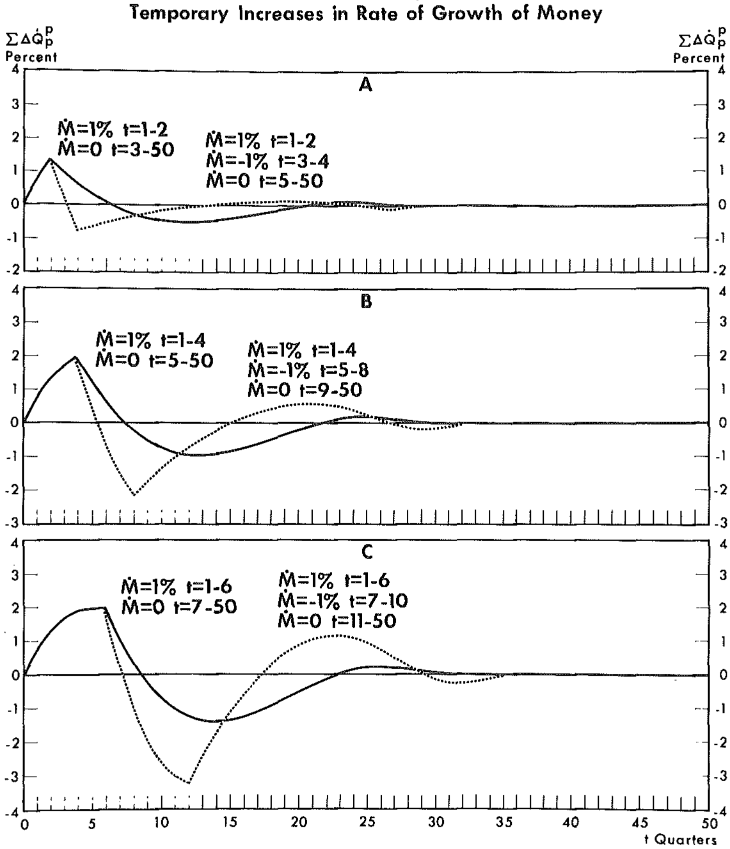
Short-Run Deviations Around Constant Trend

Two types of simulations of short-run deviations of money growth around a constant trend rate are examined in this section. The first type, as illustrated in panel A below, is a 1 percentage point increase in the growth rate of money for various length periods followed by a deceleration to the initial trend growth rate. The second type, panel B, is a positive 1 percentage point change from trend for six or less quarters, followed by a negative 1 percentage point change from trend for corresponding periods of time, and then a return to trend. In this last case the short-run rate of money growth averages the same as the trend. Chart V presents the simulation results for periods with temporary accelerations of two, four, and six quarters.



Results from both types of simulations indicate that, *starting from equilibrium with output growing at its trend rate,* a temporary increase of 1 percentage point in the quarterly change in money for a period even as short as two quarters has a substantial, positive impact on output. The positive response of output to a two quarter acceleration of money growth above trend is a rate of 1.3 percent per quarter after those two quarters, over a four quarter period of acceleration output growth increases by 1.9 percentage points, and for six quarters the rate of growth of output increases by 2.0 percent. The following downswing in output, as the rate of growth of money returns permanently to its trend value, and subsequent variations until equilibrium is achieved again are greater when the acceleration in money growth is offset by an equal decrease and then returned to trend (the dashed line) than when money growth is returned immediately to its trend rate after the acceleration.

Chart V
Cumulative Effect on Output Growth of
Temporary Increases in Rate of Growth of Money



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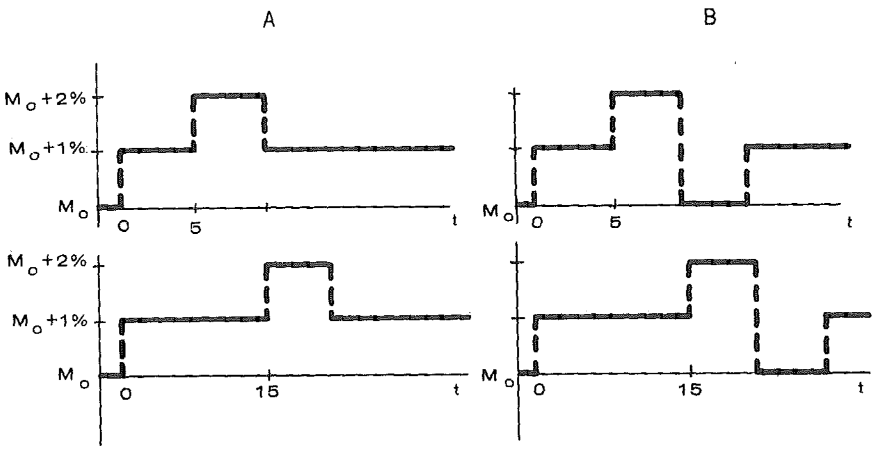
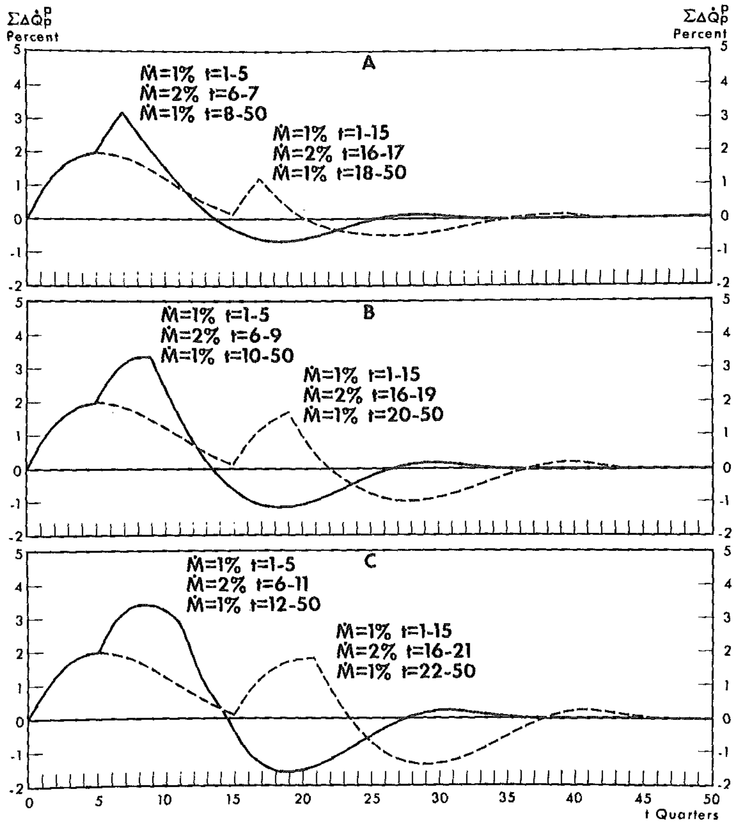
It should be remembered that these simulations were performed starting from a position of equilibrium growth of output. As shown in the previous set of simulations, the short-run output response also depends on initial conditions in terms of the stage of adjustment to prior shocks. To investigate the effect of temporary accelerations in money growth with different initial conditions, the simulations reported previously in the present section were run starting with a 1 percentage point increase in the money growth rate and then the two types of simulations under consideration were performed. In one case the rate of money growth is increased by an additional 1 percent after five quarters, and in the other case the second acceleration comes 15 quarters after the initial increase. Panel A below illustrates the patterns of money growth used to generate the results presented in Chart VI and panel B shows those associated with Chart VII. The final trend rate in these simulations is 1 percentage point greater than in the simulations from equilibrium, but there is no change in trend over the time interval of the two simulations.



In the first tier of Charts VI and VII are the results of a temporary deviation ($\dot{M}$=2%) of two quarters in length. The second tier shows the results of deviations of four quarters in length and the third shows the results of deviations of six quarters. The solid lines plot the effect of these deviations after five quarters of accelerated money growth, and the dashed lines show the effect when the deviations occur after 15 quarters of accelerated money growth.

In Chart VI, where the rate of money growth is returned immediately to its new trend after the temporary increases, one obvious effect of the different initial conditions is the much greater variability of $\dot{Q}^p_p$ in the case where the deviation comes five quarters after the initial acceleration. The effect of counteracting the temporary deviation of money growth above the new trend by a similar deviation below trend is presented in Chart VII. Compared to Chart VI the effect of this policy is a much longer decline in the rate of output growth. The end result is the same, however, as in each case output growth returns to its initial rate of increase.

Chart VI
Cumulative Effect on Output Growth of Temporary Increases in Rate of Growth of Money Given Different Initial Conditions



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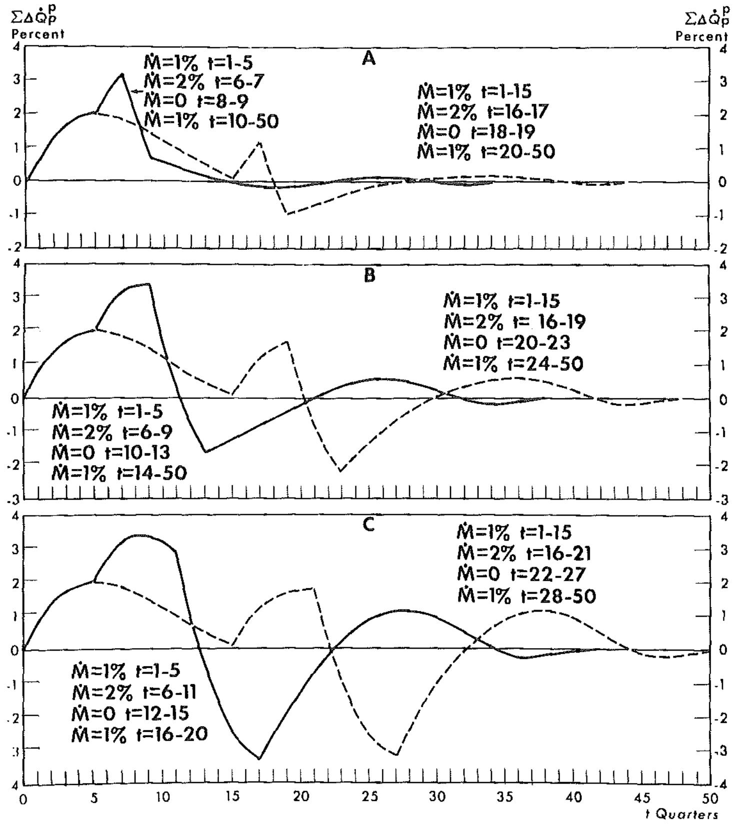
Longer-Run Deviations Around a Constant Trend

The responses of output and prices to longer-run deviations in money growth around a constant trend are investigated in this section. The deviations in money growth are in the form of a sine wave, oscillating with an amplitude of 1 percentage point about the trend rate of money growth. The responses of output and prices were simulated for different frequencies of the sine function. These simulations demonstrate two interesting properties of the responses of output and prices to longer-run variations in money growth around a constant trend.

Chart VII
Cumulative Effect on Output Growth of
Temporary Deviations in Rate of Growth of Money
Given Different Initial Conditions



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One property is that lengthening the wave length of M changes the lead-lag relationship of the responses to changes in money. These are presented in Exhibit IV. For wave lengths from 8 to 20 quarters, the peak growth of output follows shortly after that of money; at 24 quarters, the peak of money lags that of output. Peaks of price change lead those of money growth for wave lengths up to 24 quarters; the lead and the lag is the same for 28 quarters, and the peaks in prices lag the peaks in money growth for longer wave lengths.

The second property is that changes in the wave length have a discernible influence on the amplitude of the response of output and to a lesser extent on the amplitude of price response (Chart VIII). As the wave length is increased from 12 to 20 quarters, the amplitude of the output response rises sharply, but there is little change in the amplitude of the price response. Then as the wave length is increased further, the output amplitude slowly decreases, while the price amplitude slowly rises.

EXHIBIT IV

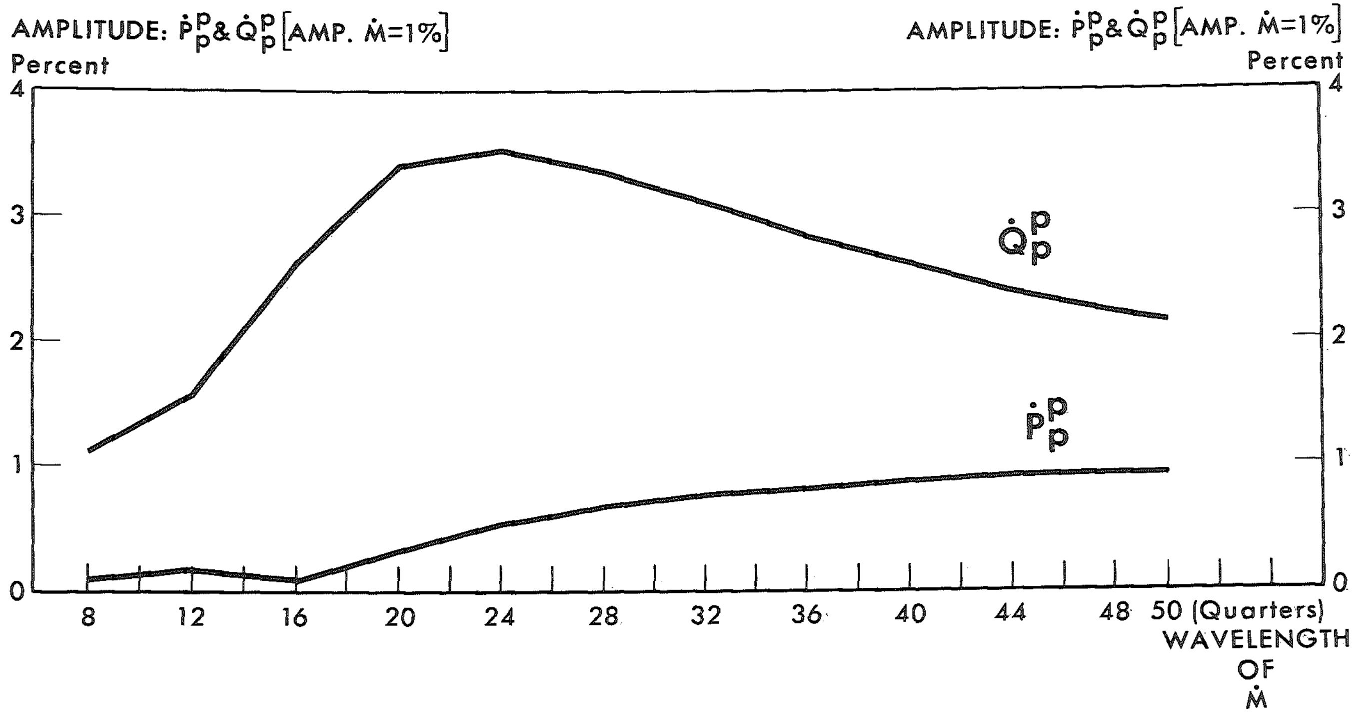
Wave Length of $\dot{M}$ Series	Number of Periods Peak of $\dot{P}^p_p$ Precedes Peak of $\dot{M}$	Number of Periods Peak of $\dot{P}^p_p$ Follows Peak of $\dot{M}$	Number of Periods Peak of $\dot{Q}^p_p$ Precedes Peak of $\dot{M}$	Number of Periods Peak of $\dot{Q}^p_p$ Follows Peak of $\dot{M}$
8	3	5	7	1
12	5	7	11	1
16	6	10	14	2
20	7	13	19	1
24	10	14	Coincident	
28	14	14	1	27
32	18	14	2	30
36	21	15	3	33
40	25	15	4	36
44	29	15	5	39
48	33	15	7	41
50	35	15	7½	42½

Conclusions

This study has presented evidence consistent with the view that in the long-run changes in money growth predominately affect prices, but the response of output and price to a change in money growth is distributed over a fairly long period of time. The regression equations indicate that a period of about 24 quarters may be a good approximation of the period of adjustment. It also presented evidence consistent with the view that these two responses are distributed in a different manner within the period of adjustment to a maintained change in the money growth rate. Simulation experiments were then performed as a means of developing the implications of these response patterns for ascertaining the expected responses to a change in money growth and for selecting the appropriate period for monetary analysis.

Chart VIII

The Relation Between the Amplitude of $\dot{P}_p^p$ and $\dot{Q}_p^p$, and the Wavelength of $\dot{M}$



The simulations demonstrate that the variable in which an analyst is interested – output, the price level, or nominal GNP – has an important bearing on the manner in which one analyzes the effects of movements in money. In the case of output, short-run variations in money growth are of foremost importance, while for the price level, the trend rate of money growth should be emphasized. Since a change in GNP is the sum of output and price changes, if one is interested in this variable both short-run variations and the trend growth of money must be taken into consideration.

It was shown that the stage of adjustment to past monetary shocks, an important type of initial condition, has a very important bearing on the observed response of output and price to a change in money growth. Therefore, one must take into consideration the pattern of money growth rates over the previous 24 quarters. This is particularly crucial for assessing the most likely short-run responses of output and nominal GNP.

The type of shocks expected in the future along with initial conditions are very important for monetary analysis. For a given stage of adjustment to prior monetary shocks, it was shown that there are different short-run responses of output depending on whether a short-run change in the money growth rate is permanent or if it is a deviation around a constant trend. The type of deviations over long periods, with a constant trend, change the observed lead-lag relationships between money growth and changes in output and price. They also change the amplitude of variations in output and price.

All of these considerations lead to the conclusion that empirical knowledge of the responses, which allows one to take into consideration the stage of adjustment to previous monetary shocks and other initial conditions, is essential in assessing the impact of a change in money growth on output, price, and nominal GNP. In the absence of such knowledge, it would be difficult to develop a general rule of thumb with regard to either the expected short-run responses or to a fixed, short-run period of analysis.

Some analysts contend that the often observed variable lag to a change in money makes it difficult to use monetary actions in economic stabilization. Although the equations estimated in this study indicate a fixed and predictable response of output and price level to changes in the money stock, the simulations using various types of money shocks and stages of adjustment to prior monetary shocks demonstrate that it is possible to observe a so-called "variable lag" response. This study indicates that such a response is to be expected and can be measured. Therefore, the frequently observed variable lag does not mean that controlling money is a "will-o'-the-wisp" tool of economic stabilization.

DISCUSSION

BENJAMIN M. FRIEDMAN*

The purpose of this conference is to talk about the control of monetary aggregates. The principal question which we have addressed thus far has been how the Federal Reserve System can so control any given monetary aggregate as to keep the values over time of that aggregate as close as possible to an appropriately-selected target path. A related, and in some sense prior, question is how the Federal Reserve should go about choosing the appropriate target path itself. An intelligent selection of the monetary aggregate target path depends upon knowledge of the relationship between the monetary aggregate and income, prices, employment or whatever aspects of the economy may represent the ultimate goals of monetary policy.

The basic thrust of the Andersen-Karnosky paper is to search for evidence on the relationships between one monetary aggregate – the money stock – and three familiar policy goals – income, real output, and prices. Hence the subject matter of this paper is a necessary precursor to the determination of the appropriate time frame for monetary aggregate control, and the paper's attempt to refine our knowledge of several key relationships is clearly a step in a useful direction. The paper itself, however, does not go on to use its empirical estimates of various linkages to address the time-frame question directly, and so I want to spend a few moments considering how to go about solving a problem of this type.

Two fundamental inputs (in addition to others of less interest at the moment) influence the choice of the time frame for monetary aggregate control: The first input, as we are already aware, is our estimate of the relationship between the monetary aggregate which we seek to control and the policy goal variables for the sake of which we undertake to do so. The second input, the unfortunate or uncomfortable aspect of the situation, is the degree of either confidence or uncertainty which we have in our estimates of these key relationships. In other words, the proper time frame for

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monetary-aggregate control depends not only on the pattern of simulation results which emerges from our best available economic model but also on the extent to which we are sure or unsure of the validity of that pattern. To what extent do we believe that this pattern is an accurate and reliable representation of the economic system, or, alternatively, to what extent do we allow for the presence of uncertainties and possible disturbances of the economic system?

Are Alternatives Incompatible?

The Morris paper, presented at the outset of this conference, emphasized the distinction between a fixed monetary policy regime as advocated by Milton Friedman, characterized by a constant rate of money growth, and a flexible monetary policy regime, characterized by discretionarily variable rates of growth of money or reserves or whatever the relevant aggregate may be. I suggest that, in fact, these two positions are not so incompatible as the Morris paper implies. In particular, allowing for the presence of uncertainty – that is, for our ignorance about the functioning of the economy – in the design of a monetary-aggregate control scheme leads inevitably to a policy system which represents a compromise between the rigid and the fixed monetary policy positions.

A simple model may serve to illustrate this point. Following the notation of the Andersen-Karnosky paper, let M and Q represent the rates of growth of the money stock and real output, respectively. Suppose, as in the material summarized by Table II of the Andersen-Karnosky paper, that the value of M, together with several other factors, determines the value of Q:

The rigid monetary policy regime advocated by Milton Friedman is always to set M equal to some fixed value, say, MF:

$$M = MF \tag{1}$$

Doing so results in a particular value of real output, say, QF:

The motivation for the flexible monetary policy regime is that the other factors which influence real output may, independently of the value of M, cause the value QF of Q to differ from its preferred value, say, QP. Under these circumstances, advocates of the flexible regime recommend replacing expression (1) by

$$M = MF + MP \tag{2}$$

where MP is a discretionary policy component of (M). Choosing a positive MP renders M greater than MF (e.g., M = 4% + 2% = 6%), and choosing a negative MP renders M less than MF (e.g., M = 4% – 1% = 3%). In the context of this simplified flexible monetary policy, relationships such as those in the Andersen-Karnosky paper indicate the impact on Q of any given choice of MP. If some fixed coefficient V represents this impact, the economic system which monetary policy makers confront is

$$Q = QF + V \cdot MP \tag{3}$$

Assuming that we know the key coefficient V, choosing MP so as to render Q equal to the preferred value QP is straightforward:

$$QP = Q \tag{4}$$

$$QP = QF + V \cdot MP \tag{5}$$

$$MP = \frac{1}{V} (QP - QF) \tag{6}$$

Expression (6) indicates the appropriate value of the discretionary policy component of M, and using this value in expression (2) yields the appropriate target value for M itself.

If we are not perfectly sure of the value of coefficient V, however, the situation is somewhat different. We may think that some value V is the most likely value, but we also usually recognize that the true value of the coefficient describing the impact of MP on Q may be either somewhat greater or somewhat smaller than our best estimate.

In the context of econometric equations such as those in the Andersen-Karnosky paper, we typically think that the true value is likely (with two-thirds probability) to be no greater than V + SE and no less than V–SE, where SE is the relevant coefficient standard error. Hence the presence of uncertainty changes expression (3) to

$$Q = QF + (V \pm SE) \cdot MPU \tag{3'}$$

where MPU indicates the discretionary policy component of M chosen under the explicit recognition of uncertainty.

If monetary policy makers confront the economic system described by expression (3'), they cannot be sure of rendering Q equal to the preferred value QP, regardless of the value of MPU which they choose. They can, however, choose MPU so as to make the expected value of the discrepancy QP – Q as small as possible. If large discrepancies QP – Q are even more than proportionally undesirable than small discrepancies, it may be appropriate to choose MPU so as to render the expected value of the squared discrepancy $(QP - Q)^2$ as small as possible. Doing so changes expression (6) to

$$MPU = \frac{V}{V^2 + SE^2} (QP - QF) \tag{6'}$$

At this point we may ask what influence the presence of uncertainty has on the choice of the discretionary policy component of M. In other words, how does MPU in expression (6') differ from MP in expression (6) The ratio of the two values is

$$\frac{MPU}{MP} = \frac{\dfrac{V}{V^2 + SE^2}}{\dfrac{1}{V}} \tag{7}$$

and straightforward algebraic manipulation yields

$$\frac{MPU}{MP} = \frac{\left(\dfrac{V}{SE}\right)^2}{\left(\dfrac{V}{SE}\right)^2 + 1} \tag{8}$$

Since the value of this ratio is clearly less than unity, expression (8) indicates that the influence of uncertainty is to lead monetary policy makers to choose a value of M which differs from the fixed MF by less than does that corresponding value of M which they would choose if they were perfectly sure of the impact of their actions. This result is intuitively both plausible and appealing; ignorance dictates caution.

In the context of econometric models, the ratio of a coefficient to its standard error – that is, the $\frac{V}{SE}$ ratio in expression (8) – is simply the t-statistic associated with the coefficient. Hence expression (8), which indicates the extent of caution dictated by a particular degree of ignorance, is in fact simply

$$\frac{MPU}{MP} = \frac{t^2}{t^2 + 1} \tag{9}$$

From expression (9) it is easy to consider the influence of a variety of degrees of uncertainty. A t-statistic of $t = 2$ for example, a familiar minimum standard in econometric work, warrants choosing a value of MPU equal to four-fifths of the corresponding value of MP which we would choose in the absence of uncertainty. A t-statistic of $t = 1$ warrants choosing a value of MPU equal to only one-half of the corresponding value MP.

Although the Andersen-Karnosky paper does not indicate the t-statistics associated with the coefficients of the regression equation it reports, Denis Karnosky kindly gave me this information for the third equation in the paper's Table II; this equation is the source of the output simulations described in the latter half of the paper. The t-statistic for the coefficient in this equation which is equivalent to coefficient V in expression (3) is approximately $t = 8$. Using this t-statistic in expression (9) implies that the appropriate value of MPU in the presence of this degree of uncertainty is $\frac{64}{65}$, or more than 98%, of the corresponding value of MP which would be appropriate if we were perfectly sure of the impact of discretionary monetary policy on Q. If this t-statistic is an accurate description of our ignorance, therefore, it is appropriate to proceed almost as if we were not ignorant at all; and the compromise between a rigid and a flexible monetary policy becomes almost indistinguishable from the flexible policy itself.

Additional Questions

At this point I want to ask, without attempting to answer, several questions about the equations presented in the Andersen-Karnosky paper.

First, the equations reported in this paper differ in several respects from previous monetarist equations. The Andersen-Karnosky equations show, for example, that it is necessary to take account of the lagged impact of monetary growth on income, real output and prices for twenty-four quarters – that is, six years – which is quite a long time. This result differs substantially from the implications of the Andersen-Jordan equation or the Andersen-Carlson model. Which is correct? The t-statistic of $t = 8$ in the Andersen-Karnosky paper is predicated on the assumption that we know the length of lag involved in these relationships, but a comparison of different monetarist results suggests that in fact we do not know.

Secondly, the three equations reported in Table I of the Andersen-Karnosky paper examine the relationship between money and prices. Even the versions of these three equations with a twenty-eight quarter lag on the money variable probably do not maximize the equation's adjusted coefficient of determination ($\overline{R}^2$). The reported value of $\overline{R}^2$ for each of the three equations rises as each additional four quarters increment the length of the lag. In this case, why stop at twenty-eight quarters?

Thirdly, a key object of these equations is to test the proposition that, in the long run, the elasticity of prices with respect to changes in money is unitary. Confirmation of this hypothesis depends upon the closeness to unity of the coefficient sums $\Sigma\, m_i$ reported in the first column of the table. For each of the three equations, however, the value of this coefficient sum is not only rising but actually accelerating as each additional four quarters increment the length of the lag. If the lag were sufficiently long so as to maximize any or all of the three equations' $\overline{R}^2$ values, would the resulting coefficient sums $\Sigma\, m_i$ be so much in excess of unity as to warrant rejecting the hypothesis of unitary elasticity?

Fourthly, the three equations reported in Exhibit III examine the relationship between money and income. A key object of these equations is to test the proposition that, in the long run, the elasticity of income with respect to changes in money is unitary. Once again, confirmation of this hypothesis depends upon the closeness to unity of the coefficient sums $\Sigma\, m_i$ reported in the first column of the table. For the first equation reported in Exhibit III, the two lag lengths which yield the greatest $\bar{R}^2$ values (twelve quarters, for which $\bar{R}^2$ = .567, and sixteen quarters, for which $\bar{R}^2$ = .564) are precisely those lag lengths for which it is necessary to reject the hypothesis of unitary elasticity. Does this result mean that we must in fact reject the hypothesis? Alternatively, what does this result imply about our knowledge of the proper lag length for equations of this type?

The point of these questions is not simply to pick holes in the Andersen-Karnosky paper's equations. These equations are useful, and they offer some interesting evidence on several relationships which are central to the formulation of monetary policy. Instead I am asking whether the extent of our uncertainty about a number of aspects of these key relationships is not greater than that implied by the t-statistic $t = 8$ which warrants setting a policy almost (98%) equivalent to the policy that would be appropriate in the absence of uncertainty.

At the conclusion of a conference such as this one, it is appropriate to ask where we should go from here. These questions which I have asked all relate to the nature of the research which would be useful for the Federal Reserve System and independent researchers to emphasize, in the interest of furthering the art of making monetary policy. We are already aware that we need to learn more about the relationships between monetary aggregates or other monetary policy variables and the variables which represent the ultimate goals of policy. Indeed, as Karl Brunner's discussion has suggested, we must think carefully about whether or not the overall theoretical structure which underlies our empirical work is correct. The somewhat paradoxical point which I have tried to emphasize in addition, however, is that we also need to learn more about our ignorance so that we may allow for it in formulating policy. Once we do so, the seemingly inconsistent positions which advocate either a rigid or a flexible monetary policy become not so inconsistent after all.

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