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7 How Feasible Is a Flexible Monetary Policy?

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7.1 Flexibility and the Lag in Monetary Policy

The position now held by monetary policy as the main tool of short-run stabilization has yet to be reconciled with the accumulating evidence of a substantial lag in its effects on economic activity. A lag complicates the execution of policy, since it means that actions take effect well after they are initiated. Hence a policy of stabilizing short-run fluctuations in the economy implies the ability to forecast the course of economic activity and the subsequent effects of policy actions.

Twenty-five years ago Milton Friedman pointed to the problems of a flexible short-run stabilization policy.[1] Adapting the argument specifically to flexible monetary policy, he later wrote: "We seldom in fact know which way the economic wind is blowing until several months after the event, yet to be effective, we need to know which way the wind is going to be blowing when the measures we take now will be effective, itself a variable date that may be a half year or year or two years from now."[2] He concluded that countercyclical monetary policy in the United States was more often a destabilizing rather than a stabilizing influence and proposed as a policy rule a constant rate of increase in the money stock.

In recent years research on monetary policy has begun to explore the problems faced by stabilization programs with short-run objectives.[3] In this paper we bring together the results of studies that provide evidence of the lag in monetary effects. The lag patterns indicate that a change in the money stock in the current quarter induces a change in GNP not only in that quarter but also in many succeeding quarters. Thus, according to these patterns, the value of GNP in any quarter is a sum of the effects produced by money stock changes in a string of preceding quarters.

Generally speaking, given the limitations of present forecasting capabilities, the longer the lag the more impracticable a policy of short-run stabilization becomes. The flexibility allowed by the short inside lag of monetary policy—the lag between the provision of reserves to the banks by the Federal Reserve System and the change in the money stock—can be negated by a long outside lag—the lag between the change in the money stock and its effects. The studies we review suggest that the problem posed by imperfect forecasting techniques combined with long lags persists and, as Friedman pointed out, seriously limits the feasibility of flexible monetary policy.

We begin by distinguishing the short-run monetary policy actions at issue here from the day-to-day and week-to-week flexibility also advocated by the proponents of flexibility. Possible conflicts are noted between the objective of stabilizing economic activity by short-run flexible monetary policy and the objective of moderating transient money market disturbances by a policy of stabilizing interest rates (section 7.2). We then compare some estimates of lags after World War II with those for the 1920s for evidence of possible changes in the lag. We were unable to establish that such changes had occurred. Our main focus is on four versions of distributed lag patterns in regression models relating GNP to the behavior of the money stock in past quarters. All the lags cover many quarters (section 7.3). We predict GNP quarterly from M_1 data for 1921 to 1970, based on each lag pattern, and select peaks and troughs in the estimated GNP series. The timing of these turns compared with actual peaks and troughs in GNP or NBER reference dates suggests that the lag pattern itself is not fixed (section 7.4). For each of these lag patterns, we calculate the hypothetical required course of monetary growth in order to achieve a specified increase in GNP above its previous level. If the attempt were made to attain the target within a few quarters, it would require a complex path of monetary growth with the attendant possibility that the attempted policy itself, if not right on target, would become a source of instability. Neither the pattern estimated by the most sophisticated methods nor by simpler methods is favorable to a flexible monetary policy (section 7.5). The effects on GNP of seasonal or other periodic movements in monetary growth are briefly discussed in section 7.6. Section 7.7 summarizes our findings.

7.2 Kinds of Flexibility

Proponents of a flexible monetary policy often have several objectives in mind, not all of which are beset by a lag problem. Indeed, a lag in monetary effects on economic activity means that day-to-day variations in monetary growth may be smoothed over by the lag and have no long-run importance for economic activity and prices. Consequently, such day-to-day variations can be made in pursuit of a transient objective without interfering with economic stabilization goals. In appraising the flexibility of monetary policy, therefore, we should distinguish three different objectives of monetary policy according to the time span over which they apply. Spans from a day up to two or three weeks may be termed transient; the short run covers spans from a month to three or four quarters, and the long run from one to several years or longer.

On a day-to-day basis, open-market operations may be used to offset transient variations in the expansion multiplier of the banking system. Such variations originate within the monetary system and affect the growth rate of the money stock. A major part of the day-to-day activity of Federal Reserve open-market operations is devoted to offsetting such variations and is believed to be desirable to control the stock of money in the short run. It can be debated whether day-to-day variations in monetary growth are of consequence, and therefore whether it is worthwhile trying to moderate them, but in any event such policy actions to offset transient movements in financial markets, typically undertaken by Federal Reserve, have little import for economic stabilization.

For the long run, policy seeks a high level of employment and reasonable price stability. There may be disagreement at any particular time on the combination of employment and price change it is desirable to try to achieve. But, given the long-run goal, it will be consistent with a particular average rate of monetary growth. So far as the long-run goal is concerned, the monetary growth rate would not have to be adjusted except perhaps infrequently for changes in the growth trend of monetary velocity. The transient and long-run objectives of monetary policy entail no problem with lags. It is the short-run objectives which face a problem.

Proponents of a flexible monetary policy argue that all three time horizons should be the concern of monetary policy, but they put particular emphasis on the need for short-run flexibility. The purpose is to moderate cyclical fluctuations in economic activity and financial disturbances which last longer than a few weeks. These two objectives are partly related, since moderating fluctuations in financial markets may help to stabilize economic activity. This is true of shifts in preferences by the public as between money balances and other financial assets. These shifts lead to changes in interest rates that can affect aggregate demand, and an accommodating monetary policy would in this case keep both interest rates and aggregate demand on a stable course. The problem is that changes in interest rates can also reflect shifts in the demand for capital goods, and if interest rates are stabilized under these circumstances, an accommodating monetary policy will destabilize aggregate activity by feeding an inflation when interest rates rise or deepening a depression when they fall.[4] Unfortunately, there is often no clear indication of the reason for changes in interest rates at the moment they occur. To avoid the possibility of interfering with the more important long-run objective of stabilizing aggregate demand, therefore, a policy of moderating changes in interest rates has to reverse itself within a short time period so as not to veer away from the appropriate long-run rate of monetary growth.

Discussions of monetary policy have long noted this conflict between the stabilization of interest rates and of aggregate demand. But the conflict is often obscured by the altogether different question of using interest rates and general financial conditions as input data for forecasting economic activity and as indicators of whether the long-run goals are being achieved. A long-run goal for employment and prices implies some appropriate behavior of monetary growth and interest rates as well as other economic variables, and any group of these variables can in principle serve as indicators. In this way interest rates and financial conditions may certainly be relevant to policy-making, but their function as indicators does not mean that they should be stabilized as targets—that is, as the objective of policy. The proper role of financial conditions in forecasting economic activity and as indicators of policy is a technical question which we put aside here.

The frequent changes that occur in financial markets nevertheless invite short-run variations in policy both to moderate the financial disturbances and to counteract the change in economic activity which those disturbances appear to indicate is underway (assuming the two objectives are consistent). Here the flexibility of policy can come into sharp conflict with the lag in its effect. Suppose that money has been growing at a rate which was thought appropriate to achieve the desired growth in aggregate demand for several years ahead. Then some new information (financial or other) becomes available indicating that aggregate demand will be lower—though not permanently so—than the long-run goal in the next several quarters. Should monetary policy attempt to correct the shortfall? The answer depends in part upon how quickly policy actions can be expected to affect aggregate demand. A change in money balances sets in motion a chain of adjustments which ultimately produces a change in aggregate expenditures, but the adjustments are spread over a considerable period of time. Hardly anyone expects policy to have its major effect on aggregate expenditures within a couple of months. But suppose it has some partial effect within a few quarters. The question can then be reformulated to bring out the problem: Should monetary growth be sharply adjusted to produce the desired effect in a few quarters with the intention of reversing it later to avoid interfering with the long-run goal?

Whether such short-run flexibility in monetary policy accomplishes its purpose is a lively issue, because the Federal Reserve makes large and frequent changes in the rate at which it supplies reserves to the banking system, apparently for all the reasons cited above. Present monetary policy works to offset transient fluctuations in the utilization of reserves by banks and to moderate other sources of disturbance to financial markets as they occur; this is the first kind of flexibility cited above. Monetary policy also pursues the second kind of flexibility to achieve stability over the short run: it is clear from the reports of the Open Market Committee that short-run operations are based on forecasts of economic activity for several quarters ahead with a view to altering the outcome in line with employment and price-level objectives, not to mention stability of financial markets.

To what extent, then, can short-run variations in policy be successful in stabilizing economic activity and prices and, despite the lag in its effect, not be a source of instability? If the net effect of a flexible policy is to increase instability in the economy at large, it cannot be justified. We shall first examine the accumulated evidence on the lag, and then the implications for policy.

7.3 Evidence on the Monetary Lag

7.3.1 Step Dates

The first statistical evidence on the lag was presented some years ago by Clark Warburton and then by Friedman and Anna J. Schwartz.[5] Warburton's measure of the lag, based on turning points in the deviations of monetary growth from its trend, is subject to considerable error because of difficulties in determining the trend. Friedman and Schwartz measured the lag from steps in the rate of change of money to corresponding business cycle turns.[6] The step method treats the monetary lag as discrete; that is, after a delay, the impact of the change in monetary growth on activity is assumed to be concentrated at one point in time.

The lags based on these steps since 1921 are shown in table 7.1 for cyclical turns in general business activity, as given by the National Bureau chronology, and in GNP. The starting date is the earliest for which quarterly GNP is available. General business activity is the most relevant single benchmark for monetary effects. While GNP gives somewhat different results, it is also relevant because most of the statistical lag patterns to be examined were estimated for GNP.[7]

Table 7.1 **Lead (−) or Lag (+) of Steps in Monetary Growth Rate[a] Compared with Corresponding Cyclical Turns in Business Activity and GNP, 1921–1970 (Quarters)**

Date and Direction of Step Turn in Monetary Growth Rate[a]		Reference Cycles[b] (1)	GNP[c] (2)
1921 IV	up	+1	0
1922 IV	down	−2	−5
1924 I	up	−2	−2
1925 III	down	−4	−5
1926 IV	up	−4	−6
1928 I	down	−6	−6
1932 II	up	−3	−3
1936 II	down	−4	−5
1938 II	up	0	0
1945 III	down	+2	+1
1949 III	up	−1	−1
1952 IV	down	−2	−2
1954 I	up	−2	−1
1955 III	down	−8	−8
1957 IV	up	−2	−1
1959 II	down	−4	−4
1960 II	up	−3	−3
1962 I	down	none	none
1962 III	up	none	none
1966 I	down	none	−3
1966 IV	up	none	−1
1969 II	down	−2	−1
1969 IV	up	−4	−4
Median	1920–38	−3	−5
	1945–70	−2	−1½

Sources: Monetary step turns, Friedman and Schwartz (unpublished manuscript), giving dates for M_1 through 1969 IV, as in Edward Gramlich, "The Usefulness of Monetary and Fiscal Policy as Discretionary Stabilization Tools," *Journal of Money, Credit, and Banking* 3 (May 1971): 506–32. Reference dates, Geoffrey H. Moore, ed., *Business Cycle Indicators* (Princeton, N.J.: Princeton University Press for NBER, 1961), 1:671, and Solomon Fabricant, "Recent Economic Changes and the Agenda of Business-Cycle Research," *National Bureau Report* 8, Supplement (May 1971):26, table 2. GNP before 1929, Harold Barger and Lawrence Klein (unpublished worksheets; thereafter, Department of Commerce).

[a]Narrow money supply, M_1.

[b]Skipped reference turns are 1945 IV (trough) and 1948 IV (peak).

[c]Nominal GNP through 1962 trough, real GNP thereafter.

The lags in column 1 of table 7.1 for business activity have an interquartile range of 1½ to 4 quarters and an overall median of 2.

7.3.2 The Step Dates before and after World War II

It is interesting that the medians shown for the two subperiods suggest that the lags after World War II are somewhat shorter than before. The growth of various money substitutes since World War II (particularly savings and loan deposits, time certificates of deposit, Treasury bills, and commercial paper) is often taken to imply just the opposite. John G. Gurley and Edward Shaw, writing of developments in the 1950s, touched off a voluminous literature on the dangers of money substitutes to the efficacy of monetary policy.[8] Their argument was that the growth of substitutes makes the demand for money balances more responsive to changes in interest rates, with the result that changes in the money stock take longer to affect aggregate expenditures. Supposedly a very elastic demand for money balances readily absorbs changes in the money stock through movements along the demand curve, thus delaying the effect on aggregate expenditures. Whatever the merits of the argument, the interest elasticity does not appear to have increased. We have estimated the short-run interest elasticity of money demand separately for the 1920s and 1953–65, using the same functional form to facilitate comparison, and find no evidence of an increase. It seems to be roughly the same or possibly lower now. Although the growth of money substitutes contributed to the long-run decline in money demand which is reflected in the postwar rise in monetary velocity, apparently it did not increase the interest elasticity of the remaining balances.[9]

7.3.3 Distributed Lags

The reduction in the average length of the lag after World War II, however, has not been great enough to counter a basic difficulty confronting a flexible monetary policy. The difficulty pertains to our imperfect knowledge of the lag in monetary effects on economic activity. The lag varies considerably over time, owing in part to errors in the data as well as the existence of other cyclical developments that reinforce or offset the monetary effects. The variation is also a reflection of the diverse channels through which monetary effects are produced, which means that the resulting changes in aggregate expenditures occur after delays of different durations. Hence, depending on the particular channels of response characterizing a cyclical episode, the average duration of the lag is likely to vary from one period to the next.

Even without changes from period to period, the various channels through which monetary effects are produced have different lag times. The differences mean that the total effects of a monetary step are distributed over time. Numerous studies have estimated the average time distribution of the lag by relating GNP to the behavior of the money stock in past quarters, taking account in some cases of other influences on GNP. The regression coefficients of past monetary changes can be interpreted as forming the weights of a distributed lag. The regression which estimates these weights has the advantage of utilizing every observation of the time series within the period examined, instead of ignoring all observations except those around the step turns. But it also has the disadvantage, which is not true of the step dates, of assuming a fixed lag distribution over the period covered and of treating every observation as equally important in estimating monetary effects.[10]

Estimates of a distributed lag were presented by Friedman and David I. Meiselman in their 1963 study,[11] and their general approach was followed in subsequent work by the research staff of the Federal Reserve Bank of St. Louis.[12] The widely discussed St. Louis equation is a relation between changes in GNP and lagged changes in the money stock, holding constant a variable representing fiscal policy (namely, changes in high-employment federal expenditures). Various versions of the lag pattern have been estimated, depending upon the period covered and the number of terms in the lag.

All versions of the St. Louis lag pattern have the same general form.[13] The weights are the largest for the current and most recent past quarters, gradually declining thereafter, and becoming negative after the fourth quarter if lag terms are included for such earlier quarters. Overshooting at the beginning is indicated when initial terms produce more than the final total effect. Negative weights at the end provide a partial offset. Such a lag pattern is theoretically appealing. It means that monetary changes induce a movement in the ratio of money to GNP initially away from its starting level because of the delayed effect on GNP, but that the ratio eventually moves back toward a long-run equilibrium level. At some point, therefore, the rate of change in GNP will have to exceed the rate of change in the money stock for a while in order that the ratio of money to GNP can move back toward its starting level. Hence we observe overshooting in which the rate of change of GNP goes past its new equilibrium for a while.[14]

We reestimated various versions of the St. Louis equation and selected one as representative.[15] Its lag pattern is presented in column 2 of table 7.2 as St. Louis *A* along with others to be discussed shortly. The shape of the lag pattern remains largely the same for a smaller or larger number of lag terms included in the regression equation. As usually presented, the St. Louis equation expresses the variables in dollar amounts, but here we used percentage changes. The percentage form makes the result more applicable to a variety of time periods among which the dollar levels of the variables differ considerably.

Table 7.2 **Estimates of the Distributed Lag of Monetary Effects**

		St. Louis			FRB-MIT-Penn	
Lag Period (Quarters)	Steps (1)	*A* (2)	*B* (3)	Silber (4)	*A* (5)	*B* (6)
0		.52	0	.32	.17	.13
1		.62	.96	.75	.12	.05
2		.47	.63	.68	.25	.16
3		.22	.26	.32	.10	.03
4		−.03	−.06	−.12	.21	.10
5		−.21	−.26	−.46	.00	.00
6		−.26	−.31	−.49	.12	.05
7		−.22	−.22	−.01	.02	.03
8		−.10			.02	.03
9						.11
10						.11
11						.11
12						.11
Average length of lag[a]	2.6	1.2	1.6	1.5	2.8	6.1

Note: No entry is shown in col. 1 since the step lag is not distributed. Cols. 2–4 give regression coefficients of a regression of GNP on the monetary variable. Cols. 5–6 give coefficients based on a simulation. Coefficients have been adjusted to sum to unity (see n. 25 below). Details of estimation of cols. 2–6 are as follows: (Col. 2) Percentage change in GNP regressed on percentage change in M_1, 1954 I to 1971 II. The fitting used an Almon polynomial lag, 4th degree, with zero end-point constraint at the tailend. (Col. 3) Same as col. 2, except that the monetary variable for the concurrent quarter was omitted. (Col. 4) Change in GNP regressed on change in monetary base as compiled and published by Federal Reserve Bank of St. Louis, 1953 I to 1969 I. See William L. Silber, "The St. Louis Equation: 'Democratic' and 'Republican' Versions and Other Experiments," *Review of Economics and Statistics* 53 (Nov. 1971): 372–75. (Cols. 5 and 6) Simulation of model (see note 24 below). Franco Modigliani, "Monetary Policy and Consumption: Linkages via Interest Rate and Wealth Effects in the FMP Model," in Federal Reserve Bank of Boston, *Consumer Spending and Monetary Policy: The Linkages* (Boston, 1971), pp. 9–84: figures kindly supplied by the author. Col. 5 is a simulation of a decrease in demand deposits, and col. 6, a simulation of an increase.

[a]For col. 1, mean of entries in table 7.1, col. 1. For cols. 2–6, weighted averages, each a sum of products of the lag period (through period 3 only for cols. 2–4, and full period for cols. 5–6) times the coefficients, divided by the sum of the coefficients included.

The other lag patterns represent various attempts, with only partial success, to overcome a problem of feedback for which the St. Louis equation has been criticized. This problem is the bias produced by economic influences on the money supply. An increase in GNP, for example, may induce banks to expand loans by reducing excess reserve ratios or increasing borrowings from Federal Reserve Banks. There are limits to how far this bank-generated expansion can go without an increase in nonborrowed reserves, but it may produce some concurrent correlation between changes in GNP and in the money supply which is not due to monetary effects on GNP. The lag weight at time zero may be spuriously enlarged by this feedback and make the average lag in monetary effects appear shorter than it is.

A drastic method for avoiding concurrent feedback is arbitrarily to assume that the concurrent coefficient is zero and to impose that constraint on the estimated pattern. The lag pattern shown in column 3 of table 7.2 as St. Louis *B* was derived by this method. It has a slightly longer average lag, as expected, but two obvious drawbacks. The method forces any concurrent monetary effects to be zero as well, which makes the average lag appear longer than it probably is. At the same time the method does not avoid the effect of feedback in the remaining lag terms.[16]

One method of dealing with feedback is to use the monetary base (that is, bank reserves plus currency held by the public) in place of the money supply. The effects of GNP on the expansion multiplier of the banking system are thereby omitted. As an alternative to the equation using the money supply, a version of the St. Louis equation using the monetary base was also presented.[17] The latter approach was then adopted by staff members of the Board of Governors and of the Federal Reserve Bank of New York.[18] Column 4 of table 7.2 gives a later version by William L. Silber which is preferable for our purposes because he included more terms at the far end of the lag distribution.[19] We have assumed that his estimates can be treated as pertaining to changes in the money stock.

The Silber equation has the disadvantage that it incorporates the lag time from the monetary base to the money stock as well as from money to GNP. Yet the average length of his lag pattern does not exceed most of the others, perhaps because the inside lag of the banking system is short. If we were to go further and exclude member-bank borrowing as well from the monetary variable, on the grounds that such borrowing is endogenous and not offset by Federal Reserve open-market operations, the appropriate monetary variable is nonborrowed reserved. Richard G. Davis has shown that the inside lag (from a change in nonborrowed reserves to a change in demand deposits) then appears to be longer, and Michael J. Hamburger, that the total inside and outside lag is longer.[20] We have not included such lag distributions in order to maintain the comparability of the different lag patterns analyzed here. The longer lag implied by models based on nonborrowed reserves would increase the difficulty of conducting a stabilizing monetary policy.

Although Silber's use of the monetary base avoids feedback from GNP to bank reserve ratios and currency holdings, it incorporates any feedback from GNP to the monetary base due to a systematic Federal Reserve response to economic and financial developments (as do the other equations as well as those using nonborrowed reserves). For example, if the Federal Reserve moderated movements in interest rates which accompany fluctuations in GNP, the monetary base would tend to display a positive covariation with GNP. A special econometric technique devised by Christopher A. Sims shows, however, that feedback on the money stock is not strong enough to account for the lag relationship between money and GNP, and indeed does not appear to be very important if we disregard the concurrent quarter.[21] Sim's technique does not deal with feedback in that quarter and so does not rule out an important immediate feedback from GNP to money. If it is important, however, it has the effect of raising the estimated weight of the concurrent term in the lag distribution and of making the average lag appear shorter than it is. Hence the St. Louis and Silber patterns may understate the lag and therefore the difficulties of flexible monetary policy. (The St. Louis *B* pattern in table 7.2 does not appear to be an adequate solution to this feedback problem, possibly because of serial correlation in the variables.)

Another estimation problem recently discussed by Levis Kochin arises from the policy control of monetary growth to stabilize the economy.[22] Insofar as monetary policy succeeds in offsetting the effects on economic activity of various nonmonetary disturbances, part of the fluctuation in monetary growth will not correspond with observed movements in GNP. In the extreme case, if monetary policy succeeded in removing all fluctuation from GNP, the correlation between GNP and money would be zero. If the stabilization policy is partially but not completely successful, the correlation will be negative, and if the stabilization policy overcorrects for nonmonetary disturbances, the correlation will be positive. Since we observe a positive correlation, monetary policy in practice overcorrects; that is, less fluctuation in monetary growth would reduce the fluctuation in GNP growth. But insofar as monetary policy is successful in offsetting the effect on GNP of some nonmonetary disturbances, the observed relationship between GNP and money does not portray the full effects of money. Moreover, in that case, it is not at all clear how the estimates of the lag distribution are affected.

In theory the solution to this estimation problem is to take account of all the effects on GNP of nonmonetary variables which monetary policy partially offsets. The estimation procedure can then allow for the interaction between monetary growth and other variables.

The intention of the large econometric models is indeed to take account of all influences on GNP. Columns 5 and 6 of table 7.2 present the lag pattern of monetary effects implied by the FRB-MIT-Penn econometric model.[23] This is a large-scale model which takes into account many relationships, including feedback from GNP to the financial system and nonmonetary influences on GNP. Despite simplifications to make the model manageable, it has the most elaborate financial sector of any econometric model so far constructed and represents the "state of the art" of model building as it exists today. Yet we are not alone in doubting seriously whether even this elaborate model deals adequately with feedback and with the more important problem just discussed of isolating the effects of stabilization policies. So far it has proved difficult to capture in an econometric model all the disturbances affecting GNP which monetary policy may try, in part successfully, to offset. We regard the lag estimates produced by the FRB-MIT-Penn model—the best of the attempts to allow for interactions—as representative of large econometric models.

The lag pattern of this model was derived by simulation.[24] The estimates represent the effect of a hypothetical $1 billion change in demand deposits on the level of GNP in 1967 I. A simulation for a decrease in demand deposits is shown as *A* in table 7.2, and one for an increase as *B*. Because monetary policy will produce changes in GNP before the full effects on the level occur, we expect the FRB-MIT-Penn lag pattern to be longer than the others. The longer average lag of the pattern may also be due to the fixed channels of monetary effects it prescribes. Changes in monetary policy in the model have the effect of changing particular interest rates and thereby various components of investment and consumption. Insofar as the actual channels are more diverse and varying than the model provides for, the effects tend to be understated and very likely tend to be faster in coming than it predicts.

The lag patterns in table 7.2 have been adjusted to sum to unity.[25] Thus each weight gives the percentage of the total effect which occurs in each quarter. Although none of the estimation procedures imposed such a condition, we made the adjustment so that they would all give the same long-run relation between GNP and the money stock. (The adjustment also converts the FRB-MIT-Penn patterns, which were estimated from variables in dollar terms, into a form applicable to variables in percentage terms.) The condition is theoretically appealing. For the levels of the variables, a sum equal to unity means that the ratio of money to GNP eventually returns to its initial level. For rates of change of the variables, it means that the growth rates of GNP and the money stock eventually become equal.[26]

The patterns shown in table 7.2 represent the best of recent research on monetary lags.[27] Each of the methods of estimation presents certain problems, as noted, and none can be clearly preferred. Hence the exact form of the pattern remains in doubt. All agree, however, in showing a distributed lag covering many quarters. On that the evidence is clear. If monetary policy is to take account of lags, it will have to reckon with the results of studies such as these.

7.4 Turning Points Implied by the Lag Patterns

Whether the lag in monetary effects implied by these patterns is biased toward the long or the short side can be tested by the turning points in business activity derived from them. This test also indicates how consistently such fixed lag patterns fit the data over a long period, and particularly whether the variability of the leads in step turns can be explained by the configuration of monetary growth surrounding the steps.

We calculated the predicted levels of GNP from 1921 to 1971 estimated by each lag pattern. As noted earlier, we used the predicted level before 1960 and the level divided by the implicit price deflator for GNP thereafter, because of the difficulty of selecting turns in the undeflated level during the second half of the 1960s. For the FRB-MIT-Penn pattern pertaining to levels, the logarithm of demand deposits was run through the lag pattern to derive an index of the level of GNP (in logarithms). Of course, this procedure gives only an approximation to a full simulation of the model. For the other patterns pertaining to rates of change, the quarterly rate of change of M_1 was run through the lag pattern to generate an estimated rate of change of GNP (with the constant term omitted). These rates of change of GNP were then used to derive an index of the level of GNP. Since the lag patterns are adjusted to sum to unity, the average rate of growth of this GNP index is the same as that of the money stock. The trend of the index and the trend of actual GNP differ by the trend in the ratio of GNP to the money stock. But these trend differences have little effect on the dates of turning points.

We selected peaks and troughs in the estimated GNP indexes. The turns not corresponding to turns in actual GNP were disregarded. The selected turns were compared with the actual peaks and troughs in National Bureau reference cycles (which sometimes differ from the turns in GNP).[28] The timing differences are presented in table 7.3, together with the average of these differences compared with the average deviation for step cycle turns.

The FRB-MIT-Penn model has the shortest leads or longest lags (because of its long pattern). It fails to register many of the turns. The turning points of the other lag patterns, which are shorter than it is, are generally close to the turns in business activity. The differences in timing among the three lag patterns excluding FRB-MIT-Penn do not appear significant. (As we shall see below, however, the differences are important for policy purposes.) On this evidence, it is hard to choose among these three. The variability in their timing is about the same. The Silber pattern has the smallest average deviation because of its bullseye at the 1957 III peak, which the St. Louis patterns miss by well over a year. Otherwise it is not more accurate.

Table 7.3 **Lead (−) or Lag (+) and Average Deviation of Estimated Turns Compared with Actual Turns in Business Activity, 1921–70 (Quarters)**

Peaks and Troughs in Business Activity[a]		Steps	St. Louis *A*	St. Louis *B*	Silber	FRB-MIT-Penn
1921 III	trough	+3.6	+2	+2	+2	[b]
1923 II	peak	+0.6	+1	+1	0	[b]
1924 III	trough	+0.6	−1	−1	−1	−2
1926 III	peak	−1.4	−2	−2	−2	[b]
1927 IV	trough	−1.4	−1	−2	−2	[b]
1929 III	peak	−3.4	+1	+2	+2	+1
1933 I	trough	−0.4	+1	−1	−1	+7
1937 II	peak	−1.4	−1	0	0	+2
1938 II	trough	+2.6	+1	+1	+1	[b]
						[b]
1948 IV	peak	[b]	−4	−3	−3	[b]
1949 IV	trough	+1.6	0	0	−1	[b]
1953 II	peak	+0.6	0	+1	−1	[b]
1954 III	trough	+0.6	−1	0	−1	[b]
1957 III	peak	−5.4	−6	−7	0	[b]
1958 II	trough	+0.6	−1	0	0	[b]
1960 II	peak	−1.4	−3	−2	−3	[b]
1961 I	trough	−0.4	−1	−1	−1	[b]
1966 IV	peak	−0.4	−1	0	−1	−1
1967 I	trough	+1.6	0	+1	+1	0
1969 IV	peak	+0.6	−1	0	−1	−2
1970 IV	trough	−1.4	−3	−2	−2	−3
Average absolute deviation[c]		1.5	1.5	1.3	1.2	2.2

Note: Entries for step turns are the deviations from the average lead of 2.6 quarters (see table 7.2). GNP, estimated from lag patterns, was deflated for 1966–70 before selecting turns. Without deflation, most of the estimates skip the turns. For FRB-MIT-Penn estimated GNP, peaks were selected from estimates based on table 7.2, col. 5, troughs from estimates based on table 7.2, col. 6.

[a]Peaks and troughs in National Bureau reference cycles (see source note to table 7.1) except for 1966–67, which is not designated a reference cycle and is based on turns in real GNP. The 1945 reference peak and trough are omitted.

[b]No matching turn.

[c]Average of leads or lags, without regard to sign, excluding 1948 peak and, for FRB-MIT-Penn, other skipped turns.

This last result deserves emphasis. If the variability in step lags were due to the assumption of a discrete rather than distributed lag, a distributed lag should give more consistent estimates of turning point dates. As measured by average deviations, the estimated lag patterns perform only a little better than the step dates. The failure of the lag distributions to give sharply better predictions is presumably due to variability in the true lag pattern over time, so that fixed patterns do not give very good estimates.

7.5 Implications of the Monetary Lag for Policy

Effects which are distributed over time create problems for policy. Granted, if the lag pattern were known with certainty, the monetary authorities could calculate a path of monetary growth to achieve the desired path of GNP. But the calculated path appears to require wide swings in monetary growth. Because of uncertainty over the effects, large swings pose the danger of adding to instability.

We can examine the problems inherent in these lag patterns by means of a simple but common situation. Suppose that the economy lies below the desired growth path of GNP and monetary policy is called upon to close the gap in one quarter and thereafter to hold GNP at the previous rate of growth. The gap between the desired and actual level of GNP is the most common criterion by which policy is judged, for this gap influences the rate of unemployment and rate of change of prices; but a more complicated assessment of policy would take the effects on these and other variables explicitly into account. For present purposes we do not distinguish between monetary effects on prices and on real output. Table 7.4 gives the required path of monetary growth for closing a gap between the desired and actual levels of GNP. It is assumed that the previous monetary growth rate, if unchanged, would keep GNP growing at the desired rate but along a trend now viewed as 2 percent too low. The figures shown for monetary growth increase GNP 2 percent above its previous level in one quarter and thereafter maintain the previous rate of growth.

The results point to two serious difficulties for policy. First, the initial increase in the monetary growth rate must be relatively large, because the concurrent effect on GNP is small. Thereafter the rate must swing up and down to offset the continuing effects of the initial and subsequent changes. For example, with the St. Louis pattern, to achieve a 2 percent increase in GNP above its previous level in one quarter, the money stock must grow in that quarter at a 15.5 percent annual rate ($2 \times 4/.52$). To offset the lagged effect of that 15.5 percent rate of monetary growth, the growth rate in the next quarter would have to drop to −18.6 at an annual rate. To offset the cumulated lagged effects of the 15.5 percent rate in the initial quarter and the −18.6 percent in the quarter after that, the monetary growth rate in the following quarter would then have to rise to 8.4 percent, and so back and forth in subsequent quarters.[29]

The lag patterns are jagged, due no doubt to errors in the estimates. The true distribution of monetary effects could theoretically have a

Table 7.4 **Monetary Growth Policy Which Achieves Target Level of GNP 2 Percent above Trend in One Quarter: Deviations from Long-run Growth (Percentage per Year)**

	St. Louis			FRB-MIT-Penn	
Quarter	*A*	*B*	Silber	A	B
0	15.5	none	25.0	46.2	63.0
1	−18.6		−58.6	−30.7	−23.8
2	8.4		84.2	−46.4	−100.5
3	0.0		−97.8	49.6	40.3
4	1.5		118.4	−5.5	31.1
5	− 0.5		−139.7	−4.6	−26.8
6	0.1		159.4	9.6	−10.5
7	0.4		−199.7	−42.1	−7.3
8	− 1.1		299.8	52.6	15.9
9	1.3		−467.2	1.7	−18.9
10	1.4		694.8	−62.2	−40.5
11	− 1.9		−991.2	59.5	58.4
12	0.7		1379.2	−20.4	16.2
13	0.1		−1865.9	−12.6	−24.0
14	0.4		2475.4	49.6	24.1

Note: Method of computation—For each quarter a change in monetary growth is calculated which will maintain GNP 2 percent above trend, given the lag pattern and past monetary growth. It is assumed that monetary growth was at the trend rate before the beginning quarter and thereafter is as calculated. Rates would be double for 4 percent increase in target, and so on.

variety of patterns, but it is more likely represented by a relatively smooth curve. The jagged estimates therefore impose jumps on the required monetary growth path here which are not in fact needed to stabilize GNP. But this source of fluctuation is probably of minor importance.

The main difficulty is that the swings become larger and larger—that is, they are explosive or close to it for all except the regular St. Louis equation (*A*).[30] If not explosive, the fluctuations in the monetary growth rate would converge upon the long-run equilibrium rate which, in table 7.4, is assumed to be zero (the rates are given as deviations from the long-run path). There is nothing in the property of lag distributions which requires them to have this kind of stability for policy purposes. Even in the St. Louis case, which is convergent, the changes in monetary growth have to follow a complicated back-and-forth pattern for many quarters.

A necessary requirement for stability is that the later effects and the needed offsets to them be sufficiently small relative to the initial effects. It might seem, therefore, that the overshooting produced by some patterns is beneficial to policy, since a given early effect on GNP can be produced by small increases in monetary growth. But the overshooting requires complicated offsets later as the initial increase runs through the negative part of the lag distribution.

Given the uncertainties in forecasting future GNP and our limited knowledge of the precise lag patterns, monetary policy cannot risk large swings in monetary growth. Small errors of diagnosis would reinforce rather than reduce instability in the economy. It is clear from table 7.4 that monetary growth rates appropriate for one pattern would produce considerable undesired fluctuation in GNP if one of the other patterns were in fact the correct one. Much of the literature on stabilization policies assumes that the magnitude of errors of execution is given independently of the complexity of the policies to be followed. But actually the magnitude of error is likely to increase sharply with complexity.

Based on such lag patterns as these, we conclude that stabilization goals must be content with longer time horizons than one quarter. How long? A first step toward an answer is provided by table 7.5. Here the policy goal is to achieve a 2 percent increase in GNP in two quarters rather than one. The required monetary growth in each quarter is determined by the difference between the desired and actual level of GNP and the weight of the first two terms of the lag pattern, which give the monetary effect on GNP occurring in the first two quarters.

While this policy rule reduces the fluctuation in monetary growth considerably, much still remains. The least fluctuating path is still given by the St. Louis pattern *A*, but its required monetary growth goes from 7 to −3 percent at an annual rate in the first three quarters and follows a convergent but still complicated course thereafter. The gain of a less fluctuating monetary growth path occurs at the expense of deviations from the GNP target. The target is never reached but only approached, since policy is continually offsetting the accumulating effects of previous monetary changes.[31] Deviations from the target are shown in table 7.6 for the St. Louis *A* and FRB-MIT-Penn models. The deviations are expressed as percentages of the target increase and in this form are invariant to the size of the desired target increase. For St. Louis, deviations from the target level of GNP of nearly 20 percent continue until the fifth quarter, after which the discrepancy remains between 5 and 11 percent. For FRB-MIT-Penn, the deviations continue to range up to 16 percent.

At first sight a discrepancy which after a few quarters remains below 11 or even 16 percent seems attractive. But we need only glance back at table 7.5 to realize how unattainable even this weak policy rule is. It entails extremely complicated and continuing variations in monetary growth. A realistic policy must be based on fairly modest and simple variations in monetary growth. However, as we weaken the stabili-

Table 7.5 **Monetary Growth Policy Which Aims for Target Level of GNP 2 Percent above Trend in Two Quarters: Deviations from Long-run Growth (Percentage per Year)**

	St. Louis			FRB-MIT-Penn	
Quarter	*A*	*B*	Silber	A	B
0	7.0	8.3	7.5	27.8	45.7
1	0.0	0.0	0.0	−11.1	−12.5
2	−2.9	−5.4	−4.8	−19.7	−38.1
3	−1.4	−2.2	−2.2	8.2	13.5
4	1.4	4.1	3.9	−2.9	8.4
5	2.4	5.1	6.1	8.8	−0.8
6	1.2	0.3	1.1	−0.3	−1.7
7	−0.4	−4.1	−7.2	−10.0	−12.6
8	−1.2	−3.7	−5.2	10.2	5.0
9	−0.6	2.0	5.5	−3.0	−11.6
10	0.8	5.7	10.0	−0.2	−16.2
11	1.4	2.1	0.5	3.6	20.1
12	0.5	−4.3	−11.1	−6.3	2.5
13	−0.6	−5.0	−8.2	5.8	11.8
14	−0.8	1.0	7.9	0.2	11.3

Note: Method of computation—Same as table 7.4, except that monetary growth in each quarter is determined by dividing the deviation from the target level of GNP by the fraction of monetary effects which occurs in two quarters according to the lag distribution. Thus the entry for St. Louis *A* in quarter 0 is 2 × 4/1.14 (sum of first two weights in table 7.2), or 7 percent per year. This yields an increase in GNP above trend in that quarter of .91 (7 × .52/4). The deviation from the target level of a 2 percent increase above trend is 1.09. This is reduced to zero in the next quarter, because the 7 percent monetary growth of the initial quarter then increases GNP by 1.09 (7 × .62/4). Hence a zero monetary growth rate in period 1 achieves the target level of an increase in GNP of 2 percent above trend. No further change would be required in period 2, but past monetary growth will generate an increase in GNP above trend of .82 (7 × .47/4), producing a deviation from the target level. A negative monetary growth rate in period 2 is therefore required: −2.9 (−.82 × 4/1.14). And so on. Monetary growth rates would be double for 4 percent increase in target, and so on.

zation target further in order to reduce the fluctuations in monetary growth, say by achieving the target in three quarters instead of two, the deviations from the target will increase. There is no smooth pattern of monetary growth which will closely approximate desired changes in GNP within a few quarters. As policy tries to reduce deviations from the target, the more complex becomes the monetary growth path.

The two-quarter rule depicted by tables 7.5 and 7.6 seems to us a reasonable way to extend the perfect but unattainable one-quarter policy depicted by table 7.4. There is a trade-off here between the size of required variations in monetary growth and that of deviations from the target level of GNP. Different rules produce different combinations of fluctuation in the two variables, and there is no clear optimum. Continuing fluctuations in monetary growth can be avoided, of course, by

Table 7.6 **Deviations of GNP from Given Target Level under a Two-quarter Policy Horizon (Percentage of Target Increase)**

	St. Louis	FRB-MIT-Penn	
Quarter	*A*	*A*	*B*
0	−55	−40	−27
1	0	−24	−20
2	+22	+4	+3
3	+12	−8	−5
4	−11	−3	−10
5	−19	−16	−10
6	−9	−15	−9
7	+3	−1	−1
8	+9	−16	−4
9	+5	−11	+3
10	−7	−4	+13
11	−11	−6	+0
12	−4	+9	−1
13	+5	+4	−8
14	+6	+8	−15

Note: The data shown are cumulated changes in GNP in each quarter, based on current quarter and past monetary growth rates, expressed as a percentage of target increase in table 7.5. Results are the same for any target level which is a constant percentage of the trend level.

simply making a change in one quarter and then maintaining a stable rate. Such a policy, however, does not solve the problem of lags. It merely shifts the consequences of the lag from money to GNP. We may illustrate with the lag pattern of the regular St. Louis equation (*A*). An initial growth rate of 7 percent achieves a 2 percent increase in GNP in the second quarter (table 7.5). No change in monetary growth from trend is required in the second quarter, but changes are required in subsequent quarters to offset the initial increase. If these subsequent changes were not made, it would greatly lessen the complexity of the policy. But the result would be to increase the subsequent fluctuations in GNP, as the initial increase in money worked through the lag pattern and no offsets were provided. The deviations from the GNP target increase are given in table 7.7. They do not fall below 40 percent of the target increase until the sixth quarter. Since the lag is eight quarters in length, GNP does not fluctuate after that, though it only attains seven-eighths of the target increase. This is the most favorable case for a one-shot change in monetary growth among these lag patterns. The other patterns produce even more fluctuation in GNP, because they require larger offsets.

Perhaps someone can offer a more appealing strategy than simply extending the two-quarter rule illustrated here to three or more quarters. A rule which is sometimes suggested is based on rates of change

Table 7.7 **Deviations of GNP from Given Target Level for a One-quarter Increase in Monetary Growth (Percentage of Target Increase)**

Quarter	St. Louis *A*
0	−55
1	0
2	40
3	60
4	57
5	39
6	16
7	−3
8	−12

Note: The data shown are changes in GNP in each quarter, based on monetary growth rate in quarter 0 only, expressed as a percentage of target increase. Results are the same for any target level which is a constant percentage of the trend level.

in GNP rather than levels.[32] While such a rule appears to require less volatility in monetary growth,[33] it does so only at the cost of larger discrepancies from the target level. Unless shown otherwise, we conclude that any other rules which may be suggested for these lag patterns will be equally unsatisfactory.

These results do not prove that policy cannot contribute at all to short-run stability. Given reliable forecasts of GNP, small uncomplicated changes in monetary growth can be made to bring the economy closer to the target. Because of uncertainty, however, the changes will have to be modest if they are not frequently to be a source of instability. But, if they are modest, the achievements will likewise be modest, so that the risks of error do not obviously outweigh the possible gains.

7.6 Seasonal or Other Periodic Movements in Monetary Growth

If policy objectives with a short-run horizon are not feasible because of lags, day-to-day objectives for financial markets might for that reason seem feasible, on the grounds that the lag smooths over transient variations in monetary growth. For long, flat lag distributions, that is true. But for lag distributions with overshooting, it is generally not true. The consequences of periodic variations in monetary growth are shown in table 7.8 for the two sample patterns used previously. It is assumed that an average 4 percent per year rate of monetary growth is concentrated all in the first one, two, or three quarters of a symmetrical cycle. The table shows the effect on GNP. As calculated, the level of GNP starts below or even with the old trend, goes above, and then returns to it, because monetary growth first speeds up and then is reversed.

Table 7.8 **Deviations of GNP from Trend Level Produced By 100 Percent Variations Around a Monetary Growth of 4 Percent per Year (Percentage of Trend Level)**

	Pattern of Monetary Growth and Lag Pattern					
	1Q Variation (8, 0, 8, 0, etc.)		2Q Variation (8, 8, 0, 0, etc.)		3Q Variation (8, 8, 8, 0, 0, 0, etc.)	
Quarter	St. Louis *A*	FRB-MIT-Penn *A*	St. Louis *A*	FRB-MIT-Penn *A*	St. Louis *A*	FRB-MIT-Penn *A*
1	+.17	+.54	−.24	+.04	−.97	0
2	0	0	+.35	+.08	−1.07	−.16
3	Repeats		+.59	+.04	−.03	+.23
4			0	0	+.93	+.22
5			Repeats		+1.04	+.38
6					0	0
					Repeats	

Note: It is assumed that the pattern of monetary growth has been in effect at least for the length of the lag patterns. Cumulated change in GNP in each quarter, based on alternative monetary growth patterns, is converted to a deviation from a 4 percent trend in GNP.

The lag patterns smooth the effect but not completely, and GNP fluctuates cyclically around the new growth path. Some of the fluctuations are not minor. The fluctuation for St. Louis with the two-quarter pattern is from −.24 to +.59, or an amplitude of .83 percent. In a trillion dollar economy, that is a fluctuation of $8.3 billion. For the three-quarter pattern, the fluctuation is $20 billion. For FRB-MIT-Penn, the fluctuations are narrower as a consequence of its long, flat lag pattern. Such fluctuations could well be eradicated in the data by an overly absorbent seasonal adjustment, but they remain real contributions to instability nonetheless.

7.7 Summary and Conclusions

For monetary policy to be stabilizing on net, either it must operate with a short lag in its effects, or if the lag is long, economic forecasting must be accurate far ahead so that monetary policy can take the lag in effect into account and be guided appropriately. These prerequisites are not an important obstacle to either transient or long-run objectives. Transient effects on financial markets can be produced with little carryover to economic activity if the lag in effect on activity is long. And monetary policies designed for the long run have a long-run effect which is independent of lags. But for short-run policies—those which range from a quarter to a year—the unreliability of economic forecasting and the lag in monetary effects become important. The continued use and defense of short-run flexibility in monetary policy have yet to be reconciled with the growing evidence on the lag in its effect.

The issue has remained unsettled in large part because the exact pattern of the monetary lag has not been determined. Numerous studies of the lag give somewhat different results. We examined four of the most sophisticated estimates of the lag pattern and found that their predictive power of turning points in economic activity was only slightly better than that of the simple step method. This suggests that the lag distribution varies over time and cannot be reliably estimated by a fixed pattern.

Despite these drawbacks, the estimates all agree on a distributed lag of monetary effects which spans two years or more, with the strong possibility that the initial effects overshoot the long-run effect. In the light of this evidence, it no longer seems possible to maintain that the lag is short and uncomplicated. We pointed out that the step lag appeared to be shorter since World War II than formerly (contrary to some theoretical implications of the growth of money substitutes), but the decline, if any, was too slight to lessen materially the difficulties of short-run monetary stabilization.

We explored these difficulties by calculating the path of monetary growth required to achieve target levels of GNP. In the first set of calculations the target was an increase in the level to be achieved in one quarter and maintained thereafter. Such policies are sharply circumscribed by a long lag pattern because of its tendency to be explosive. This causes the offsets to the future effects of policies to become unmanageably large. The version of the St. Louis equation used here is not explosive, though pursuit of a flexible policy under its lag structure is still severely constrained by the practical need to avoid complicated swings in monetary growth. All the other patterns examined are explosive or close to it, especially the pattern implied by the FRB-MIT-Penn model, which, despite its limitations, many consider to be the most sophisticated representation of the economy so far constructed. These other patterns circumscribe much more severely than does the St. Louis equation the degree to which stabilizing variations in monetary growth are feasible.

We presented a second set of calculations for a weaker policy rule which aimed to achieve the target level in two quarters. Even under the weaker rule, the required path of monetary growth entails swings up and down from quarter to quarter, much too complicated, we believe, even to be approximated by the present state of the policy art. Attempts to do so, in the light of uncertainties over the exact form of the lag pattern, are likely to increase instability rather than reduce it. Given in addition the usual uncertainties over the course of economic activity, limited policies which push the economy mildly in the desired direction are the most that appear feasible.

Very short-run variations in monetary growth will not have large disruptive effects, because a long lag pattern tends to smooth out the effects of such variations in monetary growth. But we showed that periodic variations which are offset within one to three quarters do not necessarily have insignificant effects on economic activity. If such variations are intentionally introduced to offset undesired changes in economic activity, they must be timed and executed with considerable precision, else they will miss the mark and add to instability. Unless precisely executed, they are still a net detriment to economic stability. It is the basic difficulty of monetary sharpshooting, given the available evidence on the lag distribution and our meager knowledge of it, that stacks the case against the success of a flexible short-run monetary policy.

The evidence which has accumulated on monetary lags since Milton Friedman first proposed a constant rate of monetary growth as the wisest policy has by and large supported his case. The estimates of the lag reviewed here all indicate similar difficulties for policy. At the same time, estimates of the lag distribution differ sufficiently to indicate that we still lack the precise knowledge which, if it were available, might partially overcome these difficulties.

Notes

1. Friedman, "The Effects of a Full-Employment Policy on Economic Stability: A Formal Analysis," in *Essays in Positive Economics* (Chicago: University of Chicago, 1953), pp. 117–32.

2. Friedman, *A Program for Monetary Stability* (New York: Fordham University, 1960), p. 93.

3. Stanley Fischer and J. Phillip Cooper, "Stabilization Policy and Lags," *Journal of Political Economy* 81 (1973): 847–77; Edward Gramlich, "The Usefulness of Monetary and Fiscal Policy as Discretionary Stabilization Tools," *Journal of Money, Credit, and Banking* 3 (May 1971): 506–32; Michael J. Hamburger, "The Impact of Monetary Variables: A Survey of Recent Econometric Literature," in Federal Reserve Bank of New York, *Essays in Domestic and International Finance* (New York, 1969), pp. 37–49; James L. Pierce, "The Trade-Off between Short- and Long-Term Policy Goals," in Board of Governors of the Federal Reserve System, *Open Market Policies and Operating Procedures—Staff Studies* (Washington, D.C., 1971), pp. 99–105; James L. Pierce and Thomas D. Thomson, "Controlling the Money Stock" (manuscript, April 3, 1972).

4. In terms of the usual textbook analysis, changes in interest rates due to shifts in the *LM* schedule affect aggregate demand. Such shifts would be offset by stabilizing the general level of interest rates, so that the intersection point

of the *LM* and *IS* schedules would remain the same. When changes in interest rates reflect shifts in the *IS* schedule, however, a policy of keeping interest rates unchanged would amplify the change in aggregate demand. Numerous articles have made this point. See, for example, Jerome L. Stein, "A Method of Identifying Disturbances Which Produce Changes in Money National Income," *Journal of Political Economy* 68 (Feb. 1960): 1–16, and William Poole, "Rules-of-Thumb for Guiding Monetary Policy," in Board of Governors of the Federal Reserve System, *Open Market Policies*, pp. 135–89.

5. Clark Warburton, "The Theory of Turning Points in Business Fluctuations," *Quarterly Journal of Economics* 64 (Nov. 1950): 525–49; Friedman and Schwartz, "Money and Business Cycles," *Review of Economics and Statistics* 45 (Feb. 1963): 32–64.

6. The steps are successive high and low levels of the month-to-month percentage rate of change in money—a step peak corresponding to the last month of a high level of monetary change, a step trough to the last month of a low level of monetary change.

7. For the turns in the second half of the 1960s, GNP deflated for price changes is used, because the turns are difficult to identify in nominal GNP. The deflation, may, however, tend to shorten the lag.

8. Gurley and Shaw, *Money in a Theory of Finance* (Washington, D.C.: Brookings, 1960).

9. The possibility that such a leftward shift in the demand schedule for money balances need not increase the elasticity of the schedule was pointed out by Alvin L. Marty, "Gurley and Shaw on Money in a Theory of Finance," *Journal of Political Economy* 69 (Feb. 1961): 56–69.

10. However, dummy variables are sometimes used to hold constant the quarters in which strikes occurred. We may also note that spectral analysis can be used to segregate various frequency bands of movement in the variables. See Christopher A. Sims, "Money, Income, and Causality," *American Economic Review* 62 (Sept. 1972): 540–52.

11. Friedman and Meiselman, "The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States, 1897–1958," in *Stabilization Policies* (Englewood Cliffs, N.J.: Prentice-Hall, for the Commission on Money and Credit, 1964), pp. 165–268.

12. Leonall C. Andersen and Keith M. Carlson, "A Monetarist Model for Economic Stabilization," Federal Reserve Bank of St. Louis, *Review* 52 (April 1970): 7–21; Leonall C. Andersen and Jerry Jordan, "Monetary and Fiscal Actions: A Test of Their Relative Importance and Economic Stabilization," ibid., 50 (Nov. 1968): 11–23; Michael W. Ketan, "Monetary and Fiscal Influences on Economic Activity—The Historical Evidence," ibid., 51 (Nov. 1969): 5–23.

13. One exception is the Laffer-Ranson model which involves no lag; see Arthur B. Laffer and R. David Ranson, "A Formal Model of the Economy," *Journal of Business* 44 (July 1971): 247–70. However, Michael J. Hamburger, "The Lag in the Effect of Monetary Policy: A Survey of Recent Literature," Federal Reserve Bank of New York, *Monthly Review* 53 (Dec. 1971): 289–98, has shown that their results depend critically on the inclusion of the years 1948–53, which other studies exclude as atypical due to the Federal Reserve's bond support program.

14. Although negative values in the lag distribution imply that the ratio of money to GNP begins to move back toward its original position after having first moved away from it, the return movement does not take the ratio all the way back unless the sum of the positive terms equals the sum of the negative terms (signs reversed). This condition is not imposed on the estimates and is

not satisfied in those reported here, presumably because long-run changes in the money-GNP ratio during a particular period are not captured by the constant term of the regression but instead affect the lag pattern. Ideally, movements which are not produced by variations in monetary growth should be absorbed by other variables and not be allowed to bias the estimates of the lag pattern. But such bias is difficult to prevent. The estimates of the lag pattern, therefore, will depend to some extent upon the particular period covered.

15. Our selected equation omits the fiscal variable. The omission makes little difference to the shape of the lag pattern. With the fiscal variable included in percentage terms, the lag coefficients are: .22, .37, .31, .16, .00, −.11, −.16, −13, −06.

16. Such feedback is possible even though GNP can only affect concurrent and later changes in the money stock. While there is no direct feedback on past changes in money, GNP can correlate with lagged money terms statistically because of autocorrelation in the variables.

17. Andersen and Carlson.

18. E. Gerald Corrigan, "The Measurement and Importance of Fiscal Policy Changes," Federal Reserve Bank of New York, *Monthly Review* 52 (June 1970): 133–43; Frank de Leeuw and John Kalchbrenner, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization—Comment," Federal Reserve Bank of St. Louis, *Review* 51 (April 1969): 6–11.

19. Silber, "The St. Louis Equation: 'Democratic' and 'Republican' Versions and Other Experiments," *Review of Economics and Statistics* 53 (Nov. 1971): 372–75. This particular version excludes the fiscal variable. With that variable included, the pattern is still about the same: .43, .97, .86, .36, −24, −.69, −70, .01.

20. Davis, "Estimating Monthly Changes in Deposits with Reduced-Form Equations" (manuscript, 1972); Hamburger, "Lag in the Effect of Monetary Policy."

21. See n. 10 above.

22. Kochin, "Judging Stabilization Policies" (Ph.D. dissertation, University of Chicago, 1972).

23. Franco Modigliani, "Monetary Policy and Consumption: Linkages via Interest Rate and Wealth Effects in the FMP Model," in Federal Reserve Bank of Boston, *Consumer Spending and Monetary Policy: The Linkages* (Boston, 1971), pp. 9–84.

24. In the simulation, demand deposits in one run were decreased and in another run increased from their actual level by $1 billion in each of the two successive quarters 1967 I and II. For each run the model then generated values of the level of GNP, given the actual values of all other exogenous variables (though it was not said what was done about nonborrowed reserves). The source (Modigliani) gives the resulting dollar decreases or increases in GNP in subsequent quarters. We have adjusted these figures to reflect a $1 billion change in the initial quarter only and then, as noted below, expressed each weight as its proportional part of the total effect. Some missing values of the lag pattern were interpolated.

25. This was done by dividing each term by the cumulative sum of the terms before adjustment.

26. For rates of change of the variables, a condition that the ratio of money to GNP return all the way to its starting level requires that the areas of the cumulative lag pattern above and below unity be equal.

The lag patterns as estimated did not satisfy these conditions of long-run equilibrium, because such conditions are difficult to meet by unconstrained equations fit to particular periods. However, if constrained estimates had been derived, they would no doubt differ somewhat from the adjusted lag patterns of table 7.2.

27. We have disregarded two estimates due to J. Ernest Tanner, "Lags in the Effects of Monetary Policy: A Statistical Investigation," *American Economic Review* 59 (Dec. 1969): 794–805, and "Lags in the Effects of Monetary Policy: Reply and Some Further Thoughts," ibid., 62 (March, 1972): 234–37, and Paul E. Smith, "Lags in the Effects of Monetary Policy: Comment," ibid., pp. 230–33, which give very short lag patterns, because they are so far at odds with other research and because their method of estimation is likely to bias the lag pattern toward the short side. In each case, the underlying model used Koyck lags to estimate the effect of interest rates on aggregate expenditures and the demand for money balances. Because of autocorrelation in the variables, the implied lag in the monetary effect on expenditures can be biased toward the short side. If the very short lags derived from these estimates were correct, full monetary effects would occur in one quarter, and a trial-and-error monetary policy to stabilize the economy would be feasible.

28. The NBER chooses reference turns after examining a variety of economic measures, including GNP in current and constant dollars, industrial production, employment, personal income, and business sales. It is the consensus of the turns in these measures, rather than the turn in GNP alone, that is the basis for the NBER decision on reference dates.

We prefer the reference dates to turns in GNP for present purposes because variations in monetary growth have effects on general business activity and not only on GNP, even though the lag distributions are estimated from regressions which use GNP as the dependent variable.

29. The FRB-MIT-Penn pattern pertains to levels of the money stock and GNP. The calculations were therefore applied to levels. The required levels of the money stock to achieve the target were then converted to rates of change for presentation in table 7.4.

30. This has a mathematical interpretation. For equations using rates of change of the money stock, the difference equation of the lag coefficients has an explosive solution if the largest root of the characteristic equation is greater than unity. It is not possible, however, to make revealing inferences about the stability of the difference equation from casual observation of the general shape of the lag pattern. See Robert S. Holbrook, "Optimal Economic Policy and the Problem of Instrument Instability," *American Economic Review* 62 (March 1972): 57–65.

31. The target could be achieved every second quarter if policy in the intervening quarters abstained from any correction, set monetary growth to the trend rate, and awaited the results of the previous quarter's correlation. But this would simply produce large deviations from the target in the intervening quarters, whereas the policy described in the text produces a deviation in every quarter which on the average is smaller.

32. Another possibility is a policy which diminishes in intensity as the goal is approached, with constraints on very large or very low rates of monetary growth. Such a policy strategy was investigated by William Poole, "Alternative Paths to a Stable Full Employment Economy," in *Brookings Papers on Economic Activity*, no. 3 (1971): 579–614, in simulations with the FRB-MIT-Penn model. His results are similar to ours, in that his rapid recovery option (see his fig. 4) takes three quarters to achieve most of the target and entails large swings in monetary growth.

33. J. Phillip Cooper and Stanley Fischer, "Simulations of Monetary Rules in the FRB-MIT-Penn Model," *Journal of Money, Credit, and Banking* 4 (May 1972): 384–96.