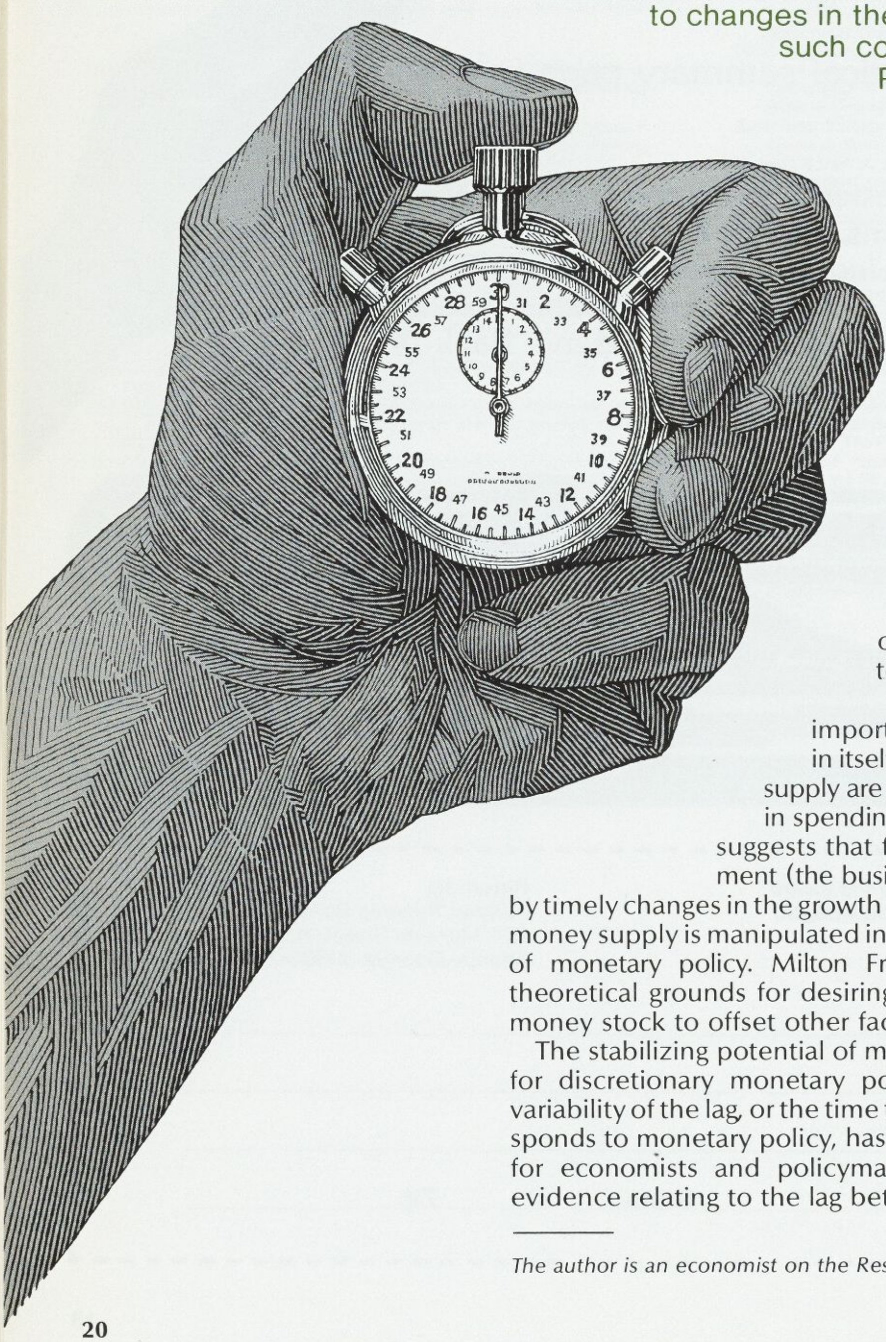
Lags in the Effect of Monetary Policy

Mary Susan Rosenbaum

Despite intensive study of how the economy responds to changes in the money supply, the timing of such consequences remains elusive. Policymakers must be alert to this uncertainty when considering prospects for stabilizing the economy.



Most observers agree that changes in the rate of monetary growth can have potent short-term effects on real economic activity.[1] This impact is felt even though money is neutral with respect to real activity in the long run. That is, over a prolonged period monetary actions affect the price level and not real economic activity in an economy expanding at its long-term potential.

Control of the money supply is important to policymakers, not as an end in itself, but because changes in the money supply are associated with subsequent changes in spending and real economic activity. Theory suggests that fluctuations in output and employment (the business cycle) can be counterbalanced by timely changes in the growth rate of the money supply. When the money supply is manipulated in this way, it is an intermediate target of monetary policy. Milton Friedman acknowledges "persuasive theoretical grounds for desiring to vary the rate of growth of the money stock to offset other factors."[2]

The stabilizing potential of money supply changes makes a case for discretionary monetary policy. As a result, the length and variability of the lag, or the time that elapses before the economy responds to monetary policy, has emerged as an important question for economists and policymakers alike. We will examine the evidence relating to the lag between one intermediate target, M1

The author is an economist on the Research Department's macropolicy team.

(coin, currency, and checkable deposits), and economic activity.

The lag before an economic stabilization policy takes effect has been debated intensely for the last 30 years. Although the issue pertains both to monetary and fiscal policy, monetary policy's lagged effect has received most of the attention since Milton Friedman addressed the problem (1953, 1960, 1961 and Friedman and Schwartz, 1963, a,b). Research and debate focus not only on the exact length of the delay between introduction of a change in the rate of monetary growth and its initial impact on nominal gross national product (GNP), but also on the time required for a monetary impulse to attain its maximum effect and eventually, to be dissipated completely. Extensive research over the last three decades offers various, and often conflicting, estimates of this lag's duration, ranging from one quarter to several years. The variability of the lag is an object of study, as well. This entire body of research has failed to produce unambiguous conclusions regarding the length of these lags and their stability over time. The lack of consensus is important because it is associated with related disagreements over the proper scope of monetary policy.

Variability and excessive length of lags complicate policymaking in different ways. If the goal is to achieve a given level of GNP growth, then lag variability could complicate the proper timing of monetary actions, even if the policy response is appropriate in every other way. A desirable action may be "wrong" if it affects the economy at a different time than anticipated. Thus, an accurate forecast of the economy's condition at the time the policy effects will occur is crucial for gauging the proper policy action, particularly when long lags are involved. The further into the future a forecast is made, the greater its uncertainty; consequently, errors are more likely.

Assumptions and Lag Classifications

For this discussion, we will assume that the Federal Reserve as monetary authority, has effective control of the money supply, which we use to represent monetary policy. Where possible, we will employ the narrowly defined monetary aggregate, M1; when the evidence uses M2 (M1 plus time deposits, MMDAs, MMMFs, and overnight Eurodollar balances) or reserves, this is noted.[3]

A lag may occur between the time a policy action is taken and the money supply responds. This is part of the "inside" lag, typically defined as the time required to recognize and respond to economic conditions requiring policy action, plus the time required to affect the chosen growth rate of the intermediate target. The "outside" lag measures the time between the change in that target and the response of the ultimate objectives: output, employment, and prices.[4] The outside lag concerns us here.[5]

Also important in the study of policy lags is the distinction between initial and cumulative lags. The initial, (or impact) lag is the time between the policy change and its first measurable impact on nominal GNP. The cumulative lag is the time between a policy change and the final measurable response in GNP.

The Timing of Monetary Influence: Reviewing the Evidence

A huge body of research addresses the channels of monetary influence and may provide some insight into the timing of lagged policy impacts. The research we surveyed attempts to answer such questions as the following: How many months or quarters after the initial change in monetary growth will we first observe a response in GNP? How long before we observe the maximum effect? What is the time pattern?

Before Friedman's work focused attention on lag length and variability, few formal empirical studies had analyzed this question. The many estimates made since then fall into several groups. First is work based on the reference cycle method that Friedman used. Second is reduced-form (often single equation), econometric models that concentrate on the relationship between overall economic activity (GNP) and policy variables. The third group is based on structural models. These are large econometric models, composed of many equations, sometimes hundreds, specifying the relationship among GNP, financial market variables (primarily interest rates, but also monetary aggregates), nonfinancial markets, and international trade.

Reference-Cycle Turning Point Analysis. Employing reference-cycle analysis, Milton Friedman's work revived interest in the potency of monetary policy and stimulated much subsequent research into policy lags.

Hypothetical Lag Pattern and Policy Implications

The economy's adjustment to changes in monetary growth is not a discrete, all-at-once event, but takes place as a distributed lag. The effects of a monetary policy action tend to begin gradually, build to a peak, and then subside. Thus, past monetary growth continues to influence GNP long after the monetary growth actually occurs. An increase in the rate of monetary growth temporarily stimulates real economic activity. Once such resources as labor and capital are fully employed, or once inflation becomes generally anticipated, monetary growth produces a permanent increase in the price level. While this description of the transmission mechanism is extremely simplified, it suffices for an examination of timing issues.

To understand what lags in the effect of monetary policy imply, let us look at a hypothetical lag structure. To simplify the example, we will assume that the pattern of monetary influence can be represented by a single, nonstochastic equation.[6] Let us also assume that GNP is growing along a trend path, and that the only dislocations from the path are caused by monetary policy.

Consider an expression for percentage changes in GNP away from trend as a function of past growth in the money supply.[7] This does not represent any of the specific lag structures we will survey later, although its shape conforms to the classic response profile found in many studies of monetary policy lags.[8]

$$\%\Delta GNP_t = 0.3\%\Delta M_{t-1} + 0.5\%\Delta M_{t-2} + 0.4\%\Delta M_{t-3} + 0.2\%\Delta M_{t-4}$$

This equation reads that the percentage change ($\%\Delta$) in real GNP in the current period, (t) is determined by the percentage change in monetary growth in the previous four periods (t-1, t-2, t-3, t-4). The contribution of each period's monetary growth to current GNP growth is determined by the lag weights (0.3, 0.5, 0.4, 0.2), which are the coefficients of the $\%\Delta M_t$ variables. According to our model, a one period increase in monetary growth of, say, 1 percent, will produce an increase in GNP growth of .3 percent the following period, .5 percent two periods later, .4 percent three periods later, and .2 percent four periods later.

This example, an extreme simplification of even the most basic lag structures shows that monetary policy's influence on real GNP exhausts itself after four periods. Many studies point to much longer lags, a different pattern of lags (lag weights that decline monotonically, for instance), or lag weights that turn negative. (In the long run the lag weights must turn negative and sum to zero if money is neutral.) Also, our example does not specify the length of a "period;" the t's could represent quarters or years.

To set the stage for studying the impact of a change in monetary growth, assume that monetary growth ($\%\Delta M$) has held steady at 5 percent for a long time. This level of growth implies that nominal GNP has been growing at 7 percent. The economy, fully adjusted to the 5 percent monetary growth, is said to be in equilibrium. Assume now that monetary growth is raised to 10 percent ($\%\Delta M_t = 10$). Despite this doubling of monetary growth, GNP growth will remain at 7 percent during period t. That is, it will not appear to respond to the doubling of monetary growth. This follows from the fact that the impact on GNP is "in the pipeline" but not immediately evident. Not until the next period, when the quickened monetary growth "comes on line" does GNP growth begin to rise above 5 percent. If the 10 percent monetary growth is sustained, GNP growth will continue to increase until it stabilizes at 14 percent in the fourth period after the initial acceleration of monetary growth.

Now consider the consequences of a decrease in monetary growth to the original 5 percent level. How long will it take to bring GNP growth back to 7 percent? In the period when monetary growth is reduced, GNP does not reponsed visibly to the decline. In the next period, t+1, monetary growth decreases, and in the subsequent periods GNP growth approaches the original 7 percent level consistent with long-run monetary growth of 5 percent. Only after four full periods following the decrease in monetary growth does GNP growth return to its original pace.

The simplified example used here assumes away many of the problems that complicate real-life monetary policy decisions. First, the example treats only one influence on GNP, monetary growth, when in reality a multitude of influences—some predictable; others random—impinge upon it. Second, we assume the monetary authority can achieve the desired growth rate for money immediately, when we know that actual money growth also depends on consumers' and businesses' choices about currency holding and the banking system's choices about deposit expansion. Third, the lags are assumed to be known as well as stable. Together, these

Friedman (1953, 1960, and Friedman and Schwartz, 1963a,b) compared the time between business cycle turning points and the preceding turning point in monetary growth from 1867 through 1960. That span covered 18 complete business cycles. Omitting war years, he demonstrated that the peaks in money supply led (reference cycle) peaks in GNP by an average of 16 months. For troughs, the average lead time was 12 months. The peak-to-peak lag varied from six to 29 months. It was these findings that supported Friedman's widely publicized assertion that the lags are long and variable.

Friedman contended that the lag between a turning point in the rate of monetary growth and the economy's response was so long and variable that the intended countercyclical effects of discretionary monetary policy often occurred when they were neither intended nor appropriate. "In terms of past experience," Friedman wrote, "action

Table 1. Path of GNP Following Change in Monetary Growth (in percent)

	When ΔM_t Raised to 10 Percent from 5 Percent					When ΔM_t Lowered to 5 Percent from 10 Percent				
	t	t+1	t+2	t+3	t+4	t	t+1	t+2	t+3	t+4
M_t	10	10	10	10	10	5	5	5	5	5
M_{t-1}	5	10	10	10	10	10	5	5	5	5
M_{t-2}	5	5	10	10	10	10	10	5	5	5
M_{t-3}	5	5	5	10	10	10	10	10	5	5
M_{t-4}	5	5	5	5	10	10	10	10	10	5
ΔGNP	7.0	8.5	11.0	13.0	14.0	14.0	12.5	100	8.0	7.0

Source: Federal Reserve Bank of Atlanta.

assumptions create optimal conditions for carrying out monetary policy; yet even this best case implies severe constraints on achieving desired GNP growth quickly.

Consider another experiment. Suppose monetary growth were reduced to 1 percent long enough to trim GNP growth to 1.4 percent. Four full periods are required after monetary growth is increased to 5 percent to return to the original 7 percent path of GNP growth. This lengthy delay suggests another tactic.

The monetary authority could return GNP growth to the 7 percent path rapidly if it "played" the lags by initially increasing monetary growth above 5 percent. If the authorities raised monetary growth to 19.6 percent, GNP growth would return to 7 percent in one period. However, if the authorities wanted to maintain this 7 percent GNP growth they would need to offset the higher, 19.6 percent level of monetary growth by mandating decreases in the next period. In fact, keeping GNP on the 7 percent track would entail considerable oscillation in period-to-period monetary growth. The length and weight of the lag values determines the exact pattern of oscillation. This relationship helps illustrate another point: if the monetary authority cannot predict the variability in lag impacts, oscillation is almost a certainty.

The preceding example demonstrates that lags in the impact of monetary policy make it impossible to achieve GNP goals immediately without variability in monetary growth. At any given time, observed GNP growth exhibits evidence of earlier changes in money growth. Knowledge of the lag structure is necessary for judging the probable short-run reponse of GNP to current policy. When forecasting GNP, policymakers must consider the pattern of monetary growth over as many previous periods as it takes for monetary influence to be dissipated completely. For example, a four-period history must be considered in the instance above. Estimates of monetary lags suggest that actual lags may be quite a bit longer, and so a more protracted, more complicated history must always be kept in mind.

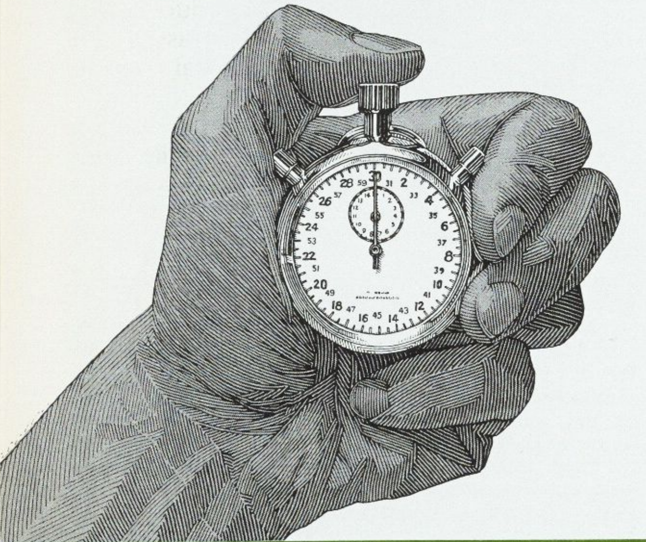
Our example illustrates some of the policy complications that attend even a very simple lag structure. The survey of the evidence makes it clear that even such considerations are minor in comparison to the complex patterns of policy effects.

taken now to offset the current recession may affect economic activity in six months or not for a year and six months."[9] Earlier he had concluded: "The difficulty is that, in practice, we do not know when to vary the growth rate of the money stock and by how much.... therefore, deviations from the simple money growth rule have been destabilizing rather than the reverse."[10]

Friedman's research was criticized on a number of points. For example, cycle turning point analysis does not distinguish among different rates of monetary expansion nor between short-lived and sustained changes in the rate of monetary growth.[11] Moreover, early criticisms emphasized that the level of economic activity (GNP) was inappropriately linked to the rate of change of the money supply.[12] The most frequent criticism was that the lag should not be measured by the time between the change in money growth and the cycle turning point, but between the change in money and the initial response of income—that is, when the monetary influence displaced income from what it would have been.

One of the first published responses to Friedman's findings came from J. M. Culbertson (1960, 1961), who not only took issue with the "long and variable" finding (he argued that "substantial effects" occur within six months or less) but disagreed with its policy implications as well.[13]

Even though Friedman's work was criticized widely, his finding that lags are long and variable and his conclusion that this implies limited scope for countercyclical monetary policy have shown considerable staying power for several reasons.



First, once researchers addressed the major criticisms of Friedman's work, some still found long and variable lags. More importantly, the lack of consensus on the length and variability of monetary policy lags as well as the lack of standardization hampering intermodel comparisons have lent passive support to Friedman's assertions.

Using a reference cycle methodology similar to Friedman's, Beryl Sprinkel (1959) compared changes in the growth rate of the money stock with business cycle peaks and troughs for 1909-1959. The money supply data were measured in a variety of ways, to yield statistical series that were both sensitive to recent changes in monetary growth and smooth enough to reflect turning points. Sprinkel's results resembled Friedman's, with the average lag for recoveries being 8.6 months and for recessions 19.9 months, with a variability of up to 29 months. The "long and variable" conclusion was reinforced.

Clark Warburton (1971), reporting results of a case-by-case cycle history over the period 1919-1965 found great variability in lag lengths. He attributed this to a steadily changing economy, to the different stages in the business cycle at which policy was applied, and especially to the economy's continual adjustment to past monetary disturbances. No statistical method of controlling for these influences was suggested. Warburton's analysis of cyclical history as a whole was not optimistic about the possibility of developing such methods. Thus, his findings suggest that variability is the norm and that any conclusions based on summaries and averaging offer scant meaning for the study of policy lags.

In a study of monetary growth around cyclical peaks, William Poole (1975) measured the magnitude of monetary decelerations by the growth of the money stock relative to an established trend. He was considering the necessary and sufficient conditions for a cyclical peak, using cyclical peaks from 1908 to 1972, and 24-month trend monetary growth. The results show that monetary growth decelerations typically lead cycle peaks by about six months.

Generally, the application of reference cycle methods to the study of monetary policy lags yields estimates that suggest the lags are indeed long and variable. Consequently, such analysis is understandably pessimistic about the probable success of countercyclical monetary policy.

Other (Non-Model) Based Methods. Using a nonparametric approach, Gene C. Uselton (1974) demonstrated that in the ten-year period from 1952 to 1961 the average lag in the effect of changes in monetary growth on changes in industrial production was seven months or less. The lag proved to be the same for contractionary and expansionary policies. The effect was shown to peak at seven months, after which the additional stimulus from policy declined rapidly. Uselton found the lag to be highly reliable but distributed over several periods of up to 10 months.[14]

M. Ray Perryman (1980) employed noncyclical monetary indicators, such as Federal Open Market Committee (FOMC) directives and discussions, to measure the lag in monetary policy's impact. His measures of the outside lag show an average slightly over three quarters for the period 1953-1975, with variability averaging a little over one quarter.

In a direct response to the reference cycle approach, specifically to Friedman (1953), John Kareken and Robert M. Solow (1963) analyzed the timing of the outside lags by economic sector, concentrating on investment. The authors provided no estimate of the total lag implied by the various sectoral lags. While Kareken and Solow asserted that considerable stabilizing power occurs after six months, their results also imply a substantially longer total lag.

Other researchers continued to use the sectoral approach to lag estimation. Thomas Mayer's (1966) attempt to correct and complete Kareken and Solow's estimates of component lags identified eight sectors of the economy which accounted for almost three-quarters of all domestic investment, plus consumer credit. Mayer then combined the eight sectors to yield a weighted lag he treated as an estimate of the complete lag between a change in credit availability and its effect on national income. His findings imply that the outside lag is quite long—on the order of 17 months—and critically dependent on the degree to which the economy had adjusted to previous monetary policy changes. After adjusting several of Mayer's response estimates, William H. White (1961) found that the policy lags were much shorter, approximately 12 months or less.

In contrast to the reference cycle research, the nonparametric approaches of Uselton and Perryman indicate shorter and more reliable lags. (Note that the sample periods they consider cover a much shorter history than does the reference cycle work. [15]) Although the sectoral approach initially claimed to disprove Friedman's "long and variable" finding, the lag suggested by these findings is in fact quite long.

Economic Models. Complete structural models of the economy can track the path by which changes in monetary policy influence the economy. Still, they are not designed specifically to examine the money-lag sequence.

In contrast to structural models "reduced-form" models express key economic variables, such as GNP or inflation, as direct functions of policy and other outside (exogenous) variables. Supporters of the reduced-form approach contend that, if users of statistical models are concerned principally with explaining and forecasting the behavior of only a few primary economic variables, it is unnecessary to derive estimates for all the variables of a structural model. Besides, they argue, our economy's complexity eludes even the most ambitious structural model.[16] Accordingly, they contend that it may be preferable to isolate and examine only the relationship between the "driving" variables, representing monetary and fiscal policy, and the policies and the variables ultimately affected by them, such as output or inflation. In general, reduced-form models look for a net effect rather than the process of economic adjustment.

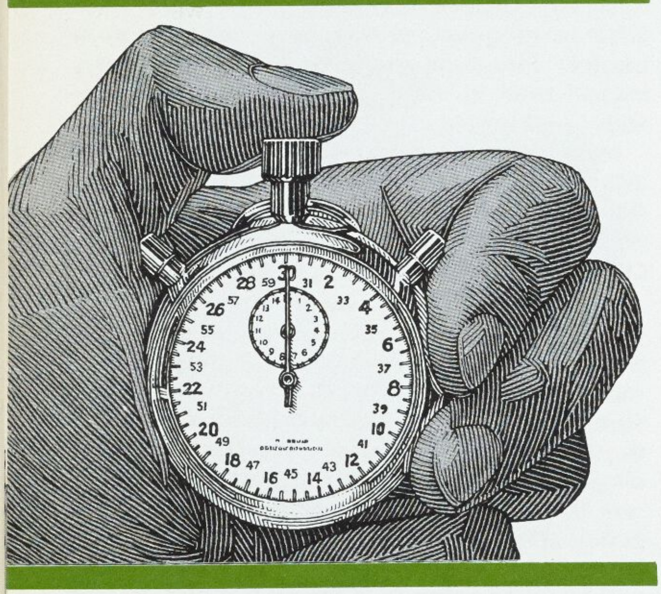
Reduced-form models, such as the St. Louis model, are more likely to show an immediate impact of money on output (and extensive lags in the cumulative effect). For this reason, economists who believe in a strong causal response of GNP to monetary growth favor reduced-form models. Structural models used to assess the impact tend to show a weaker causal relationship.

Most research conducted explicitly to examine lags in monetary policy's effect has involved designing and testing reduced-form models. Consequently, considerably more evidence can be culled from such models.

Reduced-Form Models. Leonall C. Anderson and Jerry L. Jordan (1968), in a seminal exposition of the St. Louis model, constructed a reduced form model to measure GNP's response to two measures of monetary policy (the money stock and the monetary base) and to several measures of fiscal policy between 1952 and 1968. One goal was to gauge the speed with which monetary policy affects GNP. They found relatively short lags and strong effects attributable to monetary actions.[17] Their work showed that the impact effect (the marginal contribution of money to nominal GNP in each period) reached its maximum in two quarters, and that the total effect (the cumulative impact of policy up to a given point) peaked within one year—evidence at odds with the "long and variable" finding.

Another response to Friedman's work showed that even if the economy's actual response to monetary policy was quick and highly predictable, the reference cycle turning point technique would yield estimated lags that were indeed long and variable. Donald P. Tucker (1966), J. Ernest Tanner (1969), and Paul E. Smith (1972) were less concerned with actually measuring the lags than with constructing plausible reduced-form models of the economy's response to monetary policy, models consistent with specific channels of monetary influence. They demonstrated that the timing of the response is extremely sensitive to the magnitude and duration of a monetary expansion or contraction. This research did not disprove that the lag was long and variable. It showed that reference cycle analysis could point to long and variable lags even if, in fact, the lags were neither.

A number of empirical studies have shown that aggregate investment responds only gradually, over a long period, to changes in interest rates.[18] Some have inferred that monetary policy may be constrained by these interest rate lags and thus may work too slowly to be useful for stabilization purposes. According to Tucker (1966), the investment responds to interest rate changes with a long distributed lag, but other components of aggregate demand (namely consumption) respond more quickly. The model Tucker developed is theoretical. However, simulations using some "reasonable" U.S. economic data yielded estimates of an extremely short initial lag: one quarter. While the cumulative lag is quite extended, the simulations suggested that income could adjust to within 10 percent of its equilibrium level within two quarters.



Tucker's work was extended by Tanner (1969) and Smith (1972) who considered the interest rate responses implied by Tucker's results to be unrealistically rapid but found other features of the model valuable. Tanner, using data from 1947 to 1967, estimated a two-sector model that explicitly accounted for the interrelation between goods markets and financial markets. The effect of monetary policy on GNP was estimated to peak in three to six months. Combined with the assumption that accurate economic forecasts can predict further than six months into the future, both Tanner's and Smith's work suggests that discretionary monetary policy can be used for economic stabilization.[19]

In a paper updating the original St. Louis model, Leonall C. Anderson and Denis Karnosky (1972) found "sharp and substantial positive response of real output growth for five quarters following a permanent change in the rate of increase of money" from 1955 to 1971.[20] "Growth of output then ceases to accelerate and falls rapidly while the rate of price increase rises moderately."[21] They also noted that "the adjustment of output, while zero in the long run, is extremely volatile compared to the adjustment pattern of prices.... The length of the adjustment period for both prices and output to a monetary shock was found to be almost 24 quarters."[22] These specific findings conflict with the long and variable results of some other researchers. Yet Anderson and Karnosky showed that in simulations using various types of money shocks and different stages of adjustment to prior shocks (using equations that indicate a consistent and precise response of output and prices), variable lags could result. Thus, they suggested that variability is to be expected.

Similar results reported by J. R. Moroney and J. M. Mason (1971) revealed consumption spending responding to policy adjustments long before investment. They showed that consumption is affected initially during the quarter when monetary policy (as proxied by the monetary base) is changed, while investment spending does not begin to respond until two quarters later. Overall, they concluded, the influence of a change in monetary growth peaks in roughly three quarters, and the total impact appears to last 15 quarters.

With a small model using unanticipated monetary growth as the policy variable, Rose McElhatton (1981) studied how output and inflation respond to monetary policy.[23] She concluded that output's initial response is small in the first quarter and rises steadily for seven quarters to a peak; the total effect is complete in about 10 years.

While these results are not unusual, the implications for countercyclical policy are discouraging because of the severe constraints associated with designing policy around unanticipated monetary growth.[24]

Clearly, some divergence exists in estimates of policy lags. None of the estimates is particularly robust with respect to different estimation periods and estimation techniques. However, only Tanner (1979) and Thomas F. Cargill and Robert A. Meyer (1978) have explicitly examined systematic variability of the lag. They questioned whether past estimates that implicitly or explicitly assumed that the lags did not change over time may have been biased. They also asked whether and why the lags might change systematically through the years.

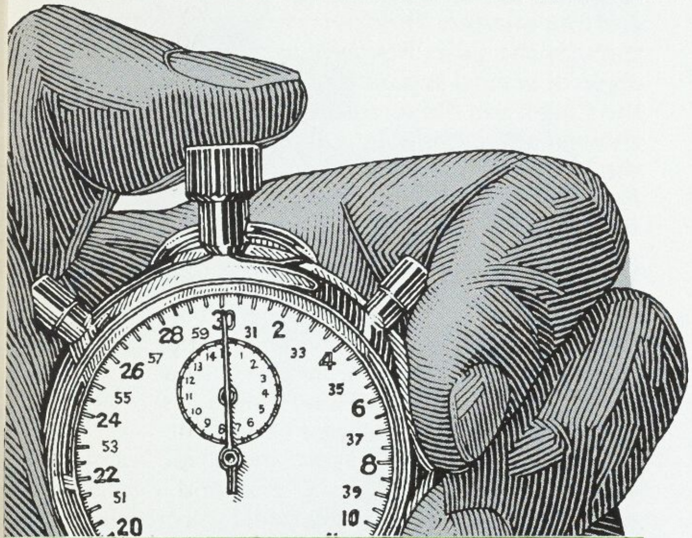
Cargill and Meyer examined the stability of income's response to changes in monetary policy by employing two small econometric models of the U.S. economy. Each of these models embodies fairly different ideas of policy effectiveness and channels of monetary influence. Using data from the period 1953-1973, the authors found that the economy's structure and hence the response time to policy changes is more appropriately modeled by using time varying techniques—that is, techniques that yield not one unchanging estimate representing response, but an estimate for each period. Both models were estimated using the constant coefficient as well as time varying coefficient techniques. The results indicate that while the classic response profile of a fairly short initial lag and long cumulative lag is typical for the constant coefficient estimations and the time varying estimations of both models, the response has varied considerably over the years. Additionally, the timing of income's response to changes in monetary growth (that is, lag pattern and lag length) is influenced profoundly by stage of the business cycle at which the policy change occurred.

Unfortunately, the results can not be generalized easily because Cargill and Meyer report estimates only for four selected time points—two each of tight and easy monetary policy. However, the results provide several insights and whet our appetite for a closer examination of the cyclical history of the selected time points. First, the empirical findings show that the cumulative response of income to a unit change in monetary growth declined unevenly between 1960 and 1972, but the impact lag was shorter and the initial response constituted a greater proportion of the total response in those later years.

About the same time Cargill and Meyer's research was published, Tanner (1979) examined the variability issue while also considering causes for possible systematic change in the lags from 1953 to 1974. This approach allowed for variation due to different stages of the business cycle, the posture of monetary policy (relative ease or restraint), and the trend in the dynamic relationship between policy changes and GNP. Initially, the estimates were made without separately specifying all three influences. These first results indicated that over the entire period the initial impact lag is about one quarter, while the time required for income to exhibit its maximum response to monetary change is between three and four quarters. There is considerable variation through the years however, as revealed by analysis of several separate periods. In contrast to the Cargill and Meyer results, Tanner's estimates showed a substantial lengthening of the lag from the 1950s to the 1960s. When Tanner accounted for the array of varying economic conditions, though, rather different results emerged. First, the cumulative lag appears to grow longer over time. Tanner explains that this result illustrates the dominance of the trend toward somewhat tighter monetary policy over the entire period. At the same time, however, this lengthening tends to obscure his finding that loose policy is associated with a shortening of the lag, a result interesting to those studying more recent monetary history. Tanner's overall findings are pessimistic for the scope of countercyclical monetary policy: the lag is found to vary in a systematic way depending on the stance of monetary policy over time, but does not appear to be predictable from episode to episode, over the business cycle.

The general profile of lags that emerges from reduced-form models is that of fairly short (two quarters or less) impact lags, and fairly long cumulative lags. Monetary policy appears to have its greatest total impact on nominal GNP within the first two years after implementation; its influence dissipates precipitously thereafter. While this generalization is quite broad, it is robust across a variety of models and time periods.

Structural Models. Even though most structural models have not been designed explicitly to examine the timing question, policy simulations on the models can extract some information about timing. Because structural models ordinarily use nonborrowed reserves as the exogenous monetary policy variable and reduced-form models use the money supply, comparability problems immediately emerge. Nonborrowed reserves often are considered "more" exogenous than money; that is, they are better controlled by the monetary authority. Thus, the problem of possible two-way causation between money and economic activity may be addressed more effectively in structural models using nonborrowed reserves. However, the difficulty in isolating an appropriately exogenous monetary variable to study lags is compounded by the fact that the



controversy is not over the reserves-money-income sequence but the money-income timing pattern. Any conclusions about the latter based on the former must assert a reliable timing relationship between money and reserves.

Early explorations of policy effects in structural models (for example, Ta-Chung Lui [1963]) were done by exogenizing interest rates, which made it impossible to examine the money-GNP timing issue. Later, however, results of experiments using reserves or money were published. Michael K. Evans (1966) described a quarterly model of the U. S. economy that pointed to an impact lag of about three quarters; policy evokes no income response for six months. The marginal impact peaks at the end of year one and virtually disappears by the end of the sixth year. Evans' work is notable for explaining how the uniqueness of multipliers, and thus lag patterns, varies inversely with the degree of nonlinearity in the models being compared. This characteristic should be remembered when comparing all model results.

In response to Anderson and Jordan, R. G. Davis (1969) examined the MPS model for sensitivity to monetary policy changes. This structural model was one of the first to specify a highly developed financial sector. Davis found that not only was there no impact on GNP in the quarter in which monetary policy (measured by changes in nonborrowed reserves) was changed, but that even after four quarters the effect was small.

About the same time, Frank de Leeuw and Edward M. Gramlich (1969) also reported on the MPS model simulations, concentrating on the channels by which monetary and financial forces affect nominal GNP. Their results indicate some influence in the first quarter after policy is changed. The effect increases to reach its maximum in about 2 1/2 years. They concluded that the largest single impact occurs in the third and fourth quarters, then falls off steeply so that, by the end of the fourth year, the policy change's effect is virtually limited to higher prices. That study also demonstrated that the economy's initial condition greatly influenced the timing of effects.

George G. Kaufman and Robert D. Laurent (1970) simulated monetary policy on a version of the same model. Like de Leeuw and Gramlich, they imposed an injection of $1 billion of nonborrowed reserves into the money supply. The response was slower than found by Anderson and Jordan, but not as slow as other structural model results. By the end of the first year, GNP had reached about one third of its total response; by the end of the second year, 72 percent of its total.

The maddening problems of comparing the various types of models was addressed by Gary Fromm and Lawrence R. Klein (1975). Although the quarterly response of income to the monetary policy variable is not available, a summary of results from the DRI (1974) version, St. Louis, MPS, and Wharton Mark III models was provided. Except for MPS, the large structural models typically showed the initial lags to be two to three quarters, with the impact cresting in about 2 1/2 years. The St. Louis model exhibited lags similar to previously reported experiments; however, those of the MPS model were shorter than lags reported by de Leeuw and Gramlich. Considering the timing of monetary policy effects, Laurence H. Meyer and Robert H. Rasche (1980) summarized the consensus across models rather pessimistically. They summarized policy simulations of five models, both reduced-form and structural, and used different estimations of several models. According to their results, the impact lag averages two to three quarters, while the maximum effect of policy occurs in about three years. Meyer and Rasche report a secular rise in monetary policy multipliers and an attendant shortening of the impact lag from the 1960s to the mid-1970s.

Experiments using structural models show a somewhat longer impact lag and more extensive cumulative lag in the effect of monetary policy than do reduced-form models. Interestingly, results for structural models suggest a trend toward shorter lags and greater monetary policy impacts from the early 1960s to the later 1970s. Whether this is attributable to the increased detail in specification of the models' financial sectors, which would imply that earlier lag estimates were biased, or to a secular shortening of the lag, is unclear. One result common to both types of model is the classic response profile: a reasonably short initial lag, a peaking of influence within two to five years, and a long tailing off over several more years.

Little consensus exists on the exact profile of money lags in structural models. Nonetheless, the extensive research results do not contradict an assertion made over 20 years ago: "the full results of monetary policy changes on the flow of expenditures may be a long time coming. . . but some (initial) effect comes reasonably quickly and builds up over time so that some substantial stabilizing power results and remains after a lapse of time. . .and then dissipates."[25]

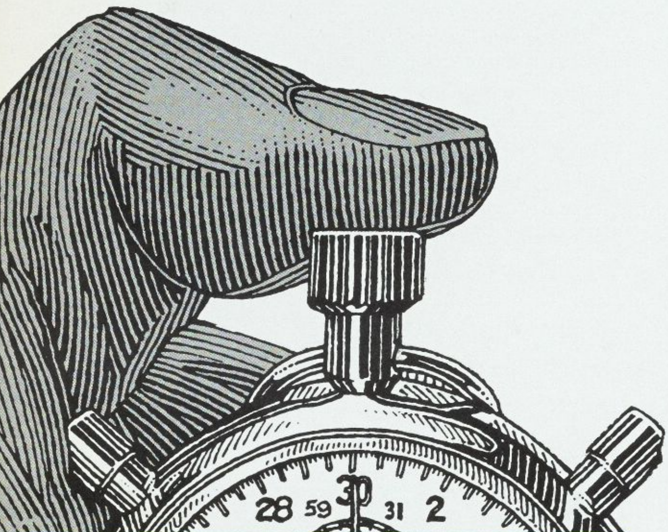
Rational Expectations. A new approach to business cycle analysis, emphasizing the importance of expectations, began to dominate the study of monetary policy effects in the mid-1970s. Since then few studies have directly addressed the issue of monetary policy lags. The controversy over policy effectiveness and its appropriate scope and timing took a new direction with the publication of a series of papers that established the rational expectations literature.[26] This research has profound implications for the study of lags in the effect of countercyclical policy.

Rational expectations applies the principle of rational, optimizing behavior—which economists have always assumed in the microeconomic setting—to the acquisition and use of information in the macroeconomic setting where stabilization policy analysis is conducted. Together with the assumption of efficient markets, rational expectations forms the core of the new classical macroeconomics. This approach asserts that any attempt to stabilize real activity in the short run is ineffective; that is, it claims for the short run a neutrality previously applied only to the long run. Minimally, the new classical macroeconomics implies that even if variations in monetary growth have some effect on real output, a systematic policy designed in such a setting would be untenable. Additionally, the lag coefficients would change, perhaps unpredictably, with every change in policy. Moreover, if policy is neutral in its effects then the study of lags is pointless, for rather than real consequences, only price effects would result from policy changes. This reasoning dominated the theoretical discussion of policy for several years and stimulated considerable research into its likely empirical implications.

In the last four or five years critics of the neutrality proposition have shown that, in the presence of "market imperfections," short-run non-neutrality of money is consistent with an economy characterized by rational expectations. These imperfections are formal and informal institutional structures including overlapping multi-year labor contracts, other arrangements that limit price flexibility, investment that requires time to build, and particular inventory strategies.[27] Certainly, these studies have dismissed the initial assertions of policy ineffectiveness. The institutional structures they associate with non-neutrality suggest that countercyclical policy may be feasible, even in a rational expectations setting. Consequently, lags continue to be an important concern for policymakers.

Recent Estimates. Recent estimates of lags are quite short. For example, Milton Friedman (1984) now maintains that money changes initially affect output after only six months. In other words, the highest correlation of monetary growth and nominal GNP growth occurs when the latter is lagged two quarters. Friedman also concludes that variability is considerably less than projected earlier, only about three to nine months.[28] He associates both the shortened length of the lag and the decrease in variability from late 1979 to late 1982 to the unusually large fluctuations in monetary growth over that period. "The effect," as he puts it, "was to enhance the importance of the monetary changes relative to the numerous other factors affecting nominal income and thereby speed up and render more consistent the reaction."[29]

Results reported by Robert J. Gordon (1981, 1983) tend to corrobate this view. Comparing of cyclical peaks in the real money stock with



subsequent peaks in coincident economic indicators, Gordon reports an average lag of only three quarters, with a range over five post-World War II cycles of six to 12 quarters.

Policy Implications

What stands out from these results is that while some consensus exists on the overall pattern of lags in the effect of monetary policy, estimates of the lags' exact length and variability from cycle to cycle differ considerably. The purpose of research on lags is to determine how they constrain the effectiveness of monetary policy. Can monetary policy stabilize GNP growth, or is it so hamstrung by long and variable lags that policy actions designed to stabilize the economy may actually exacerbate the business cycle? Any conclusions about the significance of lags for policy must confront both the differences in results across the literature and the implications of the classic response profile, which is generally common to nearly all the studies surveyed.

Lack of Consensus. The lack of consensus regarding details of the lag pattern can be attributed in part to problems of intermodel comparisons or to possible systematic changes in lags over the history surveyed.

Intermodel Comparisons. Clearly, the lack of standardization hampers intermodel comparisons.[30] Indeed, many "established" economic relationships do not stand up under varying specifications.[31]

The largely mathematical differences between structural and reduced-form models do not necessarily involve different assumptions about the way the world works. Nevertheless, a spirited debate has developed over the relative merits of each for policy evaluation. Because the model types have become associated with particular views of policy effectiveness, the debate remains vigorous. At the base of different assessments of monetary policy's role are disagreements about the channels through which monetary variables operate. Thus, models usually are specified by researchers with strong prior beliefs about the variety and importance of the channels of monetary influence.

Comparisons of the results of reduced-form and structural models are full of pitfalls. A further complication is that some models referred to as reduced-form are actually in the final form. The final form's estimated parameters are not solved from a structural model, as are those of the true reduced-form model. By definition the final form is not mathematically equivalent to the structural form, and so we should not expect their estimated multipliers and lags to be comparable.

Even among models of a given type, especially nonlinear models, estimates of lag structures vary with the initial conditions of the estimation period.[32] Such conditions include the stage of the business cycle over which the model is estimated or forecast. Additionally, the specification of the policy instrument affects lag estimates. In nonlinear models, the magnitude of the policy change influences measured lags as well. Finally, the study of lags frequently has been hostage to the monetary versus fiscal policy debate. That controversy has been waged, to a great extent, through discussion of cumulative policy multipliers which yields little information on timing.

Systematic Changes in Lags over Time. The lack of consensus on lags may, of course, reflect changes in the lags over time. Some theories suggest that the lags vary systematically with changes in money demand that are associated with the degree to which financial markets are deregulated, the interest sensitivity of the demand for money, the extent to which monetary policy actions are anticipated, and the amount of international currency substitution.[33] The 1970s and 1980s may provide empirical evidence to test these theories: these decades have witnessed accelerated innovation and deregulation of financial markets, historically high inflation, the development of cash management techniques that help businesses (and households) react to actual and expected policy changes, and an increase in international capital integration.

A stable relationship may underlie the timing of the response of economic activity to monetary impulses, yet the relationship's complexity renders it difficult or impossible to specify completely. None of the models reviewed has attempted to account entirely for different cycle phases, initial conditions, policy instruments, and previous monetary history, let alone deal with problems of intermodel comparisons. Also, while some theoretical models suggest a relationship between, for example, the interest elasticity of money demand and the timing effects of policy, no empirical studies have explored possible changes in the lags during or between periods of shifting money demand.[34] In the late 1970s and 1980s, economists paid considerable attention to respecifying formerly reliable money demand equations (which had begun to break down in the mid to late 1970s). Research suggested that when interest rates reached new highs, the interest elasticity of money demand increased.[35] Theoretical work has shown that heightened interest sensitivity is associated with a smaller initial impact of money stock disturbances and a lengthening of the economy's adjustment to money supply changes.[36] In light of interest rate history, this finding suggests that lags should have lengthened over that period; however, the latest evidence shows they did not (Friedman, [1984] and Gordon, [1981]). But without a model that specifies the other possible systematic influences on lags, it is impossible to sort out their relative contributions.

The timing debate is no closer to resolution than before researchers launched the many investigations surveyed here. Even so, we have learned several things. First, the "long" part of "long and variable" refers to the cumulative lag, not the impact lag. Because the impact lag is fairly short, some stabilizing countercyclical policy effect can occur relatively quickly. Second, the term "variable" does not necessarily imply the predominance of random influences on lags.

Now, let us consider the meaning of the one finding that is fairly consistent with different specifications and initial conditions.

Implications of the Classic Response Profile. The classic response profile of GNP to changes in monetary policy imposes some constraints on policymakers, and implies that policy actions always carry some risk. The presence of lags means that policy-makers must recognize the likely and continuing effects of past decisions on current and future economic conditions as well as the consequences of current initiatives on future economic developments. This is not easy, as it involves both a moving target (the ever-changing economy) and a tool with delayed effects.

At any point, the real output effects of past policy can be having an impact on employment, while the price-level effects of even earlier policy may be influencing prices. Unless policy has been relatively steady over several years, these effects may be "whipsawing" the economy. For instance, we could experience high inflation at the same time we see rising unemployment if a strong expansionary policy, allowed to become overly stimulative, were followed by a severe monetary contraction. At such a juncture, policymakers would face the unappealing choice of raising monetary growth to fight unemployment during a period of inflation or lowering it to counter inflationary pressures during a recession. While policy can be changed quickly, the chain of events consequent to policy actions cannot be reversed. Since past policies cannot be neutralized by subsequent countervailing strategies, policymakers cannot start with a clean slate every time a decision is necessary. Unfortunately, the policymaker does not have the luxury of declaring a new set of initial conditions each time policy is changed. In this setting, reacting to current economic conditions without reference to past policy can be disastrous.

The response of the economy to monetary expansion or contraction clearly is not random, but the timing of the consequences is indeed problematic. The research surveyed shows a disappointing lack of consistency in measuring the time lags from monetary impulses to changes in real GNP and inflation. These results indicate substantial differences of opinion on timing. The meaningful results are rather imprecise and the precise results are easily challenged. Therefore, monetary authorities need to conduct policy with an awareness of the lags and a skepticism regarding any specific claims about their duration. Policymaking always proceeds a risky environment.

NOTES

[1]The short run refers to a period over one or more complete business cycles, shorter than the period required for output and prices to adjust completely to changes in monetary growth. The term is analytic, not technical, and may refer to different lengths of times in different settings.

[2]Milton Friedman (1960), p.98.

[3]There is a separate controversy concerning the appropriate monetary aggregate for measuring policy actions. This controversy was not particularly intense before the accelerated financial innovation and deregulation that began in the late 1970s.

[4]In this paper, output, GNP, and income are used interchangeably, to refer to the level of overall economic activity on a national basis.

[5]For a taxonomy of the different lags, see Willes (1965) and Kareken and Solow (1963).

[6]Nonstochastic implies no uncertainty about the economic relationship involved. A stochastic equation includes a term representing influences that are unforeseen, although there may be some probability of their occurring.

[7]The following representation and interpretation follows from Mason (1976).

[8]See Leonall C. Anderson, Jerry Jordan, and Keith Carlson, "A Monetarist Model for Economic Stabilization," *Review*, Federal Reserve Bank of St. Louis, vol. 52 (April 1970), pp. 7-25; Frank de Leeuw and Edward M. Gramlich, "The Federal Reserve - MIT Econometric Model," *Federal Reserve Bulletin*, vol. 54, (January 1968), pp. 11-40; and Moroney and Mason (1971). More recently, there is Frederic S. Mishkin, "Does Anticipated Money Matter? An Econometric Investigation," *Journal of Political Economy*, vol. 90 (February 1982), pp. 22-51; and Robert J. Gordon, "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980," *Journal of Political Economy*, vol. 90 (December 1982), pp. 1087-1117.

[9]Milton Friedman, *The Optimum Quantity of Money and Other Essays* (Chicago: Aldine Publishing Co., 1969), p. 186.

[10]Friedman (1960), p. 95.

[11]See Culbertson (1960), Kareken and Solow (1963).

[12]See, for example, Warburton (1971), especially p. 121.

[13]Culbertson (1960), p. 621.

[14]Uselton (1974), p. 113.

[15]Uselton (1974) covers 1952-1961 and Perryman (1980) covers 1953-1975, while Sprinkel (1959) and Warburton (1971) each consider sample periods over 40 years long. The Friedman and Friedman and Schwartz works contain cycle history covering over 90 years.

[16]This is especially true if structural is defined as invariant with respect to policy changes.

[17]Anderson and Jordan (1968), p. 22.

[18]See, for example, Kareken and Solow (1963).

[19]The proposition that the shorter the lags from money to output are, the greater the scope for countercyclical monetary policy has been challenged by Howrey (1969). Later however, Fischer and Cooper (1978) confirmed part of Friedman's conclusions. In a theoretical work, they showed how variability in lags could well bring discretionary monetary policy to grief. On the other hand, long lags were shown to require more activist monetary policy. Alternatively, Higgins (1982) discusses conditions under which lags in the effect of policy are not an impediment to attaining policy objectives.

[20]Anderson and Karnosky (1972), p. 160.

[21]*Ibid.*, p. 164.

[22]*Ibid.*, p. 161.

[23]Unanticipated money is defined as that part of actual monetary growth that is generally anticipated, and, thus can be expected to be offset, or neutralized, before any real effects occur. For a fuller explanation of this concept, see Robert J. Barro "Unanticipated Money Growth and Unemployment in the United States," *American Economic Review*, vol. 67 (1977), pp. 101-15.

[24]For example, see Thomas J. Sargent and Neil Wallace, "'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," *Journal of Political Economy*, vol. 83 (1975), pp. 241-54.

[25]A. Ando and others (1963), p. 2.

[26]For a review of the literature and extensive discussions of policy implications see Steven M. Sheffrin, *Rational Expectation and Economic Policy* (Cambridge: Cambridge University Press, 1983); Stanley Fischer, ed. *Rational Expectations and Economic Policy* (Chicago: University of Chicago Press for the National Bureau of Economic Research, 1980); and Robert E. Lucas and Thomas J. Sargent, eds. *Rational Expectations and Econometric Practice* (Minneapolis: University of Minnesota Press, 1981).

[27]See, for example, Stanley Fischer, "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule," *Journal of Political Economy*, vol. 85 (1977), pp. 191-205; Edmund S. Phelps and John B. Taylor, "Stabilizing Powers of Monetary Policy Under Rational Expectations," *Journal of Political Economy*, vol. 85 (1977), pp. 163-90; and Alan S. Blinder and Stanley S. Fischer, "Inventories, Rational Expectations and the Business Cycle," M.I.T. Working Paper no. 220 (1978).

[28]Ironically, these are the same lags claimed by Culbertson in an early reply to Friedman's long and variable finding. Friedman criticized Culbertson's 'casual' empiricism. See Friedman (1961), and Culbertson (1960) and (1961).

[29]Friedman (May 1984), p. 399.

[30]Fromm and Klein (1975), p. 396.

[31]A number of "reliable" economic relationships are subject to the same problem. The case of money demand has been taken up by Thomas F. Cooley and Stephen F. LeRoy in "Identification and Estimation of Money Demand," *American Economic Review*, vol. 71 (December 1981), pp. 825-44.

[32]See, for example, Fromm and Klein (1975), Meyer and Rasche (1980), and Hanna (1975).

[33]See Jack Vernon, "Money Demand Interest Elasticity and Monetary Policy Effectiveness," *Journal of Monetary Economics*, vol. 3 (1977), pp. 179-90, as well as Tucker (1966), Smith (1972), Tanner (1979), Michael D. Bordo and Ehsan U. Choudhri, "Currency Substitution and the Demand for Money: Some Evidence for Canada," *Journal of Money, Credit, and Banking*, vol. 14 (1982), pp. 48-57, and Sophocles N. Brissimis and John A. Leventakis, "Specification Tests of the Money Demand Function in an Open Economy," *The Review of Economics and Statistics*, vol. 67 (1985), pp. 482-89.

[34]See Vernon, "Money Demand."

[35]See Flint Brayton, Terry Farr and Richard Porter, "Alternative Money Demand Specifications and Recent Growth in M1," Staff Memorandum, Board of Governors of the Federal Reserve System, May 23, 1983.

[36]See Vernon, "Money Demand."

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