The Policy Procedure of the FOMC: A Critique†

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It seems to us that the policy procedure of the FOMC is not entirely sensible. And we write in the hope of persuading others, Committee members included, of the rightness of that judgment.

We begin by briefly describing that procedure. Then we look at an alternative policy procedure and, we hope, explain its essential wisdom. We refer to the alternative procedure as the Theil procedure, since it was Professor Henri Theil [2]‡ who showed that in certain circumstances it is optimal, the best of procedures. And then, to make our point, we compare the Committee and the Theil procedures. As will be seen, the two policy procedures, although superficially the same, are nevertheless quite different.

Toward the end of the paper we indicate how the Committee would operate if it were being entirely faithful to Professor Theil's prescription. But though we do that, we should not be interpreted as advocating the Theil procedure. The sad truth is that we are not sure how the Committee ought to operate.

Committee members may find the Theil procedure an attractive alternative to that which of late they have been following. We suspect that some will. Most of us dislike radical changes; and to switch to the Theil procedure, the Committee would have to change its routine only slightly. Yet, for the Theil procedure to be optimal, it is necessary that policy makers be certain about the structure of the world. And as the Committee would likely insist, it is more than a little uncertain about the structure of the world economy. So maybe the Committee ought to follow a

†Paper presented at policy-making seminar series, August 25, 1975. The FOMC policy procedure described in this paper is the one which was being followed at that time.

‡ Note that numbers in brackets [ ] correspond to the reference list p. 50.

procedure that is appropriate for an uncertain policy maker. It may even be that the Committee should not decide policy anew each month, that it should not respond to recent economic developments, but should instead keep some variable, presumably the System portfolio of Treasury and agency securities, increasing at a constant percentage rate. As we said, we are not sure.

Nor should it seem strange, our being unsure how the Committee ought to operate and, at the same time, confident that it has not of late been operating sensibly. If well-being is affected by future as well as current developments, then there are certain things that a policy maker should not do. He† should not disregard what his current policy choice means for the future. And although concerned about future developments, he should not decide (or, in operating, use) long-run target values for variables which are not goals of policy. To some extent, that is, it does not matter whether a policy maker is certain about the structure of the world. If certain, he follows one procedure. And if uncertain, he follows another. But those two procedures are to some extent alike. We should then have come to the same judgment about the Committee's policy procedure if we had chosen to compare it not to the Theil procedure but to some other, one that is optimal when there is uncertainty about structure. It was only to make exposition easier that we chose to compare it to the Theil procedure.

Concern About the Future

The FOMC decides policy for a country; and a country, unlike an individual, has (or must be presumed to have) an infinitely long life. The Committee should therefore be concerned about economic developments over an indefinitely long stretch of years. It should regard itself as having an infinite planning or policy horizon. At some cost, the Committee may limit its concern to the current and succeeding several years.

But even a policy maker whose concerns extend over only several periods should not behave myopically. He should not decide policy in the way that is appropriate for someone whose concern extends over just the current period. If he is to do well, he must take the future into account in deciding policy for the current period. For the choice of current or first-period policy determines, if only in part, the set of feasible policy choices or the set of attainable policy outcomes for the second and subsequent periods.

Behaving myopically, a policy maker can do relatively well in the current or first period. He may discover, though, when he comes to the second period, that he cannot do as well as he could have if at the beginning of the first period he had taken the future into account. He may

†A distinction between an individual and a collective decision-making process is essential here. The male singular personal pronoun is used in the absence of an acceptable nongender singular personal pronoun.

find that the greatest expected second-period payoff is less than it could have been. And for a policy maker with a multi-period horizon, it is the sum of the expected payoffs of the several periods of the horizon that matters.

If his circumstances are special enough, the policy maker can without penalty behave myopically, even though he has a multi-period horizon. If history casts no shadow on the present or future, he can. Or he may have sufficient control — a large enough number of instrument variables, that is. It is extremely unlikely that the FOMC's circumstances are such, though, that it can at no cost decide open market policy myopically. That the Committee should look ahead, or take account of the future in deciding policy for the current period, seems beyond dispute.

Current FOMC Policy Procedure

The FOMC typically meets every four weeks to decide policy. For each meeting, the Committee staff prepares an up-to-date, long-range forecast of important economic variables. Each long-range forecast utilizes all of the most recent observations on the economy and is conditional on an assumed path for M1. The staff also prepares a separate set of short-run financial forecasts which associate interest rate paths with alternative M1 paths.

Based in part on the information provided by its staff, the Committee at each meeting decides appropriate 12-month growth rates for M1 and other monetary aggregates. Given these long-run growth rates, the Committee then chooses paths for M1 and M2 over the current and succeeding month and specifies a related federal funds rate range for the current month. Between meetings the Manager of the Open Market Account varies the funds rate within that range in order to achieve the chosen short-term paths for M1 and M2.

This skeletal description of the Committee's policy procedure will be filled out later when we compare it to the Theil procedure. For now it is enough to know how the Committee's concern for the future is reflected in its use of long-run and short-run forecasts in deciding policy. As we argue below, however, the Committee procedure does not properly take the future into account.

Taking the Future Into Account

What is involved in looking ahead?[†] To provide an answer, we describe the Theil policy procedure. And we begin by distinguishing several sets of variables. The first is the set of goal variables. It contains all those variables that are used by the policy maker in ranking alternative states of the world or in measuring well-being. (More technically, it includes all those variables that appear as arguments in the policy maker's utility

†The Mathematical Appendix (page 31) illustrates what is involved in "taking the future into account" using two simple certainty-equivalence models.

or objective function.) The second is the set of instrument variables, and it contains all those variables the values of which are determined exactly by the policy maker, or all those variables that he controls. And lastly, there is the set of information variables, which contains all those variables not contained in either of the other two sets. So any variable is either a goal variable, an instrument variable, or an information variable.

It is convenient to consider a policy maker who has but one instrument variable. And we suppose, if only for now, that he observes all his goal and information variables with the same frequency, at the beginning of each period. Our hypothetical policy maker is concerned about what happens not just in the current period but in some number of future periods as well. Further, he knows what he likes. That is to say, he knows how any policy outcome, any combination of values of goal variables, compares with any other—whether it is better or worse or of the same value.

Now, a policy is properly thought of as a (dated) sequence of instrument variable values. And as the first step in the policy-making procedure, what in effect the policy maker does is determine the expected outcomes associated with all possible policies or instrument variable sequences.† In other words, what in effect he does is determine a set of feasible or attainable expected outcomes. For as we indicated, he determines an expected outcome for every possible policy or sequence of instrument variable values.

An expected outcome is nothing more nor less, though, than a forecast of values for all goal and information variables and, what is most important, for all periods of the policy horizon. Or better, it is a conditional forecast, since the expected outcome is for some assumed policy. We might therefore have said that what the policy maker first does is generate all possible conditional forecasts; and in doing that, he determines his choice set, the set of attainable expected policy outcomes.

That choice set does not, except in the odd instance, contain what according to the policy maker's preferences is the best of all possible outcomes. But there is a best feasible expected outcome. And in deciding, as the second step in the policy-making procedure, what that expected outcome is, the policy maker determines policy. He determines the best sequence of instrument variable values, the one associated with the chosen expected outcome.

The first term of that sequence is, though, quite unlike the remaining terms. It is an actual value. And the remaining terms are, as it were,

†There likely is an infinity of possible policies. So the policy maker can do what we said he does only if his preferences are given by a utility function and he has a formal representation (model) of his world. If the policy maker has a staff which does his reckoning for him and he does not tell the staff what his utility function is, then it can give him only a finite (as a practical matter, a rather small) number of expected outcomes. There is then some considerable advantage in having formal representations of preferences and the relationships between goal and instrument variables.

expected values. Nor will any one of them become an actual value, except with small (zero) probability. If the sequence was determined at the beginning of, say, the first period, then the first term is the actual value of the instrument variable for the first period. But the second term is not the actual value for the second period. It is the policy maker's best guess, as of the beginning of the first period, of the value of the instrument variable for the second period. When the second period has arrived, however, the policy maker will in all likelihood fix his instrument variable at a different value.†

To put the point differently, the policy maker goes through the procedure just described at the beginning of each period. Each time he observes his goal and information variables, he generates a new set of conditional forecasts or feasible expected outcomes; then, by picking the best, he determines a new policy sequence. And the first term is the actual value for the current period.

Why our hypothetical policy maker proceeds in the manner indicated is easily explained. There is a welfare loss involved in using poor forecasts. And a poor forecast is one that uses fewer than all the available observations. To do his best, he therefore is obliged to generate a new set of conditional forecasts at the beginning of each period, when he has again observed his goal and information variables. But conditional forecasts that are made at different dates, or that are based on different sets of observations, will generally differ, even though they are based on the same assumed policy. Only in the exceptional instance, when there have been no surprises, will they be the same. Only when the forecast based on actual policy has proved dead-accurate will they be the same.

Thus, in general, the policy maker confronts a new and different set of attainable expected outcomes at the beginning of each period. Consequently, he determines a new and different policy sequence at the beginning of each period. In general, the first term of the sequence determined at the beginning of some period is not equal to the second term of the sequence determined at the beginning of the previous period. So taking that second term as the actual value of the instrument variable for the current period would most of the time be foolish.

We may then sum up by saying that our hypothetical policy maker decides policy—in effect, a current-period value for his instrument variable—by choosing from among expected outcomes or conditional forecasts that extend over the whole of his policy horizon. He does not decide by choosing from among just the current or first-period expected outcomes. To do that would be to disregard the implications of the current-period policy choice for future-period choices. And because there is value in new information, our hypothetical policy maker decides a new policy at the beginning of each period. In other words, he never

†This procedure is described and shown to be optimal using Model I of the Mathematical Appendix (page 31).

commits himself beyond the current period. He knows what he expects policy to be in future periods, but in no real sense does he specify long-run target or instrument variable values for those future periods.

If There Are Missing Observations

The FOMC does not, however, observe all of its goal and instrument variables with the same frequency. It observes certain of its goal variables, real GNP and the CPI and the unemployment rate, less often than it observes various information variables, interest rates and the so-called monetary aggregates. To be realistic, we should therefore have started out by supposing that our hypothetical policy maker observes some (at least one) of his goal variables relatively infrequently. Yet, if we had, we would have gone on exactly as we did. The procedure followed by the policy maker when he does not always observe all of his goal and information variables is the same as that which he follows when he does. More particularly, the policy maker determines a new sequence of instrument variable values at the beginning of each period, even though at the beginning of some he does not observe all of his variables; and for each period, he uses as the actual value of his instrument variable the first term of the newly determined policy sequence.

Imagine the policy maker as being at the beginning of some period and as having observed some but not all of the goal and information variables. He has, though, observed some and so must generate a new set of conditional forecasts. And "must" is not an inappropriate word. An up-to-date conditional forecast, although based on an incomplete set of observations, is better than an old conditional forecast, a forecast made at the beginning of some past period, perhaps at a time when the policy maker (or his staff) did observe all of his goal and information variables. There is value even in the most fragmentary new information.

Thus, even if the policy maker observes some of his goal variables relatively infrequently, he does not in any real sense specify long-run target values.† He never uses as the actual value of his instrument variable some term of a policy sequence that was determined at the beginning of a past period. Nor does he ever try, by varying his instrument variable over several periods, to make the actual average for those periods of some information variable approximate a predetermined "target" average.‡

†This proposition is proved using Model II of the Mathematical Appendix (page 38).

‡The procedure we refer to is as follows. Imagine that the policy maker observes all of his information variables at the beginning of every period. He observes his goal variables, though, only at the beginning of every third period — at the beginning of the first period, the fourth period, the seventh and so on. At the beginning of the first (or fourth or seventh) period, he determines the best policy sequence in the appropriate way. Next, he determines the associated sequence of expected values for one of his information variables. Then, to get a target value, he averages the first, second, and third terms of that sequence. And through the first three periods he varies his instrument variable in an attempt to make the actual average come out to be equal to the target value or average.

Comparison of Committee and Theil Procedures

The procedure we have described may seem remarkably like the actual procedure of the FOMC. For each meeting, as we said, the Committee staff prepares an up-to-date conditional long-range forecast, a forecast that utilizes all the most recent observations on economic variables. It does not matter that the forecast is based, not on an assumed sequence or path for a true instrument variable, but rather on an assumed M1 path. And that it is a "judgmental" forecast is similarly of no consequence. It can reasonably be insisted, though, as later on we do, that the Committee ought always to be given several conditional forecasts, not just one but two or three or, even better, four. And to our minds it is important that the typical staff forecast, having no interest-rate component, is incomplete. But for some it may be enough that the Committee does start out each meeting with what can be thought of as a base (not an ignoble, but a base) conditional forecast, which gives it a rough notion of the relevant or currently estimated set of feasible expected outcomes.

And whatever the appearance may be, the Committee decides policy anew at each meeting. It goes through the motions of specifying what it is pleased to call long-run target values (actually, ranges of values) for a variety of monetary aggregates.† For awhile it specified six-month desired growth rates for M1 and other aggregates. Since April 1975 it has been specifying 12-month desired rates. But not effectively, or to any real purpose, for the Committee regards itself as free to change those long-run target values whenever it meets.

Consider what Chairman Arthur Burns, speaking for the FOMC Committee, told the Senate Committee on Banking, Housing, and Urban Affairs on May 1, 1975, when for the first time he journeyed to the other end of Pennsylvania Avenue to inform Congress of "the Federal Open Market Committee's objectives and plans with respect to the ranges of growth or diminution of monetary and credit aggregates in the upcoming twelve months."

> We recognize that our capacity to foresee the future is very limited, and that our control of the monetary and credit aggregates is imperfect. The growth ranges for the aggregates we have set out to achieve may need to be adjusted in one way or another. New information on economic and financial developments becomes available daily, and the course of monetary policy must therefore be reappraised continuously. In an economy as dynamic as ours, subject to unforeseen developments—such as a major business failure or a disruption of energy supplies—the economic and financial outlook can change quickly and dramatically. The Federal Reserve must stand ready to make promptly such adaptations in the course of policy as may be needed to minimize economic and financial difficulties. The Board and the Federal Open Market Committee

†Throughout this paper we pretend that the Committee chooses values, not ranges. That is out of kindness, since there is no good earthly reason for choosing ranges.

> therefore meet frequently. Thus, while I have given you our present views on the appropriate ranges of growth in the monetary and credit aggregates, these views may need to be modified a month or two from now [3].

It is a little disconcerting, his having said "...that our [the FOMC's] control of the monetary and credit aggregates is imperfect," for those words are easily interpreted as suggesting that the Committee's objective is indeed to control one or more of the aggregates and that it therefore does effectively specify long-run target values. But what follows in the quoted passage can only be read as a denial of that. The Committee, appreciative of the value of new information, never commits itself beyond the date of its next meeting.

There would thus seem to be something of a puzzle. By its own insistence, the Committee is never bound by past decisions. But why then each time it meets does it bother to specify what it refers to as long-run target growth rates for certain aggregates? One possible answer is that it uses 12-month growth rates to characterize what it regards as the best attainable policy outcome, the best attainable paths of those variables that, so to speak, are of ultimate concern. Why it should want to be so indirect in expressing its preferences is not clear to us.† What is important here, though, is that it is not a departure from the Theil procedure to use a path for some information variable to characterize or identify the most desirable attainable policy outcome. For we might have described our hypothetical policy maker as proceeding in a roundabout way.

Think of him as having a staff to do his grub work. He instructs that staff to determine what expected outcomes are associated with several assumed sequences or paths not for his instrument variable but for some arbitrarily selected information variable (for example, Ml). Then, by introspecting, he selects what he regards as the most desirable of those expected outcomes. He does not tell his staff, though, what the outcome is. Instead, he tells it what information variable path he wants to see "realized." But then the staff, using that path, calculates the associated instrument variable sequence. And the policy maker, although proceeding in a roundabout way, nevertheless ends up with precisely the policy that could have been determined more directly.

Two Sets of Forecasts Are Not Enough

Again, then, it is not a departure from the Theil procedure to use some arbitrarily selected information variable sequence or path to identify a chosen expected policy outcome. Yet, having said that, we must still insist that the Committee is not faithful to the Theil prescription for deciding policy. In deciding open market policy, it does not choose from among many or even several expected policy outcomes or complete conditional forecasts. And what that means is that the Committee

†And why it uses ranges of rates is not easy to explain either.

behaves myopically. Either that, or it takes account of the implications of its current-period policy choice for future choices in much too casual a way.

As we noted several pages back, the staff typically prepares only one conditional long-range forecast. So the Committee must guess what expected outcomes are associated with Ml sequences or paths different from that used by the staff in generating its forecast. Further, the staff forecast is incomplete. It has no interest-rate component, for an off-hand remark about interest rates increasing or decreasing hardly suffices. And consequently, the Committee, having perused the forecast, is quite in the dark about what interest rates go with alternative M1 paths, even more so than it is about, for example, what real GNPs go with those alternative paths. But for the Committee, interest rates are, rightly or wrongly, goal variables.

To be sure, there is also the set of short-term financial forecasts. And as might be argued, it is there that the Committee is told what interest-rate paths are associated with alternative M1 paths. Now, it is an interesting question why the Committee should have two sets of forecasts, not one, prepared for each meeting. The explanation, we suspect, is that the Committee mistakenly believes that once having chosen long-run growth rates for M1 and other aggregates, as a way presumably of identifying its desired "real sector" outcome, it is free to then go on and choose short-run growth rates. That, however, as we indicated, is nonsense. If in the staff's judgment some long-run path for M1 is associated with a particular policy outcome, then the associated short-run path is that implied by the long-run path. And to choose a different short-run path is to opt for a different policy outcome. It was not inadvertent, our having described the hypothetical policy maker as deciding policy in one step, not two.

Nor can it be maintained that "correcting" for any current-period discrepancy between long- and short-run paths can be managed in some future period. For the Committee, because it regards itself as free to change its long-run path at any meeting, that future period never comes. Moreover if it did, the Committee would be violating a precept of good policy making.

Here, though, what is important is that the typical financial forecast does not extend over the whole of the Committee's policy horizon. The set of financial forecasts contains various expected-value combinations for the funds rate, M1 and M2, and a reserves aggregate, but these forecasts are short-run in nature. They are all based on some assumed path for nominal GNP; and it is only over a period of months, perhaps very few months, that nominal GNP is independent of interest rates and/or M1.

Our point, put differently, is that the typical set of financial forecasts does not tell the Committee what it should know: to wit, what follows from the various interest rate-aggregates combinations that are presented in the set or how each of these alternatives restricts future policy choices.

And consequently, if the Committee uses the financial forecasts only in deciding policy, then it behaves myopically; it decides policy without regard to the implications of its current-period choice for future choices.

Or is it that the Committee, maybe using its long-range forecast as a base, figures out for itself what the short-run financial alternatives mean for the future? It may, but in our judgment not well enough. That is what we meant before when we suggested that the Committee, in taking account of the future, may be too casual.

The Committee has acknowledged that it cannot adequately figure out for itself what any particular current-period policy decision means for the future. If it thought it could, it would not employ an excellent and rather expensive staff. But that staff has not been giving the Committee what it needs to decide policy in the way proposed by Theil: namely, complete conditional forecasts for the entire policy horizon of the Committee.

Whether what we just said should be taken as a criticism of the Committee staff is not clear. Perhaps. But the Committee is master of its staff, and blame does go with responsibility.

A Modest Change of Procedure

If the typical set of financial forecasts contained several complete conditional forecasts, based perhaps on various M1 paths of different shapes and extending over a reasonable policy horizon, several years in length, then we could not be so critical of the FOMC's policy procedure.† But why separate short-term and long-term forecasts? It seems clear that if the Committee wants to be faithful to the Theil prescription, it should have more long-term conditional forecasts.

It also seems clear that the Committee staff, in preparing conditional forecasts, cannot limit itself to constant-growth or exponential M1 paths. Nor will the Committee be well-served if it gets several forecasts, each of which is based only on a constant-growth M1 path. There is the question of what paths the staff ought to use in preparing its forecasts. We are not sure. But we can imagine the Committee deciding that for itself. The staff might ask at the end of one meeting what M1 sequences it should use in preparing its forecasts for the next meeting.

If, however, the staff typically prepared several complete conditional forecasts of interest rates, the price level, the unemployment rate, and so on, each based on some assumed and perhaps rather complicated M1 sequence, then the Committee could do reasonably well at approximating the Theil procedure. It might have to do a little interpolating, but it could then, in one step, select the best M1 sequence, the one associated with the best attainable policy outcome. And the staff, using the chosen

†The evident lagged response of the price level makes necessary quite a long policy horizon. And it cannot be argued that forecasts for far-distant periods are terribly unreliable. That may be, but it makes precious little sense to try to take account of forecast errors by truncating the policy horizon.

M1 sequence, could calculate the implied inter-meeting value (or path) for the Committee's instrument variable, the System portfolio of Treasury and agency securities. The Committee might want to oversee or approve the staff's translation of the chosen M1 sequence into an instrument variable sequence.

It may be objected that if the Committee were to proceed in the manner indicated, it would have no guarantee of the funds rate staying within acceptable bounds. If the Manager of the Open Market Account were simply to achieve some predetermined value for the System portfolio (or, stretching a bit, for unborrowed reserves), the funds rate might fluctuate considerably. That is so. The variance of the funds rate, given the value of the System portfolio, may well be great. If so, then perhaps the Committee should be using the funds rate as its instrument variable. A relatively large variance does not, though, justify the current Committee procedure.

It may also be objected that if the Committee were to follow the Theil procedure, it might continually miss its M1 "target." It might through time wander further and further from course. That, however, is not so. Following the Theil procedure, the Committee would not have an M1 target value, short- or long-run. But it would in a sense always be correcting for past "misses," for past discrepancies between what was expected and what actually happened.

Imagine the Committee at one of its monthly meetings. It decides a value for the System portfolio and, in the process, determines a sequence of expected values for M1, the sequence associated with the best attainable policy outcome. Now, though, time having passed, the Committee comes to its next meeting. And as we may suppose, it observes that M1 did not increase over the past month at the expected rate. Necessarily, then, it changes its conditional forecast. The M1 path that was associated with what was the chosen expected policy outcome is now associated with a different outcome. And therefore the Committee changes its policy. It determines a current-period value for the System portfolio different from that which it had determined at its previous meeting. In doing that, it corrects, but in the appropriate way, for the M1 "miss" that it began its meeting by observing.

In the Period Between Meetings

We suggested above that the Committee, if following the Theil procedure, would come away from a regular meeting having in effect decided a sequence of monthly values for its instrument variable and, more particularly, as its instruction to the Manager of the Open Market Account, a value for the month immediately ahead. By doing a little elementary smoothing of the sequence of monthly values, the Committee (or its staff) might manufacture a sequence of weekly or even daily instrument variable values. Why it would want to do that is far from

clear. If it did, the Manager would then vary the System portfolio week-by-week or day-by-day, but along the predetermined path. He would not operate, as lately he has been, by responding to observations on the federal funds rate and, at weekly intervals, to observations on M1, M2, and the bank credit proxy.

Had we been willing to suppress our doubts about what the Committee (or its staff) knows, we could have described it as deciding a current-week value for its instrument variable, a value for the week beginning one day after its meeting, and also a rule for the Manager to follow in the remaining weeks of the inter-meeting period. Indeed, we could have described it as deciding a next-day value, a value for the day after its meeting, and in addition a rule for the Manager to follow in the remaining days of the inter-meeting period. Following the Theil procedure, the Committee could certainly decide an initial-period instrument variable value and, for the interval beyond, a rule.

The rule would be different from the sort that the Manager has been following in recent years. And not only in being less vague. For awhile now, the Committee has been specifying desired monthly values for M1, M2, and the credit proxy and having the Manager try, by varying the funds rate (and ultimately the System portfolio), to achieve those values. Each day, though, the Manager gets observations on various interest rates and certain quantities such as member bank borrowings; and at weekly intervals he gets observations on M1 and other aggregates. So the Committee, in setting monthly target values, has been denying that there is value in new information. Given the frequency of observations, some monthly target values have to be regarded as being long-run. Thus, if the Committee were following the Theil procedure, the Manager would not behave as he has been. (To get an idea of how he would behave, think of the Committee as meeting daily or weekly.) As we indicated, he would follow a rule different from that which he has been following. But the Committee, if following the Theil procedure, could nevertheless make changes in open market policy between meetings.

Manifestly, though, if a policy maker is to respond appropriately to current observations, he must know what those observations mean, how they are to be interpreted. If he does not know that, then current observations are of no value. It is therefore necessary to ask whether the Committee (or its staff) knows with any reliability how, say, the daily averages of the funds rate and other interest rates are related to certain of its goal variables, to variables defined on much longer time periods, the monthly unemployment and inflation rates and quarterly real GNP. It is also necessary to ask whether it knows how the weekly averages of M1 and M2 are related to those goal variables. We are skeptical that it knows much of anything of those relationships and, in consequence, are doubtful that it should be making between-meeting changes in open market policy. The Committee would, we believe, demonstrate an appropriate humbleness by limiting itself to deciding policy monthly and

to deciding only current-month values (or paths) for its instrument variable, whether the System portfolio or the funds rate.

In Conclusion

Now all we have left is a reminder to those readers who have persisted. As we said at the outset of this paper, we are not enthusiastic advocates of the Theil procedure—not for the Committee, that is. We grant that there is advantage in having a coherent policy procedure. Then, too, if the Committee were to adopt the Theil procedure, perhaps System staff members and outsiders as well would stop writing papers on how to control M1, on what is the best way to get M1 back on "track," etc. But the Theil procedure is for the policy maker who is certain about the structure of the world. And the Committee is uncertain about how the world economy works. Or if it is certain, it should not be.

For those who for whatever reason would prefer that Committee routine be altered only slightly, there is then an obvious challenge: to determine whether the Theil procedure can be modified, but in some sensible or defensible way, and thereby made more consistent with the true state of the Committee's knowledge.

Mathematical Appendix

In this appendix the meaning of "taking the future into account" is illustrated using two simple "certainty equivalence" models. Although each model assumes only a two-period policy horizon, the results generalize for all finite-period horizons.

Model I: No Information Lags

Let the policy maker's utility function be

$$(I.1) \qquad U = -r_1(X_1 - X_1^*)^2 - r_2(X_2 - X_2^*)^2 - d_1(\pi_1 - \pi_1^*)^2 - d_2(\pi_2 - \pi_2^*)^2$$

where X_t = unemployment rate in period t and π_t = inflation rate in period t. The variables X_1, X_2, π_1, and π_2 are goal variables, and these variables with "*" on top represent the best possible outcome. The r's and d's are nonnegative discount factors.

Let the reduced form equations generating X and π be

$$(I.2) \qquad X_t = a_0 X_{t-1} + a_1 P_t + a_2 P_{t-1} + \epsilon_x(t) \qquad t=1, 2 \text{ and}$$

$$(I.3) \qquad \pi_t = b_0 \pi_{t-1} + b_1 P_t + b_2 P_{t-1} + \epsilon_\pi(t) \qquad t=1, 2$$

where P_t = value of System's portfolio in period t and a_0, a_1, a_2, b_0, b_1, and b_2 are known.

The coefficients a_0 and b_0 represent system lags. They capture the notion that once the unemployment rate or inflation rate start to move, momentum builds in the economy to keep them moving in the same direction.

The coefficients a_1 and b_1 represent the immediate effects of policy, while the coefficients a_2 and b_2 represent lagged effects of policy. Thus, policy is assumed to have effects on unemployment and inflation in current and future periods (the lagged effects are also captured to some degree in a_0 and b_0). Most econometric models can be interpreted to have a_1 relatively large and negative and b_1 close to zero.

The residuals ϵ_x and ϵ_π are generated by stationary stochastic processes and have the following first and second moments:

$$E_t \begin{pmatrix} \epsilon_x(t+h) \\ \epsilon_\pi(t+h) \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \qquad (t \text{ and } h \geq 0)$$

$$E_t \begin{pmatrix} \epsilon_x(t+h) \\ \epsilon_\pi(t+h) \end{pmatrix} (\epsilon_x(t+k), \epsilon_\pi(t+k)) = \begin{cases} (0)_{2\times 2} & \text{if } h \neq k \\ \begin{pmatrix} \sigma_x^2 & 0 \\ 0 & \sigma_\pi^2 \end{pmatrix} & \text{if } h = k \geq 0 \end{cases}$$

where $E_t(Z) = E(Z|$ information available at beginning of period $t)$. The policy maker's information set at the beginning of period t consists of time series for X, π, and P from the beginning of time through period $t-1$ (see Figure I.1).

Optimal policy is found by maximizing

$$(I.4) \quad -E_1\{[r_1(X_1 - X_1^*)^2 + d_1(\pi_1 - \pi_1^*)^2] + E_2[r_2(X_2 - X_2^*)^2 + d_2(\pi_2 - \pi_2^*)^2]\}$$

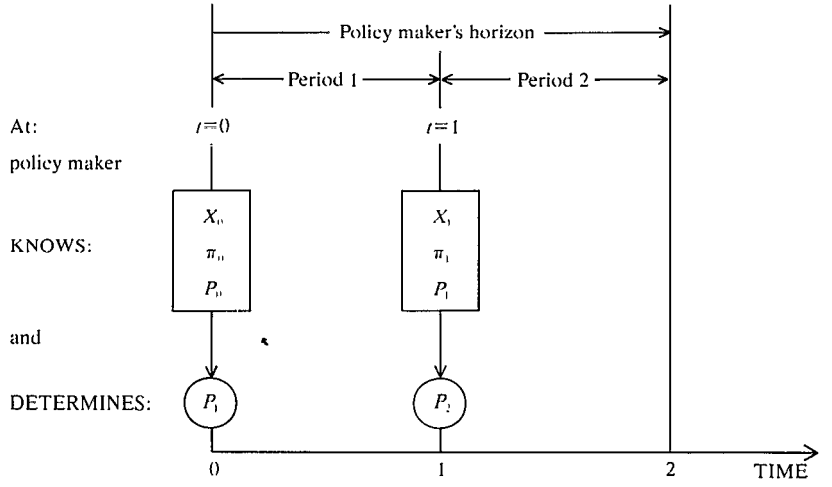
with respect to P_1 and P_2 as functions of current information sets and subject to (I.2) and (I.3). The solution to this policy-making problem is

$$(I.5) \quad \tilde{P}_1 = \frac{a_1 r_1(X_1^* - a_0 X_0 - a_2 P_0) + b_1 d_1(\pi_1^* - b_0 \pi_0 - b_2 P_0) - A \cdot B}{r_1 a_1^2 + d_1 b_1^2 + A \cdot C}$$

where

$$A = \frac{r_2 d_2}{r_2 a_1^2 + d_2 b_1^2},$$

Figure I.1
Dynamics of Policy Problem



$$B = [a_0^3 a_1 b_1^2 - a_0^2 a_1 b_0 b_1^2 + a_0^2 a_2 b_1^2 - a_0^2 a_1 b_1 b_2]X_0$$
$$+ [a_1^2 b_0^3 b_1 - a_0 a_1^2 b_0^2 b_1 + a_1^2 b_0^2 b_2 - a_1 a_2 b_0^2 b_1]\pi_0$$
$$+ [a_0^2 a_1 a_2 b_1^2 - a_0 a_1^2 b_0 b_1 b_2 - a_0 a_1 a_2 b_0 b_1^2 + a_1^2 b_0^2 b_1 b_2$$
$$+ a_0 a_2^2 b_1^2 - a_0 a_1 a_2 b_1 b_2 - a_1 a_2 b_0 b_1 b_2 + a_1^2 b_0 b_2^2]P_0$$
$$+ [a_1 b_0 b_1 - a_0 a_1 b_1 + a_1 b_2 - a_2 b_1] \cdot (b_1 X_2^* - a_1 \pi_2^*), \text{ and}$$

$$C = \{a_1[(a_0 - b_0)b_1 - b_2]\}^2 + a_2 b_1[a_2 b_1 + 2a_1 b_1(a_0 - b_0) - 2a_1 b_2]; \text{ and}$$

$$\text{(I.6)} \quad \tilde{P}_2 = \frac{a_1 r_2(X_2^* - a_0 X_1 - a_2 \tilde{P}_1) + b_1 d_2(\pi_2^* - b_0 \pi_1 - b_2 \tilde{P}_1)}{r_2 a_1^2 + d_2 b_1^2}.$$

Notice $\tilde{P}_1$ is a value, since it depends only on known initial conditions: X_0, π_0, and P_0; policy goals: X_1^*, π_1^*, X_2^*, and π_2^*; and known coefficients: a_0, a_1, a_2, b_0, b_1, and b_2. $\tilde{P}_2$ is a random variable, however, because its value depends on X_1 and π_1 which are random and unknown at the beginning of the policy horizon. In particular

$$\text{(I.7)}\quad E_1\tilde{P}_2 = \frac{a_1 r_2 (X_2^* - a_0 E_1 X_1 - a_2 \tilde{P}_1) + b_1 d_2 (\pi_2^* - b_0 E_1 \pi_1 - b_2 \tilde{P}_1)}{r_2 a_1^{\,2} + d_2 b_1^{\,2}}.$$

Thus

$$\text{(I.8)}\quad \tilde{P}_2 - E_1\tilde{P}_2 = \frac{-a_0 a_1 r_2 (X_1 - E_1 X_1) - b_0 b_1 d_2 (\pi_1 - E_1 \pi_1)}{r_2 a_1^{\,2} + d_2 b_1^{\,2}}$$
$$\equiv \phi_1 (X_1 - E_1 X_1) + \phi_2 (\pi_1 - E_1 \pi_1).$$

Equation (I.8) describes how policy should be revised in period 2 based on the differences between the realizations of X_1 and π_1 from what was expected. The actual setting of P_2, $\tilde{P}_2$, will not be equal to its expected value, $E_1\tilde{P}_2$, unless X_1 and π_1 come in exactly as forecast.

Myopic policy is

$$\text{(I.9)}\quad \bar{\tilde{P}}_1 = \frac{a_1 r_1 (X_1^* - a_0 X_0 - a_2 P_0) + b_1 d_1 (\pi_1^* - b_0 \pi_0 - b_2 P_0)}{r_1 a_1^{\,2} + d_1, b_1^{\,2}} \text{ and}$$

$$\text{(I.10)}\quad \bar{\tilde{P}}_2 = \frac{a_1 r_2 (X_2^* - a_0 X_1 - a_2 \bar{\tilde{P}}_1) + b_1 d_2 (\pi_2^* - b_0 \pi_1 - b_2 \bar{\tilde{P}}_1)}{r_2 a_1^{\,2} + d_2 b_1^{\,2}}.$$

The loss from following a myopic policy is $E_1 U(\tilde{P}_1, \tilde{P}_2) - E_1 U(\bar{\tilde{P}}_1, \bar{\tilde{P}}_2)$. When policy is made one period at a time, the policy maker does not recognize that the current policy choice affects the attainable set in the next period.

It is possible to solve this policy problem using a different method: Theil's first-period certainty equivalence. Write $E_1 U$ as

$$\text{(I.11)}\quad E_1 U = -r_1 \sigma_x^{\,2} - d_1 \sigma_\pi^{\,2} - r_1 (E_1 X_1 - X_1^*)^2 - d_1 (E_1 \pi_1 - \pi_1^*)^2$$
$$- r_2 \sigma_x^{\,2} - d_2 \sigma_\pi^{\,2} - r_2 (E_1 X_2 - X_2^*)^2 - d_2 (E_1 \pi_2 - \pi_2^*)^2$$
$$\equiv K_0 + U_1 + U_2$$

where

$$K_0 = -[(r_1 + r_2)\sigma_x^{\,2} + (d_1 + d_2)\sigma_\pi^{\,2}],$$

$$U_1 = -[r_1 (\bar{X}_1 - X_1^*)^2 + d_1 (\bar{\pi}_1 - \pi_1^*)^2],$$

$$U_2 = -[r_2 (\bar{X}_2 - X_2^*)^2 + d_2 (\bar{\pi}_2 - \pi_2^*)^2], \text{ and}$$

$$\bar{(\cdot)} = E_1 (\cdot).$$

Taking expected values in (I.2) and (I.3) in the first period and eliminating P_1 generates the expected first-period Phillips curve

$$(I.12)\quad \bar{\pi}_1 = \frac{b_1}{a_1}\bar{X}_1 + b_0\pi_0 - \frac{a_0 b_1}{a_1}X_0 + \left(\frac{a_1 b_2 - a_2 b_1}{a_1}\right)P_0$$

$$\equiv F^1(\bar{X}_1; X_0, \pi_0, P_0, \vec{a}, \vec{b}).$$

Similarly, for the second period we have

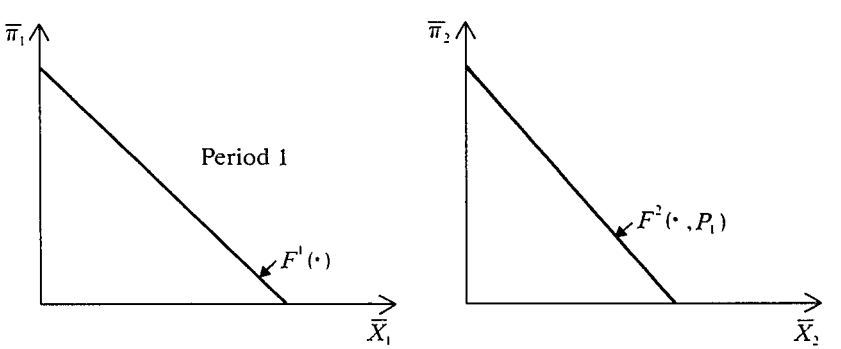
$$(I.13)\quad \bar{\pi}_2 = \frac{b_1}{a_1}\bar{X}_2 + b_0^2\pi_0 - \frac{a_0^2 b_1}{a_1}X_0 + \left(\frac{a_1 b_0 b_2 - a_0 a_2 b_1}{a_1}\right)P_0$$

$$+ \left[\frac{a_1(b_0 b_1 + b_2) - b_1(a_0 a_1 + a_2)}{a_1}\right]P_1$$

$$\equiv F^2(\bar{X}_2; X_0, \pi_0, P_0, \vec{a}, \vec{b}, P_1).$$

Different values of P_1 change the intercept of the expected second-period Phillips curve. Graphically, the Phillips curves can be represented as in Figure I.2.

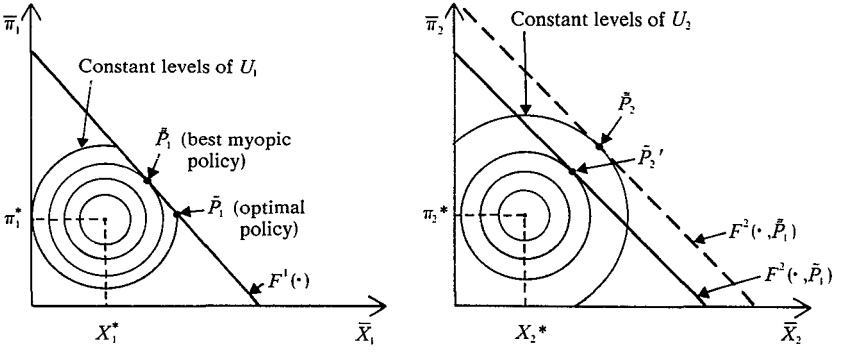
Figure I.2
Expected Phillips Curves



Each point on the first-period Phillips curve corresponds to a value of P_1, and each value of P_1 fixes the location of the second-period Phillips curve.

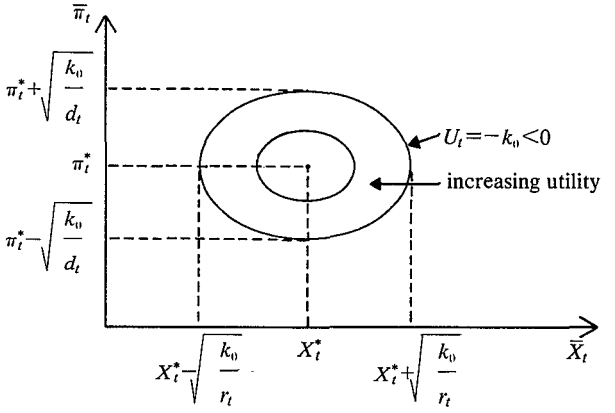
Optimal first-period policy $\tilde{P}_1$ is from the pair $\langle \tilde{P}_1, \tilde{P}_2' \rangle$ which maximize $U_1 + U_2$ in (I.11) subject to (I.12) and (I.13). Graphically, the optimal policy $\tilde{P}_1$ and the best myopic policy $\tilde{\tilde{P}}_1$ can be represented as in Figure I.3.

Figure I.3
Optimal First-Period Policy



For $U_t = -k_0 < 0$, an indifference curve is a rectangular elipse with center $\langle X_t^*, \pi_t^* \rangle$ (see Figure I.4).

Figure I.4
Period t Indifference Curve



The Theil policy procedure can be described simply as follows. Construct all forecasts of goal variables: $\bar{X}_1, \bar{\pi}_1, \bar{X}_2$, and $\bar{\pi}_2$ conditional on values of P_1 and P_2

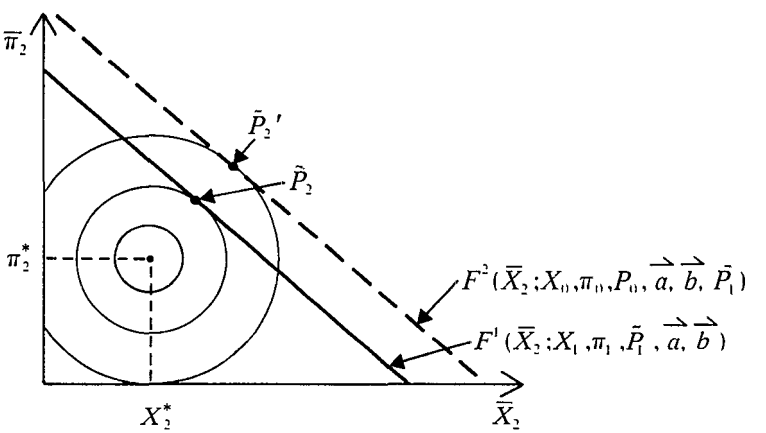
$$P_1 \longrightarrow \bar{X}_1, \bar{\pi}_1$$
$$P_2 \longrightarrow \bar{X}_2, \bar{\pi}_2.$$

From all of these forecasts choose the one which is most desirable (maximizes (I.11)). That forecast determines the optimal first-period policy $\tilde{P}_1$ and expected second-period policy $\tilde{P}_2' = E_1\tilde{P}_2$.

What about second-period policy? In period 2 we learn what X_1 and π_1 were. Based on the realizations of X_1 and π_1, the expected second-period Phillips curve will change, and optimal second-period policy $\tilde{P}_2$ will deviate from $\tilde{P}_2'$ as described by (I.8) and as shown in Figure I.5.

Figure I.5

Optimal Second-Period Policy



(Note, in the second period $\bar{X}_2$ and $\bar{\pi}_2$ are conditional on X_1, π_1, and $\tilde{P}_1$.)

In summary, this simple model illustrates our two main contentions:

- Do not disregard what the current policy choice means for the future (that is, do not set $P_1 = \tilde{P}_1$).
- Do not decide long-run target values for variables which are not goals of policy (that is, do not set $\tilde{P}_2 = E_1\tilde{P}_2$).

Model II: Missing Observations

The two-period model described here is a special case of the general model found in Kareken *et al.* [1].

Let the policy maker's utility function be:

$$\text{(II.1)} \qquad U = -d_1(X_1 - X_1^*)^2 - d_2(X_2 - X_2^*)^2$$

where X_t = nominal GNP in period t. Let the economic model be given by the following 'IS' and 'LM' curves:

$$\text{(II.2)} \qquad X_t = aR_t + \epsilon_x(t), \quad a < 0 \text{ (IS)}$$

$$\text{(II.3)} \qquad M_t = b_0 X_t + b_1 R_t + \epsilon_m(t), \quad b_0 > 0, \quad b_1 < 0 \quad \text{(LM)}$$

where R_t = Treasury bill rate in period t and M_t = money stock in period t.

It is assumed for simplicity that R is the policy instrument. The coefficients a, b_0, and b_1 are known.

The residuals ϵ_x and ϵ_m are independent, serially correlated random variables:

$$\text{(II.4)} \qquad \epsilon_x(t) = \rho_x \epsilon_x(t-1) + \mu_x(t) \qquad t=1, 2$$

$$\text{(II.5)} \qquad \epsilon_m(t) = \rho_m \epsilon_m(t-1) + \mu_m(t) \qquad t=1, 2$$

where $$E_t\begin{pmatrix}\mu_x(t+h)\\ \mu_m(t+h)\end{pmatrix} = \begin{pmatrix}0\\0\end{pmatrix} \qquad (t \text{ and } h \geqq 0)$$

$$E_t\begin{pmatrix}\mu_x(t+h)\\ \mu_m(t+h)\end{pmatrix}(\mu_x(t+k), \mu_m(t+k)) = \begin{cases} (0)_{2\times 2} & \text{if } h \neq k \\ \begin{pmatrix}\sigma_x^2 & 0\\ 0 & \sigma_m^2\end{pmatrix} & \text{if } h = k \geqq 0 \end{cases}$$

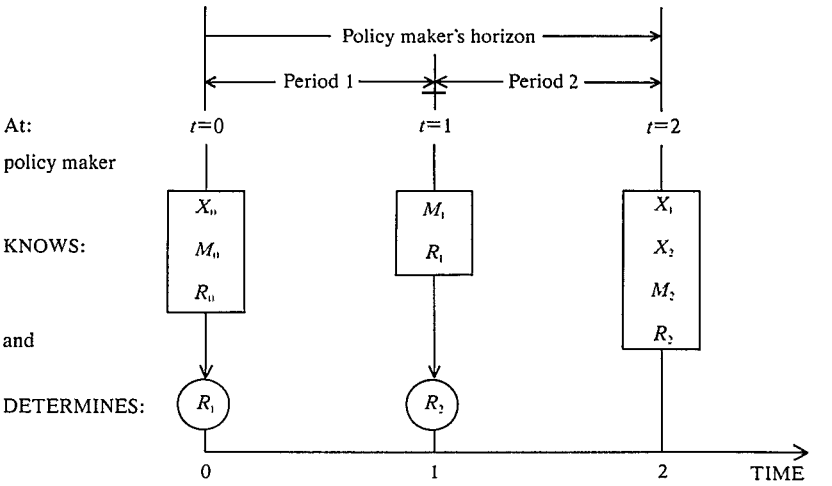
and $E_t(Z) = E(Z|$ information available at beginning of period $t)$.

It is assumed that X_0, M_0, and R_0 are known at the beginning of the first period, but only M_1 and R_1 are observed at the beginning of the second period (see Figure II.1).

A prediction error $e_x(t)$ for (II.2) can be defined

$$\text{(II.6)} \qquad \epsilon_x(t-1) = E_t \epsilon_x(t-1) + e_x(t).$$

Figure II.1
Dynamics of Policy Problem



By a well-known result in projection theory, we have

(II.7) $E_t\epsilon_x(t-1) = E_{t-1}\epsilon_x(t-1) + \{cov_{t-1}[\epsilon_x(t-1), M_{t-1}]/$

$var_{t-1}[M_{t-1}]\} \cdot [M_{t-1} - E_{t-1}M_{t-1}]$

where $cov_{t-1}[\,\cdot\,] = E_{t-1}\{[\epsilon_x(t-1) - E_{t-1}\epsilon_x(t-1)]\,(M_{t-1} - E_{t-1}M_{t-1})\}$

$var_{t-1}[\,\cdot\,] = E_{t-1}(M_{t-1} - E_{t-1}M_{t-1})^2$.

Optimal policy is found in two steps. First, (II.1) through (II.6) are used to solve for $\bar{R}_1$ and for $\bar{R}_2$ as a function of $E_2\epsilon_x(1)$. Second, (II.7) is solved in terms of the model's coefficients, and the resulting expression for $E_2\epsilon_x(1)$ is substituted into the formula for $\bar{R}_2$.

From (II.2), (II.4), and (II.6) we have

(II.8) $X_1 = aR_1 + \rho_x\epsilon_x(0) + \mu_x(1)$

(II.9) $X_2 = aR_2 + \rho_x E_2\epsilon_x(1) + \rho_x e_x(2) + \mu_x(2)$.

Since this model has one instrument and one goal variable and known

coefficients, myopic policy is optimal. It is found by setting $E_1X_1(\tilde{R}_1) = X_1^*$ and $E_2X_2(\tilde{R}_2) = X_2^*$ which yield

$$\text{(II.10)} \quad R_1 = \frac{X_1^* - \rho_x \epsilon_x(0)}{a}$$

$$\text{(II.11)} \quad \tilde{R}_2 = \frac{X_2^* - \rho_x E_2 \epsilon_x(1)}{a} .$$

Note $\epsilon_x(0) = X_0 - aR_0$ is known at the beginning of the horizon, so that $\tilde{R}_1$ is a value. Meanwhile, by (II.7) and (II.4)

$$\text{(II.12)} \quad E_2\epsilon_x(1) = E_1\epsilon_x(1) + \{cov_1[\epsilon_x(1), M_1]/var_1 M_1\} \cdot M_1 - E_1M_1]$$

$$= \rho_x\epsilon_x(0) + \{[E_1(\epsilon_x(1) - E_1\epsilon_x(1))(M_1 - E_1M_1)]/E_1(M_1 - E_1M_1)^2\}$$

$$\cdot [M_1 - E_1M_1].$$

By (II.2) and (II.3) we can solve for the reduced form of M

$$\text{(II.13)} \quad M_t = ab_0R_t + b_0\epsilon_x(t) + b_1R_t + \epsilon_m(t).$$

Thus

$$M_1 = (ab_0 + b_1)R_1 + b_0\epsilon_x(1) + \epsilon_m(1).$$

By (II.4) and (II.5)

$$\text{(II.14)} \quad M_1 = (ab_0 + b_1)R_1 + b_0\rho_x\epsilon_x(0) + b_0\mu_x(1) + \rho_m\epsilon_m(0) + \mu_m(1).$$

Taking expected values in (II.14), we have

$$\text{(II.15)} \quad E_1M_1 = (ab_0 + b_1)R_1 + b_0\rho_x\epsilon_x(0) + \rho_m\epsilon_m(0).$$

So $M_1 - E_1M_1 = b_0\mu_x(1) + \mu_m(1)$ and $\epsilon_x(1) - E_1\epsilon_x(1) = \mu_x(1)$.

Thus

$$\text{(II.16)} \quad E_1(\epsilon_x(1) - E_1\epsilon_x(1))(M_1 - E_1M_1) = E_1[b_0\mu_x(1)^2 + \mu_x(1)\mu_m(1)]$$

$$= b_0\sigma_x^2$$

$$\text{(II.17)} \quad E_1(M_1 - E_1M_1)^2 = E_1[b_0^2\mu_x(1)^2 + 2b_0\mu_x(1)\mu_m(1) + \mu_m(1)^2]$$

$$= b_0^2\sigma_x^2 + \sigma_m^2.$$

Now using (II.12), (II.16), and (II.17) to substitute for $E_2\epsilon_x(1)$ in (II.11), we have finally

$$\text{(II.18)} \quad R_2^* = \frac{\hat{X}_2 - \rho_x{}^2\epsilon_x(0) - \rho_x \dfrac{b_0\sigma_x{}^2}{b_0{}^2\sigma_x{}^2+\sigma_m{}^2}(M_1 - E_1M_1)}{a}.$$

As long as $\rho_x \neq 0$ (current income is related to past income) and $b_0 \neq 0$ (income elasticity of money demand is not zero), (II.18) indicates that the forecast error $M_1 - E_1M_1$ should be used as information in setting $\tilde{R}_2$, and hence, M is referred to as an information variable. The important point is that the deviation in M in period 1 from what was originally forecast indicates that initial conditions for period 2 cannot be as were originally forecast. And since the past tells us something about the future in this problem, optimal policy in period 2 cannot be as was initially forecast. Information on M has value in this case. Finally, note that optimal policy is not to try to have $M_2 = E_1M_2$ or, in other words, to make M a target.

References

1. Kareken, John H., Thomas J. Muench, and Neil Wallace. "Optimal Open Market Strategy: The Use of Information Variables." *American Economic Review* Vol. 63, No. 1 (March 1973): 156-72.
2. Theil, Henri. *Economic Forecasts and Policy.* Amsterdam: North-Holland, 1965.
3. U.S. Congress. Senate. Committee on Banking, Housing, and Urban Affairs. *First Meeting on the Conduct of Monetary Policy. Hearings* on H. Con. Res. 133, 94th Cong., 1st sess., 1975.