7

The Value of Intermediate Targets in Implementing Monetary Policy

Benjamin M. Friedman

Despite the growing experience with their use, both in the United States and abroad, the role of intermediate targets of monetary policy remains a source of confusion and controversy. Although some advocates apparently regard stable growth of one or another monetary aggregate as an end in itself, by far the more typical view in favor of such intermediate targets is that they somehow enable the central bank to achieve more effectively its objectives for the nonfinancial economy, usually including price stability or real growth, or both. It is in making that "somehow" more precise, and thereby making the appropriate role (if any) of intermediate targets operational, that the difficulty lies.

The ambiguity stems from the fact that measures like money or credit are not under the immediate control of the central bank. In the United States, the deposits that constitute the main bulk of any of the familiar monetary aggregates are created by more than 40,000 financial institutions, and how much money there is at any time depends on the decisions not only of these institutions but of millions of individuals and businesses that own deposits. Broader asset aggregates like total liquid assets depend on the decisions of an even wider range of institutions, as do liability aggregates like domestic nonfinancial credit. The Federal Reserve System can influence any of these measures, to be sure, but it cannot directly control them in the sense that it can control, for example, the nonborrowed

I am grateful to Diane Coyle for research assistance and helpful discussions; to Andrew Abel, Mark Watson and participants in the Federal Reserve Bank symposium, including especially Stephen Goldfeld, for helpful comments on an earlier draft; and to the National Science Foundation and the Alfred P. Sloan Foundation for research support.

reserve base or the federal funds rate. Hence these measures are at most targets, not instruments, of monetary policy—intermediate steps between the instruments that the central bank can control directly and its ultimate nonfinancial policy targets.

The object of this paper is to assess quantitatively the potential value of specific intermediate targets for monetary policy in the United States. The basic premise motivating this analysis is that a financial variable like money or credit—or, for that matter, a market interest rate—has potential value as an intermediate monetary policy target only to the extent that movements in that variable convey information about the nonfinancial economic developments that constitute the reason for having a monetary policy in the first place. Moreover, to warrant such a variable's use as an intermediate target, the pertinent information its movements contain must not be readily available elsewhere. The questions addressed in this paper are whether any familiar financial variables in fact contain such potentially valuable information and, if so, which ones and how much.

In addition to the specific conclusions provided as answers to these questions, a key contribution of this paper is the method of analysis it introduces. In particular, the paper suggests and implements a method for using structural economic models, restricted by the relevant economic theory, to answer questions that the previous literature has addressed primarily with nonstructural, unrestricted representations of economic behavior. The specific quantitative conclusions reached in this paper about the potential value of intermediate targets in the monetary policy process result from the application of this method to one macroeconometric model that is especially small and simple. The method of analysis suggested here, however, is applicable more generally, to models small and large, simple and complex.

The first section outlines the basic concept of the intermediate target as a way of gathering and processing relevant information in implementing monetary policy. The next section presents the small macroeconometric model of the United States to be used in the quantitative analysis. The third section applies this model to evaluate the potential usefulness of familiar financial variables as intermediate targets when the chief nonfinancial focus of monetary policy is the growth of nominal income. The following section undertakes an analogous evaluation focused separately on real income growth and price inflation. And a final section briefly summarizes the principal conclusions of this analysis and re-emphasizes some of its limitations.

Intermediate targets as information variables

Why should a central bank, in conducting monetary policy, take account of the movements of money or credit?[1]

After nearly a decade of formal reliance on monetary aggregate targets for monetary policy by the Federal Reserve System, and the adoption of analogous targets by an increasing number of central banks around the world, even to pose such a question may at first seem like so much inspecting the interstices of the obvious (hardly an unknown activity in the social sciences). Yet the question is a serious one. In the circumstances under which most central banks today actually conduct monetary policy, the relevance of movements in money or credit is far from self-evident. Still less self-evident is why central banks should elevate measures like money or credit to the level of intermediate policy targets, thereby creating the presumption that, in implementing monetary policy, they not only may but indeed will respond to the movements of these variables.

At least part of the reason why this issue receives relatively little serious attention in current discussions of monetary policy is probably the fault of the professional economics literature, which more often than not relies on hypothetical constructs that either rule the question out altogether or in the end make the answer—within those constructs—genuinely self-evident. At the theoretical level, for example, most models simply treat the money stock as an exogenous variable, directly subject to control by the central bank. In such models there can be no question of the central bank's *responding* to movements of the money stock, because by assumption the central bank *initiates* all such movements. Similarly, most. theoretical models include only one monetary asset, and in some models that asset is the only available form of wealth holding.[2] Such models, of course, cannot address the question of to which movements the central bank may want to respond when there are two or more monetary aggregates that covary imperfectly. At the empirical level, much of the current discussion simply assumes away the great body of evidence documenting the instability of any simple specification of the relationship between nonfinancial economic activity and any measure of money.

---

1. This section relies in part on arguments developed at a formal level in Brunner and Meltzer (1967), Tobin (1970), Poole (1970), Kareken, et al. (1973), and Friedman (1975).

2. It is astonishing that some economists, having hypothesized models including a single form of wealth holding, proceed to label that single asset "money" and then draw logical inferences on which they then base recommendations about actual monetary policy.

The circumstances under which the Federal Reserve actually conducts U.S. monetary policy are quite different. No monetary or credit aggregate is directly subject to central bank control. Instead, the Federal Reserve controls the growth of nonborrowed reserves, or perhaps a short-term interest rate like that on federal funds. There is not just a single monetary asset. Instead, the market offers a great variety of forms of deposits (and, similarly, an enormous variety of forms of borrowing), and the number of potentially definable monetary (or credit) aggregates is limited only by imagination and data collection machinery. No simple money-income or credit-income relationship is consistently reliable over short time horizons. Moreover, given the pace and extent of changes in patterns of U.S. financial intermediation, there is little ground for strong confidence in such relationships over longer horizons either.

Why, then, under these circumstances, radically different from those so often either explicitly assumed in the professional economics literature or casually assumed in discussions of current policy, should the Federal Reserve take account of the movement of money or credit in implementing monetary policy? The potential role of such variables in the policy process stems from the possibility that their movements may provide information, which is otherwise either unavailable or difficult to process, about the nonfinancial targets that the central bank seeks ultimately to affect.

The starting place for making monetary policy is a set of objectives for the nonfinancial economy. In part because of the targeting and reporting requirements imposed on the Federal Reserve by Congress, but also because much other planning takes an annual form, the typical procedure in the United States involves the tentative identification each year of a desired rate of economic growth for the year ahead, in both real and nominal terms.[3] The Federal Reserve then determines, and publicly reports to Congress, the target rates of money and credit growth that are likely—as seen in advance of the fact—to be consistent with that economic growth. Finally, the Federal Reserve determines, and implements via open market operations, the growth of nonborrowed reserves (or the federal funds rate level) that is likely—again, as seen in advance of the fact—to be consistent with the targeted growth of money and credit.[4]

3. Because of lags (inertia), of course, not all desired growth rates of either prices or real income are feasible. The discussion here assumes a choice from within the feasible range.

4. Before October 1979, the Federal Reserve's operating instrument was typically the federal funds rate. Thereafter it was the growth of nonborrowed reserves. Wallich (1984) has stated that from late 1982 on it was borrowed reserves.

As of the beginning of the year, therefore, the Federal Reserve in principle outlines a mutually consistent set of growth rates for real income, prices, money, credit, and nonborrowed reserves, and it uses open market operations to implement the one element in this package under its direct control. The question at issue here is what further usefulness—if any—the money and credit aggregates possess. If actual money or credit growth deviates from the corresponding targeted pace, should the Federal Reserve respond? And if so, why, since the ultimate policy objective is to affect not money or credit growth but real economic growth and price inflation?

Responding to aberrant movements in money or credit growth is a useful policy under these conditions only if such movements forewarn subsequent (or contemporaneous but as yet unobservable) movements of real income or prices. For example, money growth greater than targeted—that is, greater than expected in advance to be consistent with the desired growth of income and prices—may indicate that later on either real income or prices (or both) will advance more strongly than expected. If so, responding to this excessive money growth by reducing the growth of nonborrowed reserves will set in motion forces of adjustment—involving in the first instance higher short-term interest rates, but in addition much broader aspects of asset yield and price relationships—to help restrain the excessive nonfinancial economic activity. Similarly, if money growth less than targeted forewarns coming economic weakness, responding by increasing reserve growth will set in motion forces acting to bolster activity levels. The rationale for responding to either faster or slower credit growth than targeted is analogous.

This familiar monetary policy procedure, based on targeted growth rates for money and credit (or, more commonly, money only) suffers from two potential drawbacks. The first, of course, is that aberrant movements of the targeted aggregate may not indicate future economic strength or weakness after all. Instead, they may merely reflect shifts in the portfolio preferences of either financial institutions or the general deposit-holding and liability-issuing public. In that case, policy responses in the form of changes in reserve growth (or in short-term interest rate levels) will be counterproductive, pushing nonfinancial activity away from, rather than toward, its intended course. Whether or not the Federal Reserve should respond to such unexpected movements of money or credit therefore depends, in the first instance, on what information about future economic activity these movements convey. A large and long-standing empirical literature has examined this question, primarily using "nonstructural" methods that rely on no specific economic model.[5]

The second potential shortcoming in the use of monetary and credit aggregates as intermediate policy targets is that whatever information about future activity levels these aggregates do convey may simply duplicate information readily available from other convenient sources. Given the large element of inertia in short-run fluctuations of economic activity, surely the first place to look for information about income growth in the near future is in the recent movements of income itself. In other words, the relevant question is not just whether a potential intermediate target provides information about future income growth but whether it provides information not already contained in recent movements of income itself. A large empirical literature has addressed this question too, again primarily using nonstructural methods.[6] It is also possible to frame this question in a much broader way by asking whether yet other readily available data may also contain the same information that movements of money or credit convey, but the policy implications of empirical findings in this broader context are less straightforward because of the difficulty inherent in strategies explicitly relating monetary policy responses to large numbers of different variables.

The task undertaken in this paper is to address these questions about the information contained in potential intermediate targets of monetary policy, using a small "structural" macroeconometric model of the United States. The key advantage of basing the analysis on a structural model, in comparison to the more prevalent use of nonstructural methods in the recent literature, lies in the presumably superior representation of expected economic behavior, and hence the superior division of the respective movements of variables like income, money, and credit into corresponding expected and "surprise" components, that the structural model provides. The answer to any question about the information contained in unexpected movements in money or credit can be only as valid as the underlying distinction of expected versus unexpected movements on which it relies. By relying on nonstructural (usually vector autoregression) models for this purpose, the recent literature implicitly assumes that the best available representation of the expected movement of any variable is an unrestricted linear projection from past values of itself and other variables, and identifies any difference between this projection and the corresponding actual movement as unexpected. A structural model instead uses the

5. Traditional references include Friedman and Schwartz (1963) and Andersen and Jordan (1968).

6. See, for example, Sims (1972, 1980) and Friedman (1983 and forthcoming).

relevant economic theory to restrict the representation of a variable's expected movement, and hence also to identify the unexpected part of its actual movement.

A further advantage of basing the analysis on a structural model is that structural models typically make clear the relationships among the operating instruments, potential intermediate targets, and nonfinancial objectives of monetary policy. Empirical findings therefore have a ready interpretation in terms of the policy process, and specific results correspond in a straightforward way to rules for central bank response. By contrast, evidence generated without using any structural model is at best difficult to translate into policy implications.

The countervailing disadvantage of the structural approach, of course, is that the particular structural model used may rely on theory that is irrelevant or invalid. In that case the restrictions imposed may make the model's representation of expected economic behavior, and hence the corresponding distinction of expected versus unexpected movements in any given variable, not superior but inferior to their unrestricted, nonstructural analogs. Similarly, if a model does not adequately represent the relevant macroeconomic behavior, policy rules suggested by its properties may be misdirected and even counterproductive. Given its compactness and simplicity, the model used here is clearly illustrative rather than definitive.

The next section presents a small macroeconometric model, and the following two sections go on to analyze its implications for the information value of potential monetary policy targets. An important caveat is in order, however, before proceeding to that task. Even the finding that aberrant movements of money or credit contain information about future economic activity, and that such information is not readily available elsewhere, does not warrant taking account of this information by establishing money or credit as an intermediate target in any strict sense. The Federal Reserve should respond to such information, to be sure, and it may even be useful to establish a form of targeting procedure to institutionalize the presumption that it will do so. In general, however, the appropriate policy response is different—under most realistic circumstances, more modest—than that required to return money or credit fully to the corresponding targeted path.[7]

7. One reason for the more modest response, analyzed by Poole (1970) and Friedman (1975), is that in general such an abberant movement reflects some combination of unexpected economic strength or weakness and unexpected shifts in portfolio preferences. A second reason, analyzed by Brainard (1967), is that policymakers do not know with certainty the correct values of the parameters describing the economic effects of policy actions.

A macroeconometric model

Table 1 shows estimates, based on U.S. quarterly data spanning 1961:I-1979:III, for the six-equation Pirandello Model first presented in Friedman (1977) and subsequently updated in Clarida and Friedman (1983). The model includes empirical estimates for relationships describing aggregate demand, aggregate supply, money demand, money supply, and the term structure of interest rates, plus a nominal income identity.[8] For convenience, all equations are linear in logarithms, and no variable is lagged more than once. Hence the model is a simple linear first-order difference equation system.

The reason for limiting the model's estimation to data through 1979:III is that there is evidence of a break after that date in all five of the estimated relationships? To the extent that the conditions newly characterizing the immediate post-1979:III period continue to prevail, the model is therefore a description of historical behavior only. More recently, however, the Federal Reserve System appears to have moved away from the new policy procedures adopted in October 1979.[10] The model may therefore be applicable to current behavior as well, even though not to that of the few years immediately following 1979:III.

The model's aggregate demand equation includes an interest rate, or IS curve, effect (here based simply on a nominal long-term interest rate), as well as a fiscal policy effect and a terms-of-trade effect. The aggregate supply equation relates price setting to real economic activity and also to the terms of trade. The money demand equation has the standard real LM curve specification. The money supply equation combines a nonborrowed reserves multiplier effect with a borrowed reserves response associated with the discount rate and an excess reserves response associated with the short-term market interest rate." The term structure equation, which provides a link between the long-term interest rate in the aggregate demand

8. The only change in specification from the original 1977 model is due to the use of M1 rather than M2 as the monetary variable. The estimates shown in Table 1 are from the appendix to Clarida and Friedman (1983).

9. By contrast, there is no evidence of a break after 1976:II, the endpoint of the sample originally used in Friedman (1977). *See* the comparison of F-statistics in Table 5, Clarida and Friedman (1983).

10. *See* again Wallich (1984).

11. The coefficients of the two interest rate terms in the money supply equation are not significant individually but are highly significant jointly. The test statistic for the null hypothesis that both coefficients are zero is $\chi^2(2) = 16.2$.

TABLE 1
Equations of the Pirandello Model

(1) ***Aggregate demand***

$$\Delta X_t = .0064 - .1026\,\Delta r_{Lt} + .1024\,\Delta E_t - .0688\,\Delta I_{t-1} + .4397\,\Delta X_{t-1}$$

(4.8) (−2.9) (2.0) (−2.2) (5.0)

SE = .00780 $\bar{R}^2 = .49$ $\rho = -.4$

(2) ***Aggregate supply***

$$\Delta P_t = .0895\,\Delta X_{t-1} + .0542\,\Delta I_{t-1} + .8700\,\Delta P_{t-1}$$

(3.4) (3.9) (25.2)

SE = .00347 $\bar{R}^2 = .88$ $\rho = -.1$

(3) ***Money demand***

$$\Delta(M-P)_t = .1192\,\Delta X_t - .0406\,\Delta r_{St} + .8703\,\Delta(M-P)_{t-1}$$

(1.9) (−3.9) (7.7)

SE = .00676 $\bar{R}^2 = .53$ $\rho = -.5$

(4) ***Money supply***

$$\Delta M_t = .0034 + .2118\,\Delta R_t + .0097\,\Delta r_{St} - .0234\,\Delta r_{Dt} + .7627\,\Delta M_{t-1}$$

(2.3) (2.1) (0.6) (−1.3) (8.6)

SE = ,00481 $\bar{R}^2 = .53$ $\rho = -.2$

(5) ***Term structure***

$$r_{Lt} = .0472 + .1441\,r_{St} - .0579\,r_{S,t-1} + .1376\,\Delta(L-S)_{t-1} + .9100\,r_{L,t-1}$$

(1.4) (1.1) (−0.5) (2.3) (37.0)

SE = .020 $\bar{R}^2 = .98$ $\rho = .4$

(6) ***Nominal income identity***

$$\Delta Y_t = \Delta X_t + \Delta P_t$$

Notes: Equations are estimated using Fair's (1970) method for simultaneous equations with lagged dependent variables and serially correlated disturbances.
Sample period is 1961:I-1979:III.
Numbers in parentheses are t-statistics.
All variables are in logarithms.
Predetermined variables are E, I, L, R, r_D, and S.

Definitions of Symbols:
E = high-employment federal expenditures
I = import price deflator
L = outstanding long-term federal debt
M = money stock (M1)
P = GNP price deflator
R = stock of nonborrowed reserves
r_D = discount rate
r_L = Baa corporate bond rate
r_S = three-month Treasury bill rate
S = outstanding short-term federal debt
X = real GNP
Y = nominal GNP.

equation and the short-term interest rate in the money demand and money supply equations, combines a form of the standard expectations hypothesis with a debt management policy effect.[12] The nominal income identity is straightforward.

As estimated here, these six relationships determine six variables: the growth rate of nominal and real income, prices, and money, and short- and long-term interest rates. Exogenous variables include monetary policy (nonborrowed reserves and the discount rate), fiscal policy (high-employment government expenditures), debt management policy (the maturity composition of outstanding government debt), and the dollar price of imports.

An alternative way of specifying the stochastic structure of the model is to assume that the direct instrument set by the Federal Reserve's open market operations is not the growth of nonborrowed reserves but the short-term interest rate. In that case, the short-term rate would be an exogenous conditioning variable, while nonborrowed reserves would be one of the six variables jointly determined by the model. Because the Federal Reserve is free to choose either nonborrowed reserves or the short-term interest rate as its operating instrument, and because there is some ambiguity about how Federal Reserve policy has actually operated in the past, it is interesting to know the model's implications for key policy questions under either specification. The two sections below therefore report parallel sets of results along just these lines. Changing the assumed stochastic structure of the relationships among the model's variables in general changes the corresponding estimated coefficients, however, so that the alternative sets of results based on an interest rate instrument rely on a different set of coefficient estimates (not shown) than the ones based on a reserves instrument shown in Table 1.[13]

The Pirandello Model's compactness and simplicity result, of course, from the imposition of many restrictions on the data. Those restrictions

12. The coefficients on the two short-term interest rate terms in the term structure equation are not significant individually but are highly significant jointly. The test statistic for the null hypothesis that both coefficients are zero is $\chi^2(2) = 10.4$.

13. As an historical matter, of course, only one (at most) of these two descriptions of the monetary policy process can be correct for the model's estimation period. It is in general not valid to draw inferences from a model estimated assuming a stochastic structure different from that which characterized actual behavior during the estimation period. The relevant question here is which of the two policy instruments was exogenous during that period.

necessarily limit—although, apparently, to a surprisingly small degree—the model's ability to represent actual macroeconomic behavior.[14] The corresponding advantage purchased by those restrictions is not just convenience, but the facility that the resulting model's form provides for explicitly analyzing policy questions like the ones addressed here.

Intermediate targets for nominal income

A familiar, albeit simplified, representation of the process of choosing and implementing monetary policy targets begins by positing a desired growth rate for nominal income for some period ahead, then translates that desired income growth into the implied growth of the money stock, and in turn translates that money growth into the implied growth of nonborrowed reserves. The two translation steps involved could be as simple (simple-minded?) as merely allowing for average trend movements, first in monetary "velocity" and then in the 'money multiplier," or they could incorporate sophisticated econometric and/or judgmental predictions of the dynamic money-income and money-reserves relationships. Carrying out this task using the model shown in Table 1 would stand somewhere in between.

Given such a model, and given the values of the four exogenous variables other than nonborrowed reserves over the relevant time period, it is straightforward to determine what rate of reserves growth the Federal Reserve System should implement in order to make the conditionally expected nominal income growth over this period equal to any chosen rate. The model also indicates what rate of money growth to expect over this period, given the implemented reserves growth as well as the assumed values of all other predetermined variables—including, importantly, the serially correlated disturbances to the model's five stochastic relationships.

As the first entry in the middle column of Table 2 shows, the standard deviation of the model's forecasting error for nominal income growth an indefinite number of quarters ahead (that is, the final-form residual corresponding to a forecast for a period sufficiently far in the future to eliminate altogether the role of information about the model's endogenous variables) is 1.19 percent.[15] In the absence of any other information external to

14. See the discussion in Clarida and Friedman (1983). For a comparative analysis of the model's predictive behavior see Mahoney et al. (1983).

15. The final form of the simple model used here is just its solved-out autoregressive representation. If the structural model is written as $y_t = Ay_t + By_{t-1} + Cx_t + u_t$ where y and x are vectors of endogenous and exogenous variables, respectively, and u is a vector of disturbances, to the structural relationships, then the model's final form is
$y_t = \sum_{i=0}^{W} [(I - A)^{-1}B]^i (I - A)^{-1} Cx_t + \sum_{i=0}^{\infty} [(I - A)^{-1}B]^i (I - A)^{-1} u_t$. (Continued on next page.)

TABLE 2
Standard Errors for Nominal Income Residual Autoregressions

Included lags	*Model from Table I*	*Model with credit*
None	0.0119	0.0122
1	0.0104	0.0108
1,2	0.0102	0.0107
1,2,3	0.0101	0.0106
1,2,3,4	0.0100	0.0104
2,3,4	0.0105	0.0109
3,4	0.0106	0.0110
4	0.0109	0.0112

the model, therefore, nominal income growth at a long horizon out would be within about a ± 1¼ percent range of the forecast value two-thirds of the time. The remaining entries in the column also show that the availability of observations on ***recent*** income growth helps somewhat in predicting ***future*** income growth. Making the forecast of future income growth conditional also on observations of recent income growth reduces this range to about ± 1 percent for periods up to four quarters ahead. In other words, the model's final-form residuals are serially correlated, so that taking account of whether income growth has been higher or lower than expected in the recent past (that is, allowing for previous final-form residuals) reduces the model's forecasting error in comparison with the corresponding uninformed forecast. Because allowing for this additional information in general changes the model's conditional forecast of income growth, it also in general changes the reserves growth necessary to make the conditional expectation of income growth equal the same chosen rate as before.

What, then, is the potential role for the rate of money growth—or any other intermediate policy target—in the policy process? If observed money growth different from prior expectations also provides information that bears on future income growth, then a forecast of future

---

The final-form forecast (the expected movement in y) for any period is then

$$\hat{\underline{y}}_t = \sum_{i=0}^{\infty} [(I-A)^{-1}B]^i (I-A)^{-1} C\underline{x}_t$$

and the corresponding final-form residual (the unexpected movement) is

$$\underline{\epsilon}_t = \underline{y}_t - \hat{\underline{y}}_t = \sum_{i=0}^{\infty} [(I-A)^{-1}B]^i (I-A)^{-1} \underline{u}_t X$$

Because estimation of the model provides values of $\underline{u}$ only from 1961:I on, the calculation of $\underline{\epsilon}$ (and therefore all results based on $\underline{\epsilon}$ reported in Tables 2-7 below) begins in 1964:I, thereby avoiding possible problems associated with truncation of the infinite sum. (An alternative procedure would be to calculate $\underline{\epsilon}$ from $\underline{x}$ values extending back before 1961:I, but data are not available for all of the exogenous variables for enough prior quarters.) Analogous results for calculations beginning in 1966:I show no essential difference.

income growth conditional on recent money growth will likewise be superior to the corresponding uninformed forecast. In addition, as in the case of information contained in recent income growth, allowing for the information contained in recent money growth in general changes the reserves growth necessary to make the conditional expectation of future income growth equal the same chosen rate as before, and hence in general warrants a policy response in the form of a different rate of reserves growth.

The initial question to ask, therefore, is whether money growth in fact contains such potentially useful information. Moreover, as the discussion in the first section explains, establishing a presumption that the Federal Reserve will respond to whatever information is contained in money growth, rather than simply responding to observed income growth, makes sense only if the information contained in money growth is not also contained in income growth itself.

The first column of Table 3 reports standard errors for a series of equations relating the model's final-form income growth residuals to lagged values of the corresponding final-form residuals for money growth and, in all but the first two equations, lagged values of the income growth residual itself. For a model as simple as the one used here, it would be possible to infer these standard errors (or their equivalents) directly from the properties of the model's estimated coefficients, but the point of using instead regressions like those underlying Table 3 is to illustrate a method of analysis that is readily applicable to more complex models as well. The first two values shown indicate, in comparison to the standard error of 1.19 percent reported for the uninformed forecast in Table 2, that movements of money growth do contain information about future income growth. Even so, comparison with the other standard errors reported in Table 2 shows that this information is little greater than that contained in recent movements of income growth.

The issue, however, is not whether money growth contains more or less information than income growth, but whether money growth contains *additional* information not contained in income growth. The next two values shown in the first column of Table 3 are standard errors for equations relating nominal income residuals to lagged values of the money growth residual and the income growth residual itself, entered with comparable timing. Comparison with the corresponding standard errors based on lagged income growth alone, shown in Table 2, indicates that the additional information contained in money growth is significant statistically

TABLE 3
Standard Errors for Nominal Income Residual Regressions With Information from Endogenous Financial Variables (Reserves Exogenous)

	Information variable (Z)			
Variables in regression	ΔM	Δr_S	Δr_L	ΔC
Z_{-1}	0.0102**	0.0117	0.0103**	0.0092**
Z_{-1}, Z_{-2}	0.0097**	0.0117*	0.0101**	0.0092**
$Z_{-1}; Y_{-1}$	0.0098**	0.0104	0.0098**	0.0093**
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; Y_{-1}, Y_{-2}, Y_{-3}, Y_{-4}$	0.0094**	0.0098	0.0096*	0.0091**
$Z_{-1}, Z_{-2}; Y_{-2}$	0.0096**	0.0109	0.0099**	0.0091**
$Z_{-1}, Z_{-2}, Z_{-3}; Y_{-3}$	0.0096**	0.0109	0.0097**	0.0092**
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; Y_{-3}, Y_{-4}$	0.0094**	0.0103	0.0095**	0.0092**

* Z variables significant at 0.05 level.
** Z variables significant at 0.01 level.

but not economically.[16] A reduction in the standard error of the informed forecast from 1.04 percent to 0.98 percent (or from 1.02 percent to 0.94 percent) is hardly ground for establishing money growth as an intermediate policy target.

These comparisons are not necessarily apt, however, if data on money growth become available before data on income growth. It may still be useful for the Federal Reserve to react to the information contained in money growth if the' information contained in income growth, which it duplicates, is unavailable. Even with a further one- or two-quarter lag imposed on the income growth residuals but not the money growth residuals, however, there is still apparently little additional information contained in money growth. The last three values shown in the first column of Table **3** are standard errors for regressions relating nominal income growth to lagged money growth and to lagged income growth itself with just such

16. The significance levels reported in Table 3 (and in Tables 4, 6 and 7 below) are for the t- or F- statistics pertaining to the information variables (for example, unexpected money growth) in the regressions indicated. These significance levels strictly rest on the assumption that the remaining unexplained residual variation in these regressions is not serially correlated. This assumption is apparently plausible in most cases. For example, of the Durbin-Watson values for the seven regressions in the first column of Table 3 (the seven regressions based on unexpected money growth), only one indicates serial correlation that is statistically significant at the .05 level. The significance levels reported in Tables 3, 4, 6, and 7 also strictly rest on the assumption that the model's exogenous variables, including policy variables, are not affected by feedback from the endogenous variables. This assumption, of course, is more dubious.

differential lags. Once again, the additional information contained in money growth is statistically significant, but hardly enough to matter economically.

Money growth is not the only financial variable that may contain potentially useful information in this context, of course, and in principle the Federal Reserve may instead choose to alter the growth of nonborrowed reserves in an analogous way in response to some other readily observable financial variable. The model used here, with nonborrowed reserves taken to be the direct operating instrument of monetary policy, generates forecast values (and hence, after the fact, final-form residuals) not just for money growth but also for short- and long-term interest rates. The second and third columns of Table 3 present results, analogous to those based on money growth in the first column, for tests of the information about future nominal income growth contained in either of the two interest rates.

These results provide no ground at all for the Federal Reserve's responding to movements in short-term interest rates, and they suggest that the case for responding to long-term rates is about comparable to that for responding to money. The standard errors for the equations including the short-term rate residuals, shown in the second column, are uniformly larger than those of the corresponding equations including the money growth residuals, and the information contained in short-term rates is typically not statistically significant. The standard errors for the equations including the long-term interest rate residuals are only marginally larger than those of the corresponding equations including money growth, and the information contained in long-term rates is always statistically significant. The reduction in standard error, however, is again never sizeable enough to make the indicated responses very interesting in a policy context.

The three financial variables that are endogenous in this model—money growth and short- and long-term interest rates—do not constitute the entire universe of potentially useful intermediate target variables for monetary policy. The final column of Table 3 reports analogous results for tests of the information about future nominal income growth contained in movements of aggregate credit growth. These results are based on a model identical to that shown in Table 1, except that the financial quantity used in the third and fourth equations is total domestic nonfinancial credit, so that these equations become, in effect, "credit demand" and "credit supply" equations.[17] The resulting model is highly similar to that shown in Table 1,

17. This procedure is clearly inferior to the more ambitious undertaking of respecifying these equations to represent the demand for and supply of credit more appropriately. It does, however, render the results more directly comparable with those based on the model including money.

as the properties of the final-form income growth residuals reported in the right-hand column of Table 2 indicate. In addition, the results (not shown) of regression tests for the information content of the short- and long-term interest rate residuals in this altered model are very similar to the corresponding results shown in the second and third columns of Table **3.**

The results based on this altered model, reported in the final column of Table 3, indicate that the credit aggregate apparently offers the best prospect of any of the candidates considered here as a potential intermediate target for monetary policy. The standard errors for the equations including credit growth residuals are uniformly smaller than those for the corresponding equations including the residuals for any of the other three variables, despite the slightly larger bases of comparison shown in the right-hand column of Table 2. Moreover, the ***additional*** information contained in recent movements of credit, beyond what is already contained in nominal income itself, is typically greater than that contained in any of the other three variables. With a single parallel lag on both credit and income, for example, the reduction in standard error is from 1.08 percent to 0.93 percent. With four lags and a two-quarter delay on the receipt of income data, the comparable reduction is from 1.10 percent to 0.92 percent.

Finally, it is also interesting to consider the value of potential intermediate targets for monetary policy when the Federal Reserve conducts open market operations by setting the short-term interest rate rather than the growth of nonborrowed reserves. The first three columns of Table 4 present results, analogous to those shown in Table 3, based on an alternative version of the Pirandello Model estimated with the short-term interest rate taken as exogenous and reserves growth, along with money growth and the long-term interest rate, endogenous. The final column of Table 4 presents further analogous results based on this alternative model estimated with credit in place of money. The results show that, if the Federal Reserve's direct operating instrument is the short-term interest rate, only the long-term interest rate (among the four variables considered here) consistently exhibits potentially useful information about future movements of nominal income.

Intermediate targets for real income and prices

The above analysis proceeds from the simplying assumption that it is possible to summarize the Federal Reserve System's objectives for the nonfinancial economy in terms of desired growth of nominal income. This practice is broadly familiar, both because it sidesteps the arbitrariness inevitably involved in weighting two or more ultimate policy objectives, and

TABLE 4
Standard Errors for Nominal Income Residual Regressions With Information from Endogenous Financial Variables (Short Rate Exogenous)

	Information variable (Z)			
Variables in regression	ΔM	ΔR	Δr_L	ΔC
Z_{-1}	0.0109	0.0109	0.0090**	0.0106*
Z_{-1}, Z_{-2}	0.0106	0.0107	0.0091**	0.0100**
$Z_{-1}; Y_{-1}$	0.0108	0.0109	0.0089**	0.0107
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; Y_{-1}, Y_{-2}, Y_{-3}, Y_{-4}$	0.0102	0.0105	0.0092**	0.0103
$Z_{-1}, Z_{-2}; Y_{-2}$	0.0105	0.0106	0.0092**	0.0101
$Z_{-1}, Z_{-2}, Z_{-3}; Y_{-3}$	0.0103	0.0105	0.0092**	0.0101
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; Y_{-3}, Y_{-4}$	0.0102	0.0104	0.0092**	0.0102

* Z variables significant at 0.05 level.
** Z variables significant at 0.01 level.

also because some economists have hypothesized that monetary policy can only affect nominal income without affecting the division of nominal income between real and price elements.

Familiar as it is, however, focusing only on nominal income is not fully satisfactory for purposes of a discussion of intermediate targets for monetary policy. The most immediate reason is that the choice of an appropriate growth rate for the money stock, the most traditional intermediate target variable, is not invariant to the real-price composition of the associated nominal income growth. Although it is standard to assume a unit price elasticity of the demand for money, empirical evidence consistently indicates an income elasticity of (M1) money demand well below unity.[18] Hence the money growth that would be consistent with any chosen nominal income growth is greater as the underlying rate of price inflation is greater and the corresponding real growth smaller. More fundamentally in the policy context considered here, the appropriate central bank response to information about future price inflation in general differs from the appropriate response to information about future growth of real economic activity.

It is also interesting, therefore, to look beyond the information that potential monetary policy target variables contain about nominal income to see what information they contain about, at the least, real income and prices. Table 5 provides a basis for the relevant comparisons by showing

18. For recent years only, there is also some evidence of a non-unit price elasticity.

TABLE 5
Standard Errors for Real Income and Price Residual Autoregressions

	Model from Table 1		Model with credit	
Included lags	ΔX	ΔP	ΔX	ΔP
None	0.0093	0.0059	0.0101	0.0054
1	0.0091	0.0039	0.0098	0.0038
1,2	0.0091	0.0037	0.0099	0.0037
1,2,3	0.0091	0.0036	0.0099	0.0036
1,2,3,4	0.0091	0.0036	0.0099	0.0036
2,3,4	0.0092	0.0040	0.0100	0.0039
3,4	0.0092	0.0041	0.0100	0.0040
4	0.0093	0.0044	0.0100	0.0043

standard errors of the Pirandello Model's final-form residuals for real income growth and price inflation (and the corresponding residuals of the model with credit) analogous to those shown in Table 2 for the model's nominal income residuals.[19] The residuals for price inflation exhibit substantial serial correlation, but the real income residuals do not.

The upper panel of Table 6 presents standard errors, analogous to those in Table 3, for equations relating the model's final-form real growth residuals to lagged values of the final-form residuals for the model's endogenous financial variables and, in most cases, to lagged values of the real growth residual itself. The results show that movements in both money growth and credit growth, and especially in the long-term interest rate, consistently provide statistically significant information about future real income growth beyond that contained in recent values of real income growth. Comparison to Table 5 shows, however, that the associated reduction of the real growth forecasting error due to observed money growth or credit growth is too small to warrant much attention in a policy context. By contrast, that due to observed long-term interest rates—for example, from 1.00 percent to 0.82 percent with a two-quarter lag on real income data—is small but perhaps worth a policy response.

The lower panel of Table 6 presents standard errors for equations analogously relating the model's final-form residuals for price inflation to lagged values of the other residuals and lagged values of the inflation residual itself. These results show that movements in both money growth and credit growth, and in the short-term interest rate, consistently provide statistically significant information about future inflation beyond that contained in recent inflation. Here it is questionable, however, whether

19. The final-form residuals used as the basis for these calculations are again for the model estimated with reserves exogenous.

TABLE 6
Standard Errors for Real Income and Price Residual Regressions With Information from Endogenous Financial Variables (Reserves Exogenous)

	Information variable (Z)			
Variables in real income regressions	ΔM	Δr_S	Δr_L	ΔC
Z_{-1}	0.0087**	0.0093	0.0082**	0.0094**
Z_{-1}, Z_{-2}	0.0086**	0.0094	0.0080**	0.0094**
$Z_{-1}; X_{-1}$	0.0087**	0.0092	0.0083**	0.0094*
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; X_{-1}, X_{-2}, X_{-3}, X_{-4}$	0.0088*	0.0092	0.0083**	0.0096*
$Z_{-1}, Z_{-2}; X_{-2}$	0.0087*	0.0094	0.0081**	0.0095*
$Z_{-1}, Z_{-2}, Z_{-3}; X_{-3}$	0.0087*	0.0094	0.0082**	0.0096*
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; X_{-3}, X_{-4}$	0.0087*	0.0092	0.0082**	0.0095*
Variables in price regressions				
Z_{-1}	0.0053**	0.0057*	0.0056*	0.0035**
Z_{-1}, Z_{-2}	0.0051**	0.0056*	0.0057	0.0035**
$Z_{-1}; P_{-1}$	0.0038*	0.0037**	0.0039	0.0033**
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; P_{-1}, P_{-2}, P_{-3}, P_{-4}$	0.0034**	0.0033**	0.0036	0.0033**
$Z_{-1}, Z_{-2}; P_{-2}$	0.0038**	0.0038**	0.0042	0.0034**
$Z_{-1}, Z_{-2}, Z_{-3}; P_{-3}$	0.0036**	0.0035**	0.0041	0.0033**
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; P_{-3}, P_{-4}$	0.0035**	0.0034**	0.0039	0.0034**

* Z variables significant at 0.05 level.
** Z variables significant at 0.01 level.

the resulting reduction of the model's inflation forecasting error due to the information in any of these financial variables—at most, from 0.41 percent to 0.34 percent for the short-term interest rate and with a two-quarter lag on inflation data—is of value in a policy context.

Finally, Table 7 presents standard errors for both real income growth and price inflation residuals that are analogous to those shown in Table 6 but based on the alternative version of the Pirandello Model estimated under the assumption that the direct operating instrument of monetary policy is the short-term interest rate. Here the long-term interest rate stands out in consistently providing statistically significant information about future real income growth. Credit growth, and, to a slightly lesser extent, money growth and reserves growth, all provide statistically significant information about future price inflation.

Conclusions and caveats

The basic premise underlying the analysis in this paper is that any financial variable has potential value as an intermediate target for monetary policy only if observed movements of that variable contain informafion about the likely future movements of whatever aspects of nonfinancial economic

TABLE 7
Standard Errors for Real Income and Price Residual Regressions With Information from Endogenous Financial Variables (Short Rate Exogenous)

	Information variable (Z)			
Variables in real income regressions	ΔM	AR	Δr_L	ΔC
Z_{-1}	0.0101	0.0102	0.0079**	0.0095**
Z_{-1}, Z_{-2}	0.0102	0.0100	0.0079**	0.0094**
$Z_{-1}; X_{-1}$	0.0096	0.0096	0.0079**	0.0093*
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; X_{-1}, X_{-2}, X_{-3}, X_{-4}$	0.0095	0.0095	0.0079**	0.0094
$Z_{-1}, Z_{-2}; X_{-2}$	0.0100	0.0103	0.0079**	0.0095*
$Z_{-1}, Z_{-2}, Z_{-3}; X_{-3}$	0.0099	0.0099	0.0080**	0.0094*
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; X_{-3}, X_{-4}$	0.0097	0.0097	0.0079**	0.0095
Variables in price regressions				
Z_{-1}	0.0043	0.0042**	0.0044	0.0041**
Z_{-1}, Z_{-2}	0.0039**	0.0038**	0.0044	0.0034**
$Z_{-1}; P_{-1}$	0.0037	0.0036*	0.0037	0.0035**
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; P_{-1}, P_{-2}, P_{-3}, P_{-4}$	0.0032**	0.0035*	0.0037	0.0032**
$Z_{-1}, Z_{-2}; P_{-2}$	0.0039	0.0038'	0.0040	0.0034''
$Z_{-1}, Z_{-2}, Z_{-3}; P_{-3}$	0.0034**	0.0035**	0.0040	0.0032**
$Z_{-1}, Z_{-2}, Z_{-3}, Z_{-4}; P_{-3}, P_{-4}$	0.0032**	0.0036*	0.0040	0.0033**

* Z variables significant at 0.05 level.
** Z variables significant at 0.01 level.

activity the central bank seeks ultimately to affect. Further, keying monetary policy responses to observed movements of any such variable is sensible only if the relevant information it contains is not also contained in other readily available sources—in the first instance, from observed movements of nonfinancial activity itself.

The empirical results presented in this paper, based on a small quarterly macroeconometric model of the United States, indicate the absence of compelling evidence in favor of singling out any single variable as "the intermediate target" of monetary policy. Of the variables considered here—including money (M1), credit, a long-term interest rate, and whichever of either reserves or a short-term interest rate the Federal Reserve System does not set directly by open market operations—most do contain at least some statistically significant information about the future growth of nominal income, real income, or prices. In most cases, however, this information is significant statistically but not economically. In other words, the reduction in forecasting error gained from using it is typically too small to be of great moment in a policy context.

The paper's principal conclusion, therefore, is to cast doubt on the practice of designating specific financial variables as intermediate targets of monetary policy. To the extent that such targets are necessary for other reasons, however—for example, to facilitate Congressional oversight of the Federal Reserve's policy decisions—the strength of this conclusion varies from one potential intermediate target to another. Among the variables considered here, credit growth and the long-term interest rate appear to offer the best prospects of providing information that would be useful in formulating and implementing monetary policy. For example, when the direct operating instrument is growth of nonborrowed reserves and the ultimate policy objective is stated in terms of nominal income, the reduction in forecast standard error associated with the information contained in credit growth is 0.18 percent. Even so, specific results like this one for credit growth are not invariant to the assumed operating instrument and ultimate nonfinancial objective, nor to the assumed pattern of data availability, so that any positive implications for the use of intermediate targets for monetary policy are at best highly conditional.

Several further caveats about the findings reported here are also worth repeating. First, the analysis in this paper focuses only on the question of information contained in single financial variables. It therefore omits entirely the possibility that the movements of two (or more) such variables, in conjunction, may provide potentially valuable information not contained in either alone. Because the Federal Reserve currently specifies either target ranges or monitoring ranges for four financial aggregates, this possibility certainly bears investigation. Empirical findings along such lines would also have implications for the difficult question of how the Federal Reserve should respond when two of its designated target variables give conflicting signals.

Second, it is important to re-emphasize that the appropriate monetary policy response to the information contained in unexpected movements of any designated financial variable is in general ***not*** to take actions that would return that variable to its previously expected path—that is, to treat it as an intermediate target in the traditional sense. Unless there is a one-for-one relationship between observed movements in the financial variable and likely future movements of the relevant aspects of nonfinancial *economic* activity, the appropriate policy response is instead to use the information that the financial variable provides by taking action expected to return not it but nonfinancial activity to the previously targeted path.

Finally, the analysis reported here relies on an econometric model that is extremely compact and simple. The model apparently does a surprisingly good job at capturing some of the main features of macroeconomic behavior, but it necessarily omits many more. The method of analysis suggested in this paper for using a structural model to address questions for which the previous literature has relied on nonstructural models, however, is more general. The applications here to one small, simple model need be no more than an illustration. A parallel analysis based on a more powerful, and presumably more trustworthy, model would be a straightforward extension of this research.

References

Andersen, Leonall C., and Jordan, Jerry L., 'Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization: Federal Reserve Bank of St. Louis, ***Review,*** 50, November 1968, pp. 11-24.

Brainard, William C., 'Uncertainty and the Effectiveness of Policy,* ***American Economic Review,*** 57, May 1967, pp. 411-25.

Brunner, Karl, and Meltzer, Allan H., 'The Meaning of Monetary Indicators," Horwich ed., ***Monetary Process and Policy***, Homewood: Richard D. Irwin, Inc., 1967.

Clarida, Richard H., and Friedman, Benjamin M., 'Why Have Short-Term Interest Rates Been So High?" ***Brookings hpers on Economic Activity,*** No. 2, 1983, pp. 553-78.

Fair, Ray C., 'The Estimation of Simultaneous Equations Models with Lagged Endogenous Variables and First-Order Serially Correlated Errors," *Econometrica*, 38, May 1970, pp. 507-16.

Friedman, Benjamin M., "Targets, Instruments, and Indicators of Money Policy." ***Journal of Monetary Economics,*** 1, October 1975, pp. 443-73.

_________ 'The Inefficiency of Short-Run Monetary Targets for Monetary Policy," ***Brookings hpers on Economic Activity,*** No. 2, 1977, pp. 293-335.

_________ "The Roles of Money and Credit in Macroeconomic Analysis," Tobin ed., ***Macroeconomics, Prices and Quantities: Essays in Memory of Arthur M. Okun,*** Washington: The Brookings Institution, 1983.

_________ 'Money, Credit, and Interest Rates in the Business Cycle: Gordon, ed., ***Business Cycles,*** University of Chicago Press, forthcoming.

Friedman, Milton, and Schwartz, Anna Jacobson, ***A Monetary History of the United States 1867-1960***, Princeton University Press, 1963.

Kareken, John H., Muench, Thomas, and Wallace, Neil, 'Optimal Open Market Strategy: The Use of Information Variables; ***American Economic Review***, 63, March 1973, pp. 156-72.

Mahoney, Kevin, Meyer, Lawrence H., and Smirlock, Michael, "A Comparison of Small Income Expenditure and Monetarist Econometric Models," Meyer ed., ***A Comparison of the Predictive Performance of Small Macroeconometric Models,*** Vol. 2, Mimeo: Washington University, 1983.

Poole, William, 'Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model, ***Quarterly Journal of Economics,*** 84, May 1970, pp. 197-216.

Sims, Christopher A., "Money, Income and Causality," ***American Economic Review,*** 62, September 1972, pp. 540-52.

Sims, Christopher A., 'Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered: *American Economic Review*, 70, May 1980, pp. 250-57.

Tobin, James, 'Money and Income: Post Hoc Ergo Propter Hoc?" *Quarterly Journal of Economics*, *84*, May 1970, pp. 301-17.

Wallich, Henry C., 'Recent Techniques of Monetary Policy," Federal Reserve Bank of Kansas City, *Economic Review*, May 1984, pp. 21-30.