PHILIPPINE REVIEW OF ECONOMICS
Vol. XXXVIII. No. 2. December 2001

Alternative Monetary Policy Rules for the Philippines

Francisco G. Dakila, Jr. *

Abstract

A theoretical basis for modifying the currently popular nominal feedback rules is provided for the conduct of monetary policy so that they react to the forecasted inflation rate, instead of to current or past actual inflation. It is shown that such a modification reduces the risk of economic instability arising from the adoption of a nominal feedback rule, and thus produces results that are closer to the optimal solution. It is furthermore shown that given rational expectations, a forward-looking rule, and a money demand function that is not completely interest-inelastic, the optimal monetary policy entails some degree of policy activism. Friedman's constant money growth rule is therefore shown to be optimal only in a special case, i.e, when the money demand function is completely insensitive to the rate of interest. Empirical simulations are conducted, which support the view that forward-looking nominal instrument rules provide better performance in terms of keeping inflation closer to the targeted level. The simulations also provide a measure of the optimal degree of activism for monetary policy, as well as of the optimal forecasting horizon.

JEL classification: E6
Keywords: Monetary policy, inflation targeting

* Bank Officer VI, Department of Economic Research, Bangko Sentral ng Pilipinas. This paper is a condensed version of the author's Ph.D. dissertation. The author wishes to thank his thesis adviser Professor Dante B. Canlas and panel members Professors Ma. Socorro Gochoco-Bautista and Joseph Y. Lim, for their insightful and helpful comments. The author also thanks Professor Bennett McCallum for his helpful comments on an early version of this paper, and Mrs. Carmen V. Hemedes for her much-needed help in doing the simulations. Joey Tan's comments in a presentation of this paper before BSP staff were also very helpful in suggesting extensions of the original paper to the author. The author is grateful for scholarship support from the BSP, without which this paper would not have been finished. Needless to say, all remaining mistakes in the paper are solely the author's. The views expressed in this paper are the author's and do not necessarily reflect the official position of the Bangko Sentral ng Pilipinas.

1. Introduction

In recent years, a number of central banks have tried to signal to the general public the stance of monetary policy in terms of some targeted rate of inflation. This approach is reflective of a large-scale conversion in the economics profession as to what central banks can and cannot do in the long term. Whereas economists in the 1960s to the 1970s debated the existence of a trade-off between the rate of inflation and the rate of economic growth, the experience of more and more economies provided support to the idea that attempts to exploit the apparent inflation-growth trade-off (the so called "Phillips curve") only produced higher inflation in the long term, with no lasting gains for the real sector in terms of productivity, unemployment, or growth.

What has to be explained is the source of the inflationary bias in the monetary policy regimes that prevailed in the 1960s and 1970s. One possible explanation is specification error, i.e., central banks—and economists—then believed that the output effects of monetary policy are permanent or at least persist for a long enough period of time so as to make expansionary policies worthwhile. Kydland and Prescott [1977] advanced a second explanation, in terms of the time inconsistency of discretionary policy making. The time inconsistency arises because there is a short-run gain to be had by the policy authorities from departing from their stated long-term objectives. This incentive to renege is perceived by the public, and, in a policy framework in which the central bank is free to set its objectives (i.e., exercises discretion), this causes the original policy announcement not to be believed, thereby changing the opportunity set faced by the policymaker, and resulting in an outcome different from the policy pronouncement. Monetary policy should therefore be conducted through "rules", rather than "discretion".

Of particular interest is the adoption of inflation targeting by many central banks, which agrees with theoretical arguments for the conduct of monetary policy through "rules" rather than "discretion". An inflation-targeting framework is an example of a "targeting rule," the distinguishing feature of which is the pre-commitment of the monetary authority to the optimization of a particular objective function. Thus, in inflation targeting, policy authorities commit to minimizing the deviation of inflation from some targeted rate. How to go about doing this, however, is still left to the discretion of the authorities, i.e., monetary policy authorities are left free to change the settings of the monetary policy instruments or to respond to what they feel are the major disturbances affecting the value of the target variable. Svensson [August 1998] advocates using optimal control to determine the values of the central bank's instruments. In general, this solution entails for the central bank to look at all available information in setting its instrument values. Presumably, therefore, in such a framework, the objective function of the central bank but not the bank's reaction function would be announced to the public.

Against this framework, in some literature, there have appeared monetary policy rules, which have come to be referred to as "nominal feedback rules" or "instrument rules," that prescribe a specific form for the authorities' reaction function and impose limitations on the information set to which the instrument settings may respond. In general, the instrument paths prescribed by the nominal feedback rules do not coincide with the optimal control solution. These rules have been criticized by optimal control advocates for using information inefficiently.

Several nominal feedback rules have gained attention in the literature, including:

a) Friedman's constant money growth rule:

$$\Delta m_t = c \tag{1}$$

b) *McCallum's rule*:

$$\Delta b_t = \pi^* + (1/16)\left[(b_{t-1} - p_{t-1}) - (b_{t-17} - p_{t-17})\right] - A(\pi^* - \pi_\tau) \tag{2}$$

where b is the monetary base, p is a price index, π^* is a targeted long-term rate of inflation, and each time period refers to a quarter of a year. The McCallum rule sets the monthly change in the monetary base equal to the targeted rate of inflation, plus an adjustment term equal to the average quarterly change in the price velocity of base money, computed over the past four years, plus a second adjustment term which depends on the past period's deviation of inflation from its targeted value. Here the coefficient A represents the speed of response of the monetary authorities to any given deviation of inflation from target. The higher the value of A, the more activist is the monetary policy, i.e., the less accommodative is monetary policy of inflation shocks.

c) *Taylor's rule*:

$$i_t = i^* + 1.5(\pi_t - 2) + 0.5y_t \tag{3}$$

where i_t is the policy interest rate for the quarter, i^* is the long-run equilibrium interest rate, and y_t is the output gap. Here the term $\pi_t - 2$ represents the deviation of inflation from an implied long-run target of 2 percent and i^* is the rate of interest consistent with this long-run inflation target and the long-run equilibrium rate of interest. Thus the Taylor rule prescribes by how much the policy interest rate is to be raised in response to a rise in inflation above the long-run target or to a rise in output above the normal or potential level for the economy.

In this paper, we provide a theoretical basis for modifying the currently popular nominal feedback rules so that they react to the forecasted inflation rate, instead of to current or to past actual inflation. We show that such a modification reduces the risk that the adoption of a nominal feedback rule would generate instability in the economy, while producing results that are closer to the optimal control solution. Also it will be shown that given rational expectations, a forward-looking rule, and a money demand function that is not completely interest-inelastic, then optimal monetary policy entails some degree of policy activism. Friedman's constant money growth rule is therefore shown to be optimal only in a special case, i.e., when the money demand function is completely insensitive to the rate of interest. In this paper, we reserve our consideration to McCallum-type rules where the reserve money level is the monetary instrument. However, our simulations show broadly similar results for rules with interest rates as the monetary policy instrument.

2. The model

Consider a small, open economy with the demand in the goods market depending negatively on the real rate of interest. The IS function for this economy takes the form:

$$i_t = -\beta Y_t + E_t p_{t+1} - p_t + \alpha q_t + \beta e_{gt}; \quad \beta, \alpha > 0 \tag{4}$$

where i is the nominal rate of interest; Y is the real output level (in logarithms); p is the average level of nominal prices (in logarithms); e_{gt} is the disturbance in aggregate demand and is assumed to be white noise; and q is the logarithm of the real exchange rate, which is defined so that an increase in its value represents an depreciation of the domestic currency. Since we focus on monetary policy, the formulation of the IS function implicitly assumes that government expenditures are constant, and therefore, that fiscal changes can be ignored.

Here E_t is the objective conditional expectations operator, where the information set includes the values of all variables as of time t. Thus, agents' expectations in the economy are rational. A key difference between the IS function specified above and the typical forward-looking IS function is the incorporation of Turnovsky's assumption that the current price level is known to market agents. This allows us to take p_t out of the expectations operator.

The rest of the economy is assumed to be described by:

– an LM function,

$$m_t - p_t = a_1 Y_t - a_2 i_t + e_{mt} \quad a_1, a_2 > 0 \tag{5}$$

where e_{mt} is white noise and represents the random disturbance to money demand, and m_t is the nominal money stock, in logarithms;

– an expectations-augmented Phillips curve relationship given by:

$$p_t = E_{t-1}p_t + \gamma\left(Y_t - Y^*\right) - \gamma\lambda\left[Y_{t-1} - Y^*\right] + u_t \tag{6}$$

Here Y* is the logarithm of potential output, which is assumed to be constant through time.

– a nominal exchange rate equation given by

$$s_t = q_t + p_t \tag{7}$$

where s is the nominal exchange rate. Here we treat q_t as exogenous.[1]

Equations (3)-(7) constitute the model, which contains five variables y_t, p_t, q_t, m_t, and s_t. We treat y_t as endogenous and q_t as exogenous. This leaves two of the nominal variables that the model may determine endogenously, with the remaining variable being taken as exogenous. In terms of our model framework, the choice of which nominal variable to choose as exogenous becomes equivalent to the choice of the nominal anchor. Thus there are three possible nominal anchors: the money supply, the price level, and the exchange rate. These correspond, respectively, to three possible monetary frameworks for a central bank: monetary targeting, inflation targeting (or, strictly speaking in this case, price level targeting), and exchange rate targeting. In this paper, we take p as the nominal anchor and consider whether inflation targeting can be profitably undertaken through the use of a monetary policy rule. Our empirical simulations then address the issue of what specific form such a rule could take.

The model implies the following difference equation for the output level:

$$\begin{aligned}\left(Y_t - Y^*\right) = {} & \frac{-\lambda\left[1-\lambda a_2\right]\left[Y_{t-1} - Y^*\right]}{\left(1+\lambda a_2\right)} + \frac{\left(m_t - E_{t-1}m_t\right)}{\left(1+\lambda a_2\right)\left(c+\gamma+a_2\gamma\right)} \\ & + \frac{\left[c+\gamma+a_2\gamma+1\right]\Sigma_{i=1}^{\infty}\left[a_2/\left(1+a_2\right)\right]^i\left[E_t m_{t+i} - E_{t-1}m_{t+i}\right]}{\left(1+\lambda a_2\right)\left[c+\gamma+a_2\gamma\right]} \\ & + \frac{a_2\beta e_{gt} - e_{mt} - \left(1+a_2\right)u_t}{\left(1+\lambda a_2\right)\left[c+\gamma+a_2\gamma\right]}\end{aligned} \tag{8}$$

[1] Exogeneity of the real exchange rate is a simplifying theoretical assumption. The empirical assumptions do not impose invariance of the real exchange rate with respect to monetary policy changes.

Apart from the past output gap, the unexpected component of money supply growth, and the different shocks to aggregate demand, aggregate supply, and money demand, it can now be seen that the deviation of income from its normal level is affected by the revision, between the current and past period, of the anticipated time path of the money stock. This result follows that of Turnovsky [1980] and Weiss [1980] who show that the "policy irrelevance" result in the presence of rational expectations does not hold if Sargent and Wallace's [1975] assumption that agents do not know the current price level is relaxed. Several points are worth noting:

1. It is possible for an increase in the "pure" random component of policy (e.g., an increase in the variability of money supply growth) to affect the level of income through the expectational terms in (8), to the extent that this kind of increase changes the expected future money supply path. However, this policy change will likely increase the expectational errors pertaining to current money supply, and therefore increase the variability of output around its normal level.
2. An unanticipated change in the monetary policy rule, i.e., a "policy surprise," will affect the current level of output, through a change in the error of predicting the current money supply and through changes in the expected future money supply values. As in the first example, however, the increase in expectational errors is likely to increase the variability of income.
3. It is possible to design a systematic component of monetary policy such that this component has an impact on the level of income. Note that from the preceding discussion, the change in the money supply levels from this component of policy must be unanticipated as of t-1 for policy to be nonneutral; thus this policy component must be random. It is important to distinguish between the randomness of policy from its being systematic. A component of policy is systematic if it is described by a rule relating it to the other factors in the economy. If some of these factors are random, then this policy component becomes random. However, the policy component itself remains systematic since the rule relating the policy component to its determinants remains fixed.

To illustrate the above concepts, and to illustrate the consequences of a purely real sector objective for monetary policy, suppose that the central bank follows a monetary policy rule of the form:

$$m_t = u_0 + \mu_1 m_{t-1} - \mu_2 e_{gt} + \mu_3 e_{mt} + \mu_4 u_t + \eta_t \quad \text{where } \mu_2, \mu_3 > 0, |\mu_1| < 1 \qquad (9)$$

The money stock follows a random walk with drift. The term η_t represents a "pure" white noise component of policy, the terms $-\mu_2 e_{gt}$ and $-\mu_3 e_{mt}$ represent random components of policy which are contemporaneously and, respectively, negatively correlated with (actually linearly dependent on) the shock in the demand for goods, and positively correlated with shocks in the demand for money, and μ_0

represents a constant growth rate of money akin to the Friedman constant money growth rule. Here the policy rule is countercyclical, since a positive shock in the demand for goods is met by a contraction in money supply. The policy rule implies that:

$$E_t m_{t+i} - E_{t-1} m_{t+i} = \mu_1^i \left[-\mu_2 e_{gt} + \mu_3 e_{mt} + \mu_4 u_t + \eta_t \right] \tag{10}$$

Since in this policy rule, money supply follows a random walk, the current "pure" policy shock η_t and the demand for goods shock e_{gt} cause changes in the entire expected time path of future money stocks. Given that $|\mu_1| < 1$, the impact of these shocks on expectations diminish as one proceeds further into the future. Substitution of (10) into (8) yields the following expression for the variance of the output gap $y_t = Y_t - Y^*$:

$$\operatorname{var}(y_t) = \frac{\left[\Phi_2^2 \operatorname{var}(e_{gt}) + \Phi_3^2 \operatorname{var}(e_{mt}) + \Phi_4^2 \operatorname{var}(u_t) + \Phi_5^2 \eta_t \right]}{1 - \Phi_1^2} \tag{11}$$

where $$\Phi_1 = \frac{-\lambda[1 - \lambda a_2]}{(1 + \lambda a_2)}$$

$$\Phi_2 = \frac{\left\{ -\mu_2 \left[\mu_1 a_2 (c + \gamma + a_2\gamma) + 1 + a_2 \right] + a_2 \beta (c + \gamma + a_2\gamma) \right\}}{(1 + \lambda a_2)(1 + a_2 - \mu_1 a_2)[c + \gamma + a_2\gamma]}$$

$$\Phi_3 = \frac{\left\{ \mu_3 \left[\mu_1 a_2 (c + \gamma + a_2\gamma) + 1 + a_2 \right] - (c + \gamma + a_2\gamma) \right\}}{(1 + \lambda a_2)(1 + a_2 - \mu_1 a_2)[c + \gamma + a_2\gamma]}$$

and $$\Phi_4 = \frac{\left\{ \mu_4 \left[\mu_1 a_2 (c + \gamma + a_2\gamma) + 1 + a_2 \right] - (1 + a_2)(c + \gamma + a_2\gamma) \right\}}{(1 + \lambda a_2)(1 + a_2 - \mu_1 a_2)[c + \gamma + a_2\gamma]}$$

From (11), it can be seen that any increase in the variation of η_t will merely increase the variation of Y_t around Y^*. This illustrates point (1) above. As an illustration of point (3), we note that, very importantly, from (11) it can be seen that the variation of Y_t is eliminated by setting the value of the policy parameters μ_2, μ_3 and μ_4 so that:

$$\mu_2 = \frac{a_2 \beta (c + \gamma + a_2\gamma)}{\left[\mu_1 a_2 (c + \gamma + a_2\gamma) + 1 + a_2 \right]} > 0 \tag{12}$$

$$\mu_3 = \frac{(c + \gamma + a_2\gamma)}{\left[\mu_1 a_2 (c + \gamma + a_2\gamma) + 1 + a_2 \right]} > 0$$

$$\mu_4 \quad = \quad \frac{\left(1+a_2\right)\left(c+\gamma+a_2\gamma\right)}{\left[\mu_1 a_2\left(c+\gamma+a_2\gamma\right)+1+a_2\right]} \quad > \quad 0$$

Thus the policy rule is able to keep the output level always at full-employment. The policy rule (11)-(12) requires contracting the money stock following a positive shock in the demand for goods, expanding the money stock following a positive shock in money demand, and expanding the money stock following an inflationary supply-side shock. Note that this last policy response counteracts the contractionary impact of the supply shock.

In summary, given the policy objective of minimizing the variance of $y_t = Y_t - Y*$ subject to the constraints given by (4)-(6), then the *optimal control* solution is to set the money stock according to the rule

$$m_t \quad = \quad \mu_0 + \mu_1 m_{t-1} - a_2\beta\mu e_{gt} + \mu e_{mt} + \left(1+a_2\right)\mu u_t$$

$$\text{where } \mu \quad = \quad \frac{\left(c+\gamma+a_2\gamma\right)}{\left[\mu_1 a_2\left(c+\gamma+a_2\gamma\right)+1+a_2\right]} \qquad (13)$$

which implies

$$E_t m_{t+i} - E_{t-1} m_{t+i} \quad = \quad \mu_1^i\left[\mu z_t\right] \qquad (14)$$

where z_t is the composite shock $-a_2\beta e_{gt} + e_{mt} + \left(1+a_2\right)\mu_t$.

This example, therefore, illustrates how monetary policy acquires a legitimate activist stabilization role in a rational expectations model. Very importantly, this role does not depend on the presence of price rigidity. It is also important to note that the non-neutrality arises not from the purely random component η_t of the policy rule, but rather from the component $-a_2\beta\mu e_{gt} + \mu e_{mt} + \left(1+a_2\right)\mu u_t$, which reacts systematically to the different shocks in the economy. The important point is that the design of policy, through the choice of the value of μ, now has an impact on the real economy. The form of the policy *rule* itself is fixed; however, since the rule reacts to random disturbances in the economy, then the policy *instrument* becomes variable.

Moreover, since agents' decisions depend on the entire expected path of money supply, and this path depends on the specification of the monetary policy rule, then a properly posed policy simulation would ask for the impact of changes in policy rules on agents' behaviors. It can now be seen that a policy question which asks for the impact of changes in the realized future values of policy instruments on agents' behaviors is not properly posed, since the same set of realized instrument values can correspond to different policy rules, and therefore, to different behaviors of economic agents. This is one possible interpretation of the Lucas critique.

The policy rule implies the following equation for the price level:

$$p_t = -cY^* + \alpha a_2 q^* + \frac{\mu_0 + \mu_1 m_{t-1} + \mu z_t}{(1+a_2)} + \frac{c(\mu z_t)}{(1+a_2)(c+\gamma+a_2\gamma)}$$

$$+ \frac{a_2[\mu_0/(1-\mu_1)]}{(1+a_2)} + \frac{\mu_1 a_2[\mu_0 + \mu_1 m_{t-1} + \mu z_t - (\mu_0/(1-\mu_1))]}{(1+a_2)(1+a_2-\mu_1 a_2)}$$

$$- \frac{c\mu_1 a_2 \mu z_t}{(1+a_2)(c+\gamma+a_2\gamma)(1+a_2-\mu_1 a_2)} + \frac{\gamma a_2 \beta e_{gt} - \gamma e_{mt} + cu_t}{[c+\gamma+a_2\gamma]}$$

From (13), then in the absence of any shocks to the economy, the money stock tends towards the long-run value $\mu_0/(1-\mu_1)$. Hence the steady-state value of the price level is

$$p^* = -cY^* + \alpha a_2 q^* + \frac{\mu_0 a_2 \mu_0}{(1+a_2)(1-\mu_1)}$$

Thus, were it not for the shocks to the economy, money stock would tend towards a long-run level $\mu_0/(1-\mu_1)$, and prices would tend towards the value p^*. The output stabilization objective of the monetary authorities, however, introduces shocks to the money supply, which keeps money supply from attaining its long-run value.

2.1 Two examples of inflation-targeting rules

Haldane [1997] considered both a "forward-looking" monetary policy rule (which reacts to an expected rate of inflation) and a "myopic" policy rule (which reacts to the current rate of inflation) and showed that, in contrast to the forward-looking rule, the myopic rule tends to generate instability in the economy. Haldane used a two-equation rational expectations model of the economy, with an aggregate demand equation and a Phillips curve. There is no money supply variable in Haldane's model. Instead, the monetary policy stance is captured by the rate of interest. Haldane's rule also utilized the rate of interest as the monetary policy instrument in both the forward-looking and myopic policy rules. In this section, we verify that Haldane's results hold for the slightly more complicated model that we are considering.

a) A myopic rule for inflation targeting. Consider a monetary policy rule of the form:

$$m_t = \mu(p_t - p_{t-1} - \Pi^*) + A, \qquad \mu < 0 \tag{15}$$

From (15), an inflation rate that is higher than the targeted value leads monetary authorities to contract money supply. Together with the model's equations, the rule yields the following second-order difference equation for the price level:

$$E_{t-1}p_{t+1} + \frac{[c-\gamma(1+a_2)-1+\gamma\mu]}{\gamma a_2}E_{t-1}p_t + \frac{[-c+1-\gamma\mu]}{\gamma a_2}p_{t-1} =$$

$$-\frac{(1-\gamma\mu)\Pi^*}{\gamma a_2} + \frac{(1-\gamma\mu)A}{\gamma\mu a_2} - \alpha q^* + (1/a_2)Y^* + \frac{\lambda c[Y_{t-1}-Y^*]}{a_2} - \frac{cu_t}{\gamma a_2} - \frac{c\Pi^*}{\gamma a_2} - \frac{cA}{\gamma\mu a_2}$$

Note how the policy rule introduces dependence of the price level on the past level of price. The characteristic equation corresponding to this difference equation is:

$$\Lambda^2 + \frac{[c-\gamma(1+a_2)-1+\gamma\mu]}{\gamma a_2}\Lambda + \frac{[-c+1-\gamma\mu]}{\gamma a_2} = 0 \tag{16}$$

with roots given by:

$$\Lambda_1, \Lambda_2 = \frac{\dfrac{-[c-\gamma(1+a_2)-1+\gamma\mu]}{\gamma a_2} \pm \sqrt{\dfrac{[c-\gamma(1+a_2)-1+\gamma\mu]^2}{[\gamma a_2]^2} + \dfrac{4[c-1+\gamma\mu]}{\gamma a_2}}}{2}$$

An examination of (16) shows that it is possible for the roots of the characteristic equation to be negative and, moreover, to be complex. Thus it is possible that, with the adoption of the myopic rule, the monetary authorities are introducing volatility into the economy. Furthermore, if the value of m is a large enough negative number, then it is possible for the price path induced by the monetary policy rule to be unstable.

b) A forward-looking rule for inflation targeting. Consider next a monetary policy rule of the form:

$$m_t = \mu\left(E_t p_{t+1} - p_t - \Pi^*\right) + A \qquad \mu < 0 \tag{17}$$

The rule implies the following difference equation for prices:

$$E_{t-1}p_{t+1} - \frac{\left(1+\mu+a_2\right)}{\left(\mu+a_2\right)}E_{t-1}p_t = \frac{\mu\Pi^* - A - a_2\alpha q^* + cY^* + \lambda c\left[Y_{t-1} - Y^*\right]}{\left(\mu+a_2\right)} \tag{18}$$

We note that, unlike in the case of the myopic targeting rule, the forward-looking rule severs the link of the expected price levels to the past price. The equation provides a stable, nonoscillatory solution provided that

$$-a_2 < \mu < -a_2 - \tfrac{1}{2} \tag{19}$$

The money demand function (2) yields the coefficient a_2. The larger the value of a_2, the greater the interest responsiveness of money demand. The stability condition (19) places upper and lower bounds on the allowable values of the adjustment coefficient μ. Note that, in general, the greater the interest sensitivity of money demand, the more activist monetary policy should be. *Note also that, in general, for the forward-looking rule that we are considering, unless money demand is completely interest-inelastic (and therefore corresponds to the extreme monetarist case), then optimal monetary policy implies some degree of activism.* From the stability condition (19), it can therefore be seen that, in the forward-looking case, it is a simple matter to adjust the monetary policy parameter so as to produce a stable price path.

The result is analogous to the Sargent and Wallace [1973] demonstration that the Cagan monetary model, when combined with rational expectations, produces a stable solution when solved forwards and an unstable solution when solved backwards. The myopic policy rule forces a linkage to the past price level, which introduces the possibility of an unstable solution to the model. The results also support the point we made earlier, that an instrument rule that responds to an expected future rate of inflation is in general more efficient than one which responds either to the current or to the past inflation rate.

3. Empirical simulations

We conducted empirical simulations to verify whether the data support the contention that a forward-looking monetary policy rule would reduce the possibility of monetary policy introducing cyclical instability into the economy, while at the same time providing better performance in terms of keeping inflation closer to the targeted level. The models that we used were several modified versions of the short-term inflation-forecasting model, which was developed under Dr. Roberto Mariano [Mariano 1997] for the BSP. Each modified version enabled us to simulate the impacts, respectively, of adopting McCallum's rule for reserve money, of utilizing an indirect monetary targeting procedure for inflation targeting, of adopting an interest rate instrument for inflation targeting, and, lastly, of adopting Taylor's rule. For simplicity in the simulations, we used a fixed long-run rate of five percent annually. This rate is lower than what the Philippines had experienced historically, and lies midway between Sarel's threshold value and the inflation targets in developed countries that have adopted inflation targeting.[2] Thus the five percent target can be seen as a transitional target, and success in bringing inflation down to this level would pave the way for the adoption of more ambitious inflation targets.

3.1. A reserve money rule for conducting monetary policy

The first set of simulations refer to McCallum's rule where reserve money growth responds to the deviation of the current month's inflation rate from the targeted value. Two of the main equations (the forecasting equation for inflation and for GDP) of the simulation model are shown below. The inflation equation differs from that in Mariano [1997] in terms of the monetary aggregate (the equation uses reserve money whereas Mariano uses the ratio of M4 to nominal GDP), the introduction of an agricultural supply variable, the introduction of a feedback mechanism for the demand side through lagged GDP growth, and the presence of a simpler AR structure. The GDP equation is new to this simulation. The rest of the model equations consist of (1) the T-bill and exchange rate equations from a 4-equation VAR model containing seven monthly lags of the reserve money level, the T-bill rate, the exchange rate, and the consumer price index, and (2) bridge equations linking changes in the exchange rate to changes in the explanatory variables in the inflation equation. All equations used in our simulations pass standard serial correlation tests.

---

[22]Sarel [May 1995], pp. 10 and 13. Using a broad sample of developed and developing countries covering the period 1970-1990, Sarel finds evidence of a threshold value of 8 percent for the inflation rate at which there exists a structural break in the relationship between inflation and economic growth. Below 8 percent, Sarel finds that inflation does not have any effect on growth, or may even have a slight positive effect; however, beyond this threshold value, inflation acquires a significant and negative impact on growth—each doubling of the inflation rate reduces the growth rate by about 1.7 percentage points.

1. Inflation Forecasting Equation (Sample (adjusted): 1988:05 1998:12)

$$\left(LCPI - LCPI(-12)\right) = \underset{(0.003349)}{-0.000380} + \underset{(0.009894)}{0.038890^{*}}\left(LRMA(-1) - LRMA(-13)\right)$$

$$+ \underset{(0.004884)}{0.011597^{*}} DCRISIS + \underset{(0.004404)}{0.009440^{*}}\left(LWOILPR - LWOILPR(-12)\right)$$

$$+ \underset{(0.007112)}{0.019747^{*}}\left(LPNONOIL(-3) - LPNONOIL(-15)\right) - \underset{(4.40E-07)}{1.26E-06^{*}} AGRICPRESS$$

$$+ \underset{(0.030730)}{0.881586^{*}}\left(LCPI(-1) - LCPI(-13)\right) + \underset{(0.030537)}{0.072433^{*}}\left(LGDPQ(-9) - LGDPQ(-21)\right)$$

$$+ \underset{(0.099301)}{0.316319^{*}} AR(1)$$

$$R^2 = 0.969 \quad RBAR^2 = 0.967 \quad S.E.E. = 0.006035 \quad D.W. = 2.043703$$

2. GDP Equation (Sample (adjusted): 1987:08 1998:12)

$$\left(LOG\left(@MOVAV(GDPQ/3,3)\right) - LOG\left(@MOVAV(GDPQ(-12)/3,3)\right)\right) = \underset{(0.006030)}{0.012899}$$

$$- \underset{(0.002014)}{0.004310^{*}}\left(LTBILL(-4) - \left(LCPI(-4) - LCPI(-16)\right)\right) - \underset{(0.001734)}{0.004451^{*}}$$

$$D\left(LWOILPR(-3) - LCPI(-3)\right) - \underset{(0.014264)}{0.036532^{*}} D\left(LMAPNONOIL(-3) - LCPI(-3)\right)$$

$$\underset{(0.046651)}{0.93881^{*}}\left(LOG\left(@MOVAV(GDPQ(-1)/3,3)\right) - LOG\left(@MOVAV(GDPQ(-13)/3,3)\right)\right)$$

$$\underset{(0.078476)}{0.895711^{*}} AR(1) - \underset{(0.016282)}{0.959712^{*}} MA(3)$$

$$R^2 = 0.981 \quad RBAR^2 = 0.980 \quad S.E.E. = 0.003761 \quad D.W. = 1.945642$$

where LCPI = log of the consumer price index (1994 base), LRMA = log of reserve money, adjusted for changes in reserve requirements, DCRISIS = dummy variable for the rice crisis, LWOILPR = log of the weighted average of retail prices of fuel products, LPNONOIL = log of the implicit price index for non-oil imports, The simulated paths for inflation, base money, and other major economic variables for different values of A are shown in Figure 1. The third column of Table 1 shows, for different values of the coefficient of adjustment A, the RMS deviations from the target inflation path of 5.0 percent annually, for the simulation period 1991-1996.

For comparison, the last row of the table shows the deviation of the actual inflation path from the target path. Thus, for the simulation period, actual inflation was, on the average, 6.45 percentage points away from the targeted value of 5.0 percent. The simulations show that the application of the McCallum rule would have brought the inflation rate closer to the target, for most reasonable values of the adjustment coefficient A. Furthermore, the simulations also show an improvement in the controllability of inflation (a steady decline in the RMS deviation of inflation from target) as the central bank becomes more activist (i.e., as the value of A increases). However, at high enough values of A, the economy begins to show what is known as instrument instability, with monetary policy actions becoming the source of cyclical fluctuations. This can be seen, for example, in Figure 1c, with A = 0.2, when the policy rule almost drives the economy down to disinflation. The simulations also show the importance of having a feedback mechanism in the policy rule—the adoption of a (modified) Friedman-like constant money growth rule (A = 0.0), with no adjustment to deviations of current inflation to target inflation (but, however, with allowance for long-term velocity changes) actually worsens the inflation performance of the economy.

The rules prescribe considerably lower RM growth paths than what actually transpired. The contraction of RM initially leads to a higher Treasury bill rate; however, as the rate of inflation declines, the nominal interest rate also declines. The nominal exchange rate also appreciates, but this is compensated for in real terms by the lower rate of inflation. The simulations also show an initial contractionary effect on GDP arising from the adoption of inflation targeting. However, by the end of the simulation period, the GDP level goes back up to the baseline.

Column 2 of the table shows, for different values of A, the RMS deviations of inflation from target in the case when the monetary authority reacts to the past month's deviation of the inflation rate from the targeted level. The past inflation rule produces inferior results for each value of A, compared to the current inflation rule. Moreover, graphs of the relevant economic variables show that as we increase the speed of adjustment A, the performance of the past inflation rule deteriorates faster than the current inflation rule. The risk of generating an oscillative inflation path therefore appears to be greater for the past inflation rule.

The succeeding columns of the table show the performance of the McCallum rule if the rule were modified so that reserve money growth reacts to one-month ahead, two months ahead, and up to the five months ahead deviation of forecasted inflation from its targeted value.[3] A bar over an entry indicates that values of the adjustment coefficient A higher than that corresponding to the table entry tend to produce explosive oscillations in the real sector or financial variables in the economy. For example, for a one-month ahead forecasting rule, the simulations show that steady gains in inflation control can be obtained by increasing the activist stance of the central bank; however, at values of A higher than 0.3, the central bank, itself becomes the source of instability in the economy. Letting A* be the optimal value of A and s* the corresponding RMS deviation of inflation from target, then for a one-month forecasting horizon, A* = 0.2 with s* = 5.56, and for a two-month forecasting horizon, A* = 0.3, with s* = 5.25. For a three-month forecasting horizon, A* rises to 0.4, and s* falls to 4.96. A four-month horizon yields stable paths for all economic variables, with A* = 1.5 and s* = 4.16. However, lengthening the forecasting horizon to five months results in a deterioration of the inflation performance of the rule. It therefore appears that the optimal forecasting horizon for the central bank is about four months, with the central bank responding rather aggressively to shocks in the inflation outlook. The corresponding simulated paths for inflation and other relevant economic variables for this optimal monetary policy rule is shown in Figure 2c.

[3] Note that forecasted inflation may itself be expected to depend on the monetary program to be adopted, we utilized an approximate procedure. A given forward-looking monetary program may therefore be said to be consistent if, when the expected inflationary path resulting from the program is fed into our monetary rule, then the monetary rule generates the original given monetary program. In the simulations for this paper, we adopted an approximate procedure for the design of such a program. This procedure consisted of iterating twice on the monetary policy rule, first to generate the inflation forecast, given application of the rule, and second, to adjust the monetary instrument setting based on the forecast generated in the first round of simulations. The above approximate procedure may therefore be seen as the initial steps of a full iterative procedure designed to produce a consistent monetary plan.

Table 1. Simulation Results

Coefficient of Adjustment (A)	*Rule for past inflation*	*Rule for current inflation*	*One month ahead inflation forecast*	*Two months ahead inflation forecast*
0.50			5.27	4.96
0.40			5.32	5.09
0.30			5.39	5.25
0.20	5.85	5.70	5.56	
0.15	5.89	5.80		
0.10	6.02	5.97	5.94	
0.05	6.33	6.31		
0.0	7.14	7.14		
Actual	6.45	6.45	6.45	6.45

Coefficient of Adjustment (A)	*three months ahead inflation forecast*	*four months ahead inflation forecast*	*five months ahead inflation forecast*
2.0		4.44	
1.5		4.16	5.39
1.2		4.18	
1.0		4.26	
0.8		4.41	
0.6		4.62	
0.5	4.79	4.77	
0.4	4.96		
0.3	5.17		
Actual	6.45		6.45

Several patterns are apparent from the simulations.

1. The simulations support the earlier theoretical contention that basing the monetary policy rule upon a forecasted, as against to an actual value of inflation would result in an improvement in targeting performance.

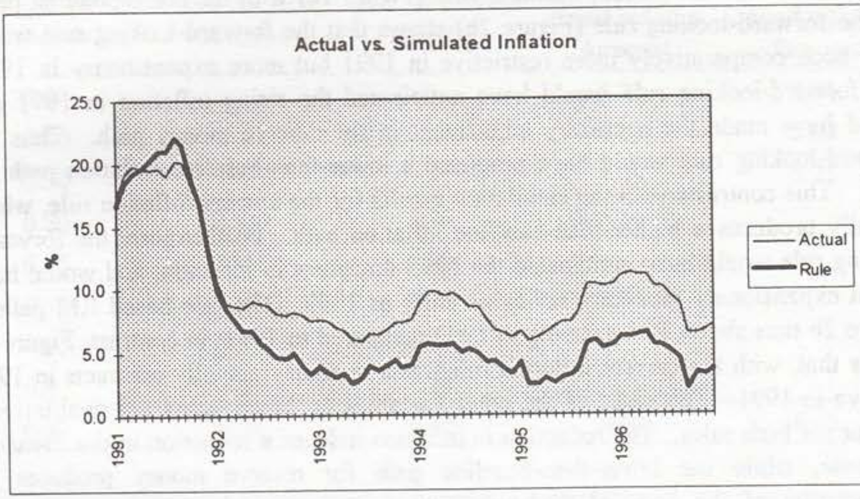
2. For most of the time horizons considered, increasing the value of A results in a continuous decline in the RMS error. However, high enough values of A tend to produce cyclical behavior of inflation and overshooting of the inflation target. At sufficiently high A, the reserve money rule can actually induce deflation of the economy.

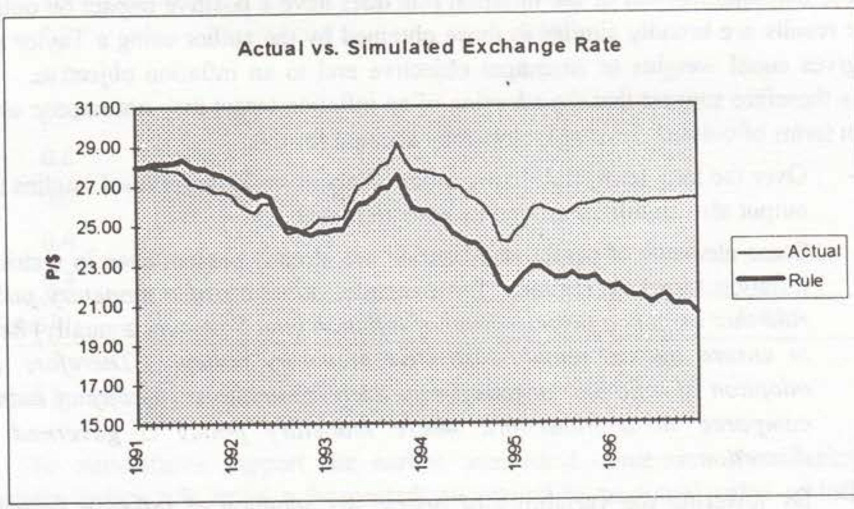
3. Incorporating inflation forecasts into the reaction function for the central bank allows monetary policy to become more activist. A comparison between the paths of inflation and reserve money which corresponds to the optimal value of the adjustment coefficient A for the current inflation rule (Figure 1c) with the corresponding paths for the forward-looking rule (Figure 2b) shows that the forward-looking rule would have been comparatively more restrictive in 1991 but more expansionary in 1993. The forward-looking rule would have anticipated the rising inflation in 1991 and would have made the necessary adjustment in the reserve money path. Thus the forward-looking rule would have produced a lower-than-baseline inflation path for 1991. This contrasts with the simulation results for the current inflation rule, which actually produces a higher-than-baseline inflation path. Furthermore, the forward-looking rule would have anticipated the 1993 downturn in inflation, and would have begun expansionary monetary policy as early as 1992. The rule-based RM path in Figure 2b thus shows RM growing in 1992 compared to 1991; in contrast, Figure 1c shows that, with the current inflation rule, reserve money actually contracts in 1992 relative to 1991. The paths of the other variables in the economy are qualitatively similar for both rules. The reduction in inflation induces a reduction in the Treasury bill rate, while the lower-than-baseline path for reserve money produces an appreciation of the nominal exchange rate compared to the baseline. This is, however, compensated for by a lower rate of inflation. Adoption of a forward-looking rule also appears to either reduce the contractionary impact on GDP of having an inflation target. In fact, the simulations show a slightly higher GDP path. It is possible that stabilization of the inflation rate does have a positive impact on output. These results are broadly similar to those obtained by the author using a Taylor rule that gives equal weights to an output objective and to an inflation objective. The results therefore suggest that the adoption of an inflation target may not impose much cost in terms of output. Several factors may account for this:

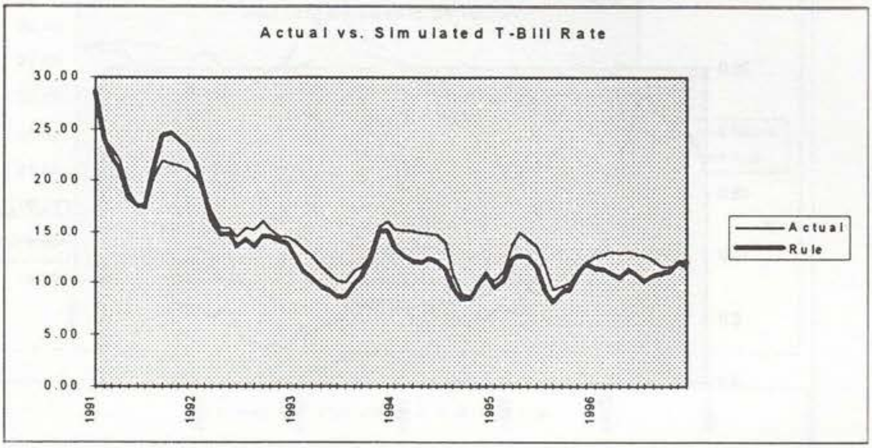
- Over the long term, stabilizing inflation about some target level implies that output also stabilizes around its potential level.
- Some elements of output stabilization are already present even in a strictly inflation targeting regime. For example, *adoption of a monetary policy rule that targets a positive level of inflation* (say 5 percent annually) *helps to ensure against unduly restrictive monetary policy. Therefore, the adoption of inflation targeting may itself lower the variability of output, compared to a framework where monetary policy is governed by discretion.*
- By lowering the variability of prices, the adoption of inflation targeting helps to reduce an important source of uncertainty in the economy, and therefore helps in achieving an environment conducive to growth. As noted earlier, Sarel finds a threshold level of 8 percent inflation, beyond which, higher inflation leads to lower growth.[4]

[4] Sarel [May 1995], pp. 10 and 13.

Figure 1a: Simulation Results for the Current Inflation Rule: A = 0.1






Actual vs. Simulated T-Bill Rate
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1991
1992
1993
1994
1995
1996
Actual
Rule

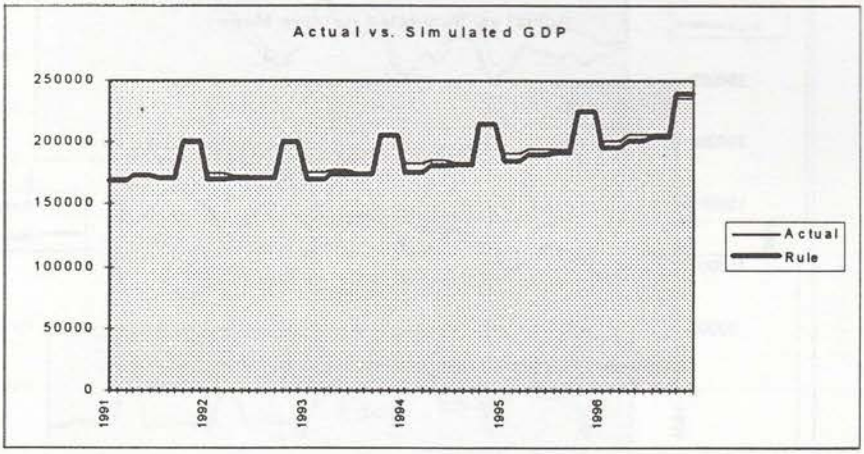
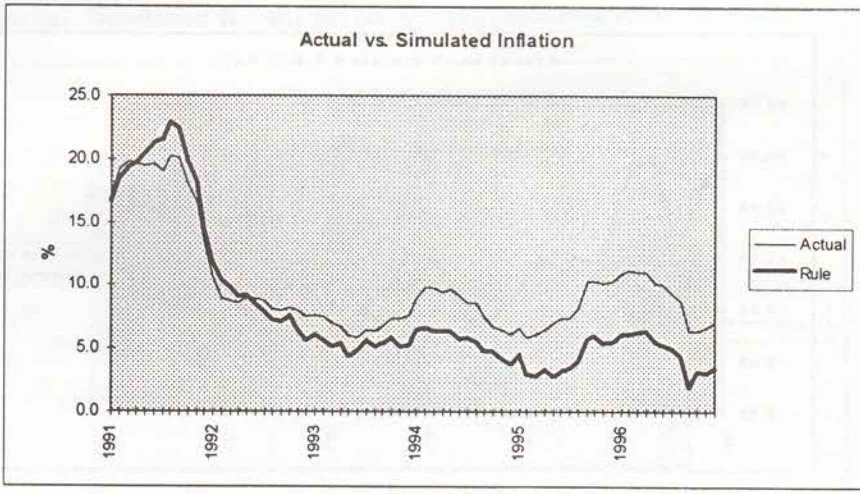
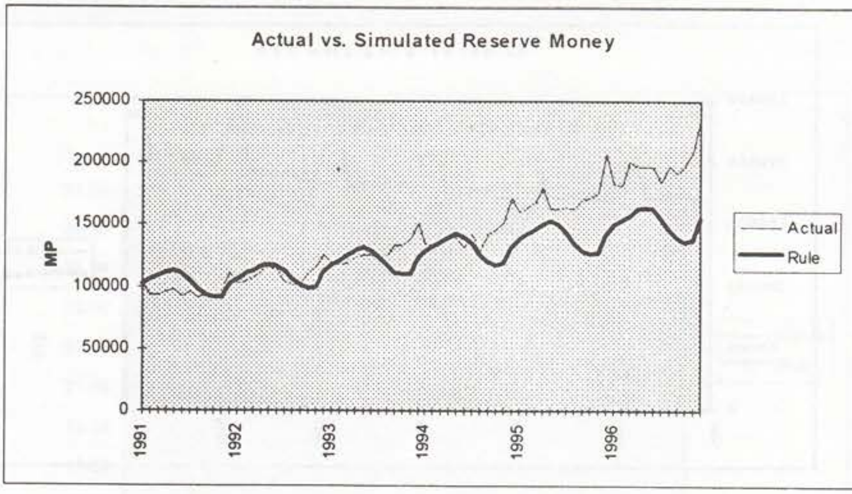
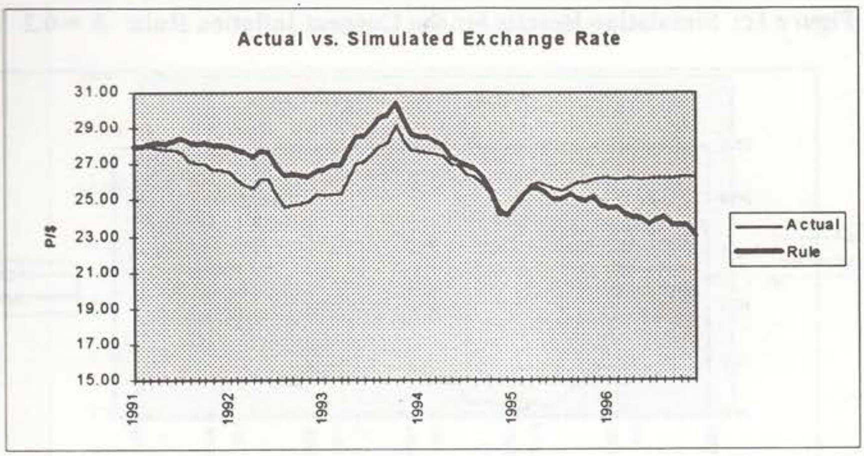
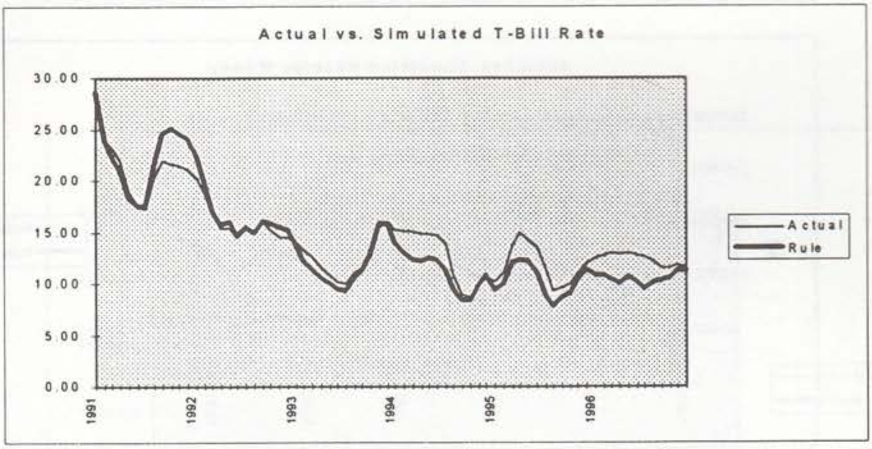

Actual vs. Simulated GDP
250000
200000
150000
100000
50000
0
1991
1992
1993
1994
1995
1996
Actual
Rule

Figure 1b: Simulation Results for the Current Inflation Rule: A = 0.05






Actual vs. Simulated Exchange Rate
31.00
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
P/$
1991
1992
1993
1994
1995
1996
Actual
Rule


Actual vs. Simulated T-Bill Rate
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1991
1992
1993
1994
1995
1996
Actual
Rule

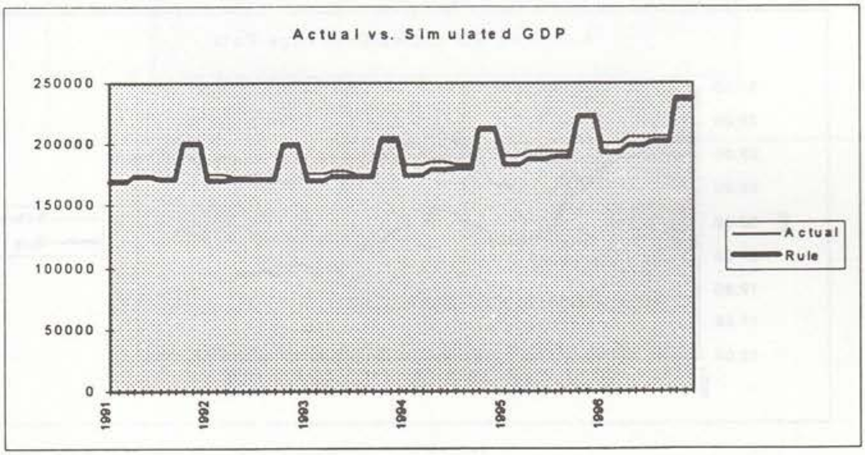
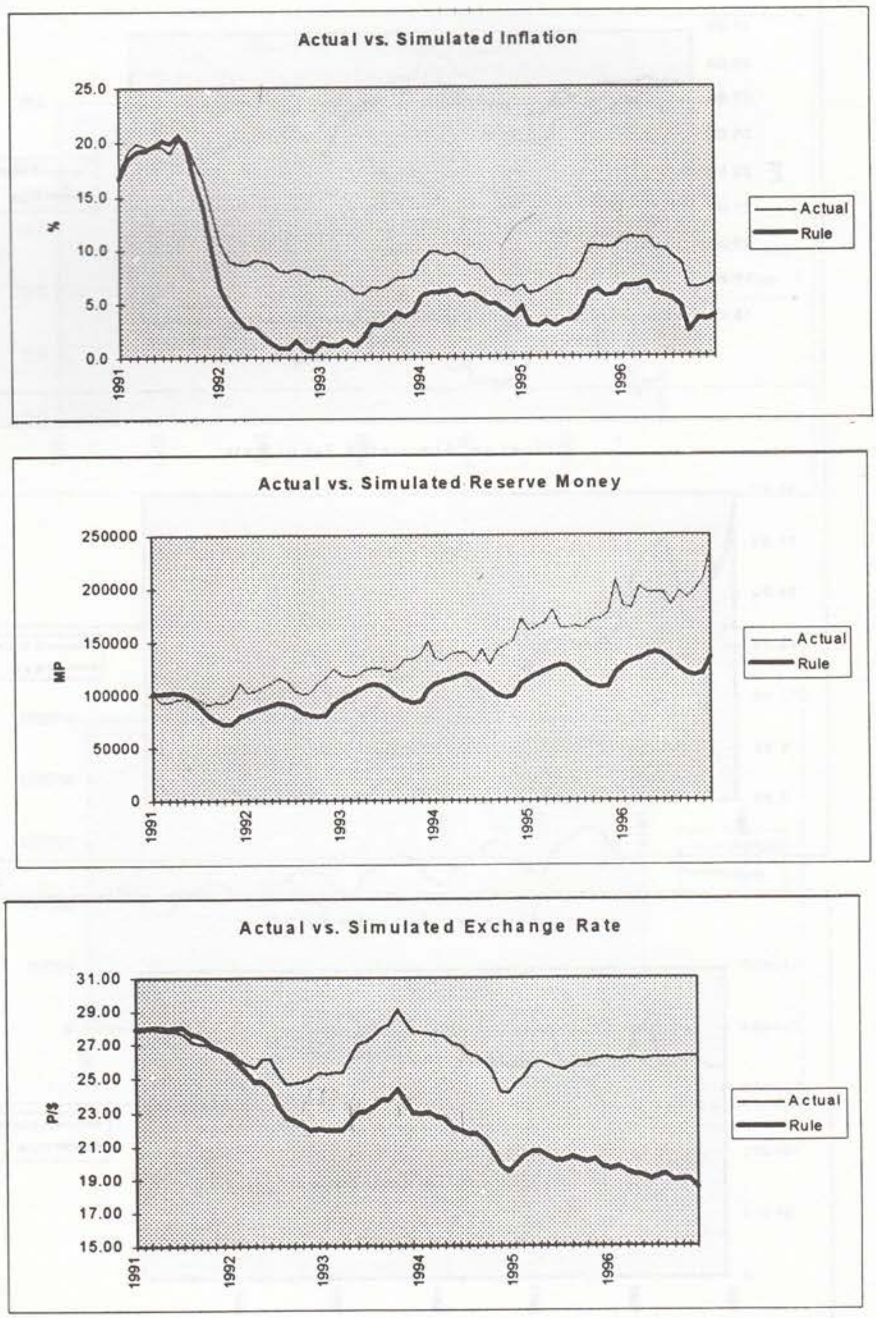
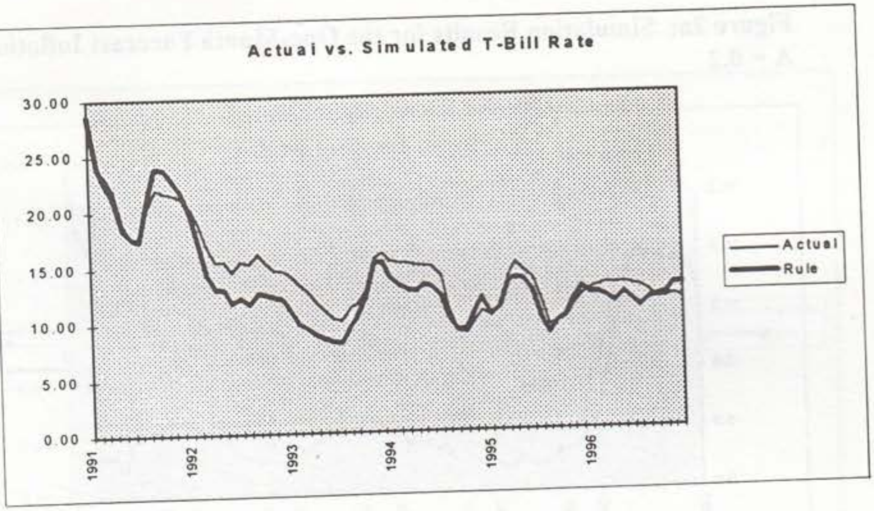
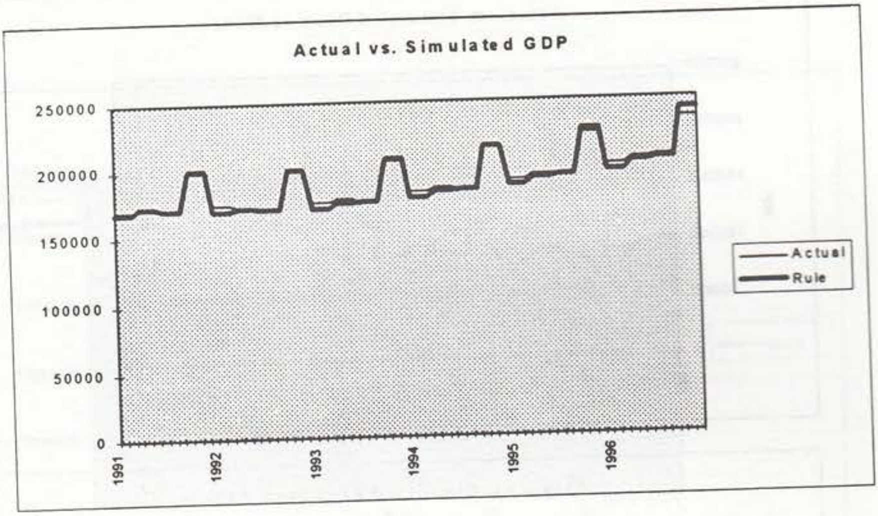

Actual vs. Simulated GDP
250000
200000
150000
100000
50000
0
1991
1992
1993
1994
1995
1996
Actual
Rule

Figure 1c: Simulation Results for the Current Inflation Rule: A = 0.2



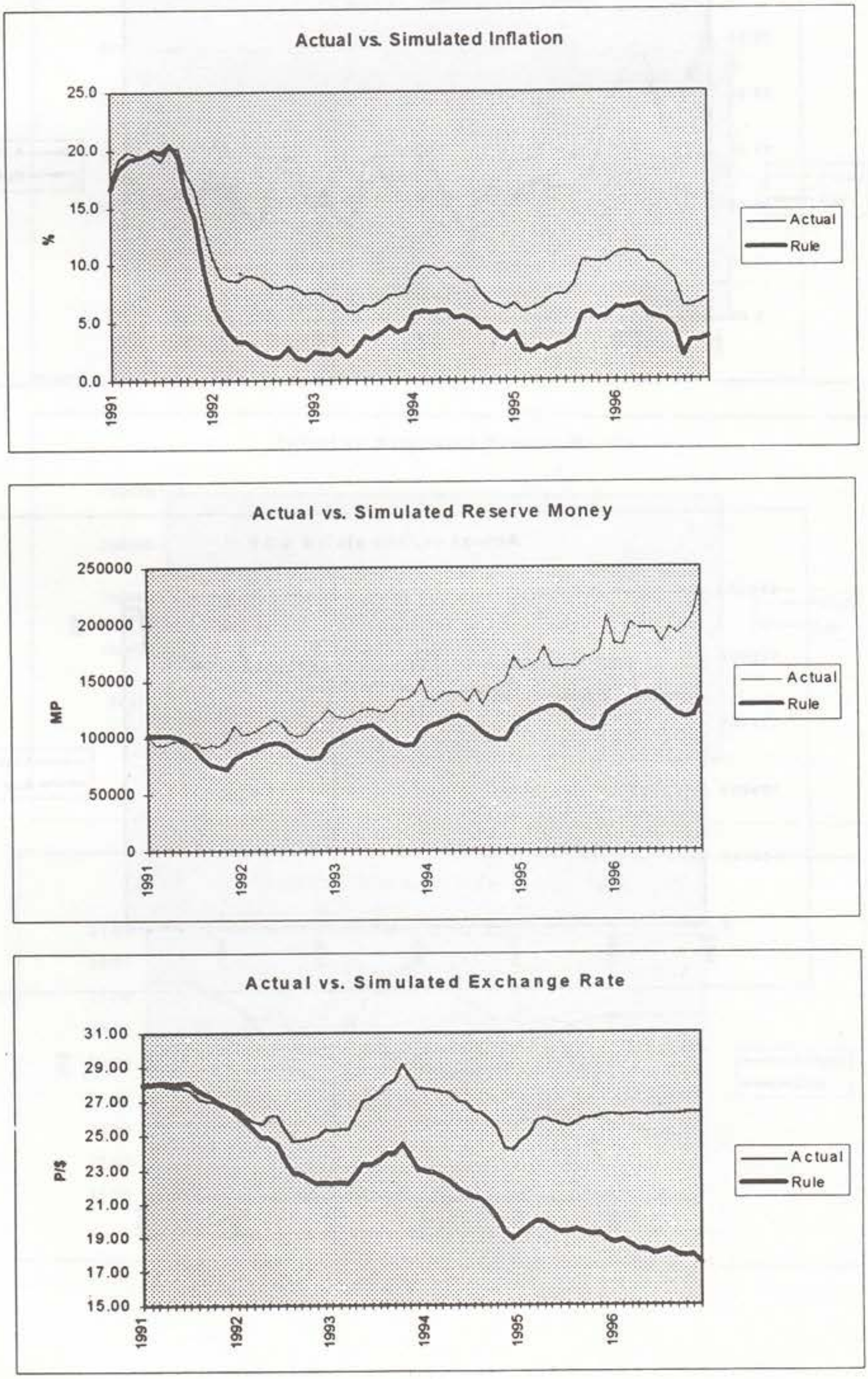


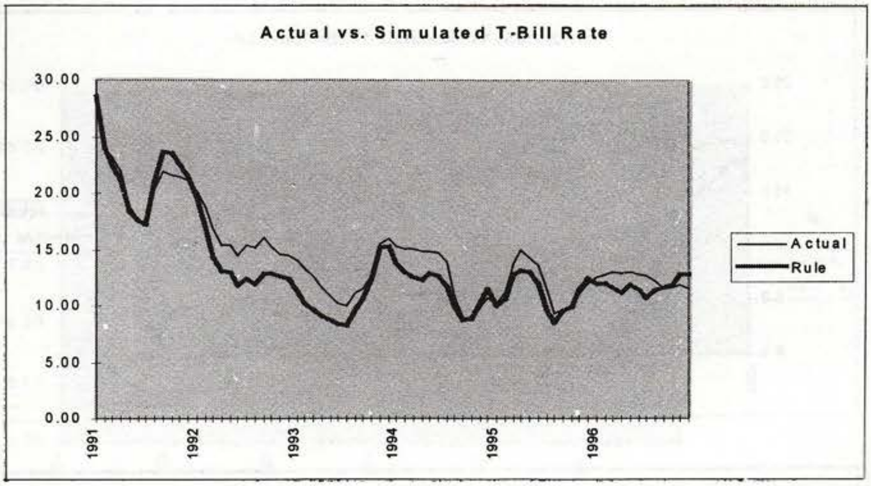
Actual vs. Simulated T-Bill Rate
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1991
1992
1993
1994
1995
1996
Actual
Rule



Actual vs. Simulated GDP
250000
200000
150000
100000
50000
0
1991
1992
1993
1994
1995
1996
Actual
Rule

Figure 2a: Simulation Results for the One-Month Forecast Inflation Rule: A = 0.2




Actual vs. Simulated T-Bill Rate
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1991
1992
1993
1994
1995
1996
Actual
Rule

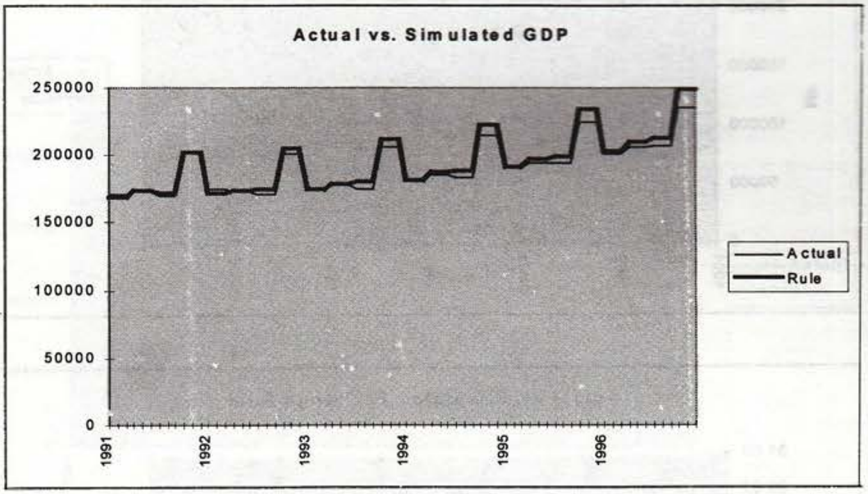
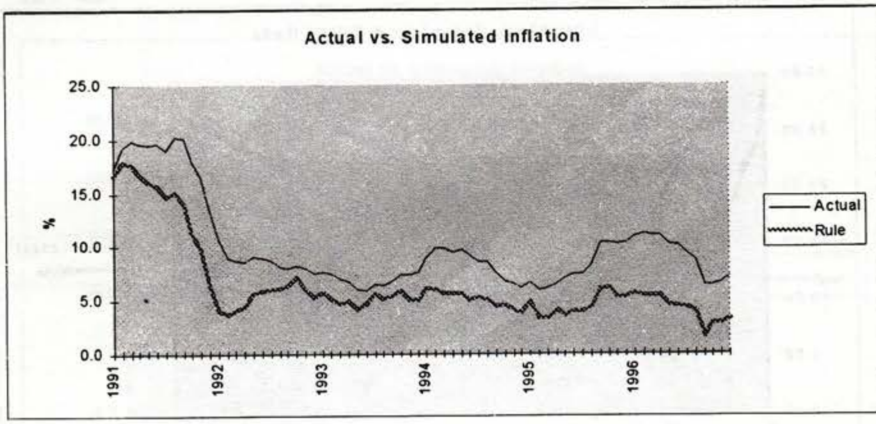
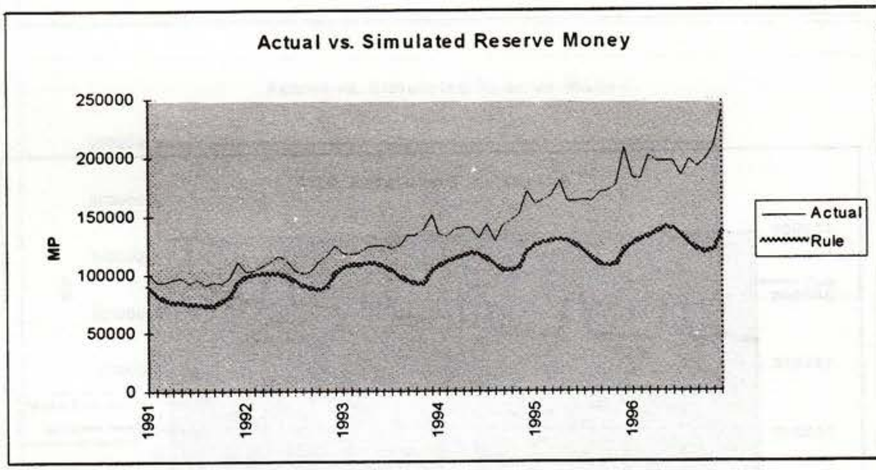
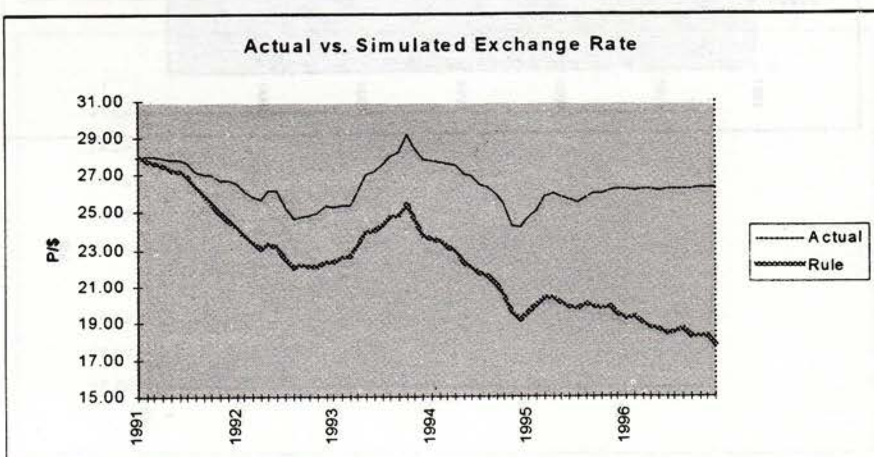
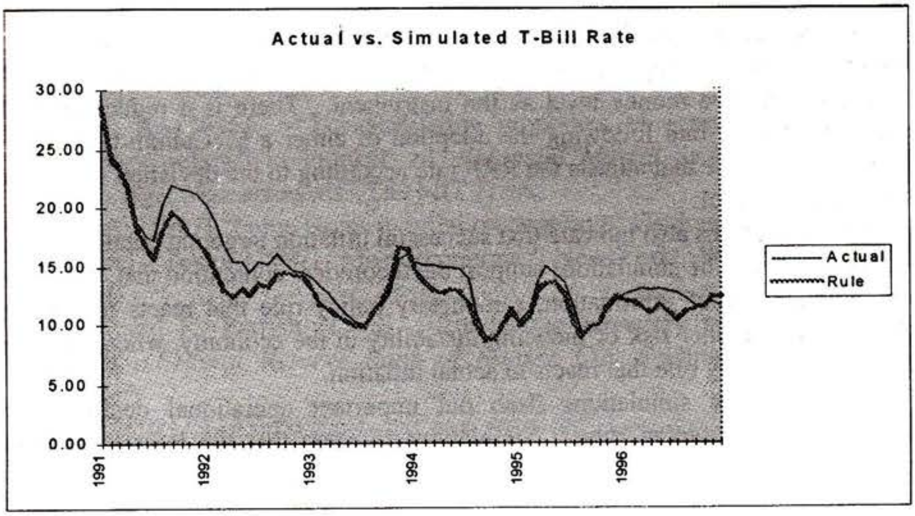

Actual vs. Simulated GDP
250000
200000
150000
100000
50000
0
1991
1992
1993
1994
1995
1996
Actual
Rule

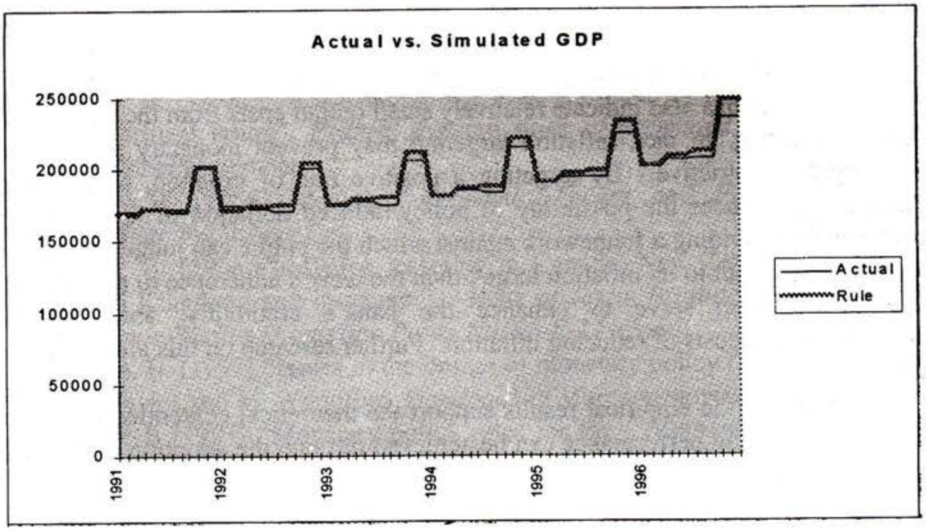
Figure 2b: Simulation Results for the Four-Month Forecast Inflation Rule: A = 1.5








Actual vs. Simulated T-Bill Rate
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1991
1992
1993
1994
1995
1996
Actual
Rule


Actual vs. Simulated GDP
250000
200000
150000
100000
50000
0
1991
1992
1993
1994
1995
1996
Actual
Rule

4. Conclusions

The preceding simulations provide evidence supporting the feasibility of targeting inflation through the use of monetary policy rules, specifically with rules that use the reserve money level as the instrument. There is a reduction in the simulated inflation rate following the adoption of either a McCallum-type reserve money rule or a rule that adjusts the RRP rate according to the deviation of inflation from a targeted level.

The simulations also indicate that successful inflation targeting entails forward-looking policies. The simulations support the theoretical contention that, by making more efficient use of information, a monetary policy rule that reacts to expected inflation bears smaller risk of inducing instability in the economy, when compared to a monetary policy rule that reacts to actual inflation.

Moreover, the simulations flesh out important operational details of the forward-looking targeting rules. Simulations indicate that the lowest deviations from a long-run inflation target are achieved with a framework that respond to forecasted inflation about four months ahead, using a reserve money instrument to target inflation directly.

The simulations indicate that lengthening the forecasting horizon (up to the optimal point) allows for a more activist monetary policy. For any given coefficient of adjustment parameter, the likelihood of a policy rule generating instability in the economy is lowered by increasing the forecasting horizon.

The simulations also indicate relatively small output costs from the adoption of inflation targeting. In fact, inflation targeting may prevent monetary policy from becoming too restrictive. By targeting a positive rate of inflation, an inflation-targeting rule reduces the possibility of policy-induced deflation of the economy. Moreover, by providing a framework against which the public can judge the Central Bank's commitment to its inflation target, then the bank's adherence to an inflation-targeting rule can serve to enhance the bank's credibility, and serve to reduce the output costs of reducing inflation. Further research on this area would be beneficial.

In summary, the empirical results support the theoretical contention that gains in inflation-targeting performance can be achieved through the adoption of forward-looking monetary policy rules.

References

Barro, R., [1978] "Unanticipated money, output, and the price level in the United States," *Journal of Political Economy.* (August)

Dueker, M. and A. Fischer [1998] "A guide to nominal feedback rules and their use for monetary policy", *Federal Reserve Bank of St. Louis Review* (July/August)

Fair, R. [1978] "A criticism of one class of macroeconomic models with rational expectations", *Journal of Money Credit and Banking:* 411-417, cited in Turnovsky (1995)

Friedman, M., [1968] "The role of monetary policy", *American Economic Review* (March)

Frankel, J. A. [1995] "The stabilizing properties of a nominal GDP rule for monetary pòlicy," in Frankel, ed. *Financial Markets and Monetary Policy.* Cambridge, Massachusetts: The MIT Press.

Haldane, A. [1997] "Some issues in inflation targeting," Bank of England

Hall, R. and J.Taylor [1997] "Macroeconomics" New York: W. W. Norton & Co., 5th ed.

Kahn, G. and K. Parrish [1998] "Conducting monetary policy with inflation targets", *Federal Reserve Bank of Kansas City Economic Review* (Third Quarter)

King, M.[1998] "The inflation target five years on", London School of Economics Financial Markets Group Special Paper Series No. 99 (February)

Kydland, F. and E. Prescott [1977] "Rules rather than discretion: The inconsistency of optimal plans" *Journal of Political Economy.*

Leroy, S. [1995] "On policy regimes", in K.D. Hoover, ed., *Macroeconometrics: Developments, Tensions, and Prospects.* Boston:Kluwer Academic Publishers.

Mariano R. [1997], "Forecasting inflation in a period of globalized finance," unpublished paper done for the Macroeconomic Reforms Management Project.

McCallum, B. [1982] "Macroeconomics after a decade of rational expectations: some critical issues", *Federal Reserve Bank of Richmond Economic Review* (November/December).

McCallum, B. [1989] *Monetary Economics:Theory and Policy.* New York: Macmillan Publishing Co.

McCallum, B. [1996] "Inflation targeting in Canada, New Zealand, Sweden, the United Kingdom, and in general", *Bank of Japan Institute for Monetary and Economic Studies Discussion Paper No. 96-E-21* (June).

McCallum, B. [1997] "Issues in the design of monetary policy rules," forthcoming in J. Taylor and M. Woodford, *Handbook of Macroeconomics* (North-Holland).

McCallum, B [1997] "Monetary policy rules for the Philippines: an introductory study," unpublished paper done for the Macroeconomic Reforms Management Project.

Mishkin, F. [1998] "International experiences with different monetary policy regimes", *Sveriges Riksbank Working Paper Series No. 57* (July).

Mishkin, F. and A. Posen [1997] "Inflation targeting:lessons from four countries," *Federal Reserve Bank of New York Economic Policy Review* (August).

McDonough, W. [1997] " A framework for the pursuit of price stability," *Federal Reserve Bank of New York Economic Policy Review* (August).

Phelps, E. [1970] "Money wage dynamics and money market equilibrium," in E. Phelps, ed. *Microeconomic foundations of employment and inflation theory.* New York: Norton.

Poole, W. [1999] "Monetary policy rules?" *Federal Reserve Bank of St. Louis Review* (March/April).

Sargent, T. [1979] *Macroeconomic Theory* . New York: Academic Press, Inc.

Sargent, T. and N. Wallace [1975] "Rational expectations, the optimal monetary instrument, and the optimal money supply," *Journal of Political Economy.*

Sargent, T. and N. Wallace [1973] "The stability of models of money and growth with perfect foresight", *Econometrica.*

Svensson, L. [1998] "Inflation targeting as a monetary policy rule", *Stockholm University Institute for International Economic Studies Working Paper* (August).

Turnovsky, S. [1995] *Methods of Macroeconomic Dynamics.* Cambridge: The MIT Press.