THE FEDERAL RESERVE BANK
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WORKING PAPER SERIES

Strategic Discipline in Monetary Policy with Private Information: Optimal Targeting Periods

Michelle R. Garfinkel
Seonghwan Oh

FEDERAL RESERVE BANK OF ST. LOUIS
Research Division
411 Locust Street
St. Louis, MO 63102

STRATEGIC DISCIPLINE IN MONETARY POLICY WITH
PRIVATE INFORMATION: OPTIMAL TARGETING PERIODS

Michelle R. Garfinkel* and Seonghwan Oh**

Federal Reserve Bank of St. Louis

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*Federal Reserve Bank of St. Louis
**University of California-Los Angeles

Abstract

This paper analyzes the optimal choice of the length of time over which the monetary authority targets money growth, in a setting where the monetary authority's lack of credibility potentially gives rise to an inflationary bias. When the monetary authority has some private information–e.g. a private forecast–that obscures the relevance of reputational considerations and the effectiveness of legislation to enforce the efficient policy, the targeting procedure serves as a device to diminish the inflationary bias while providing the monetary authority limited flexibility to react to its private information. The analysis strengthens the monetarist proposition that the monetary authority should follow a strict rule. Even when the monetary authority has a fairly accurate forecasting technology, the optimal targeting period can be very short, implying that limited or no flexibility in monetary policy would be optimal.

1 Introduction

How much flexibility or discretion should be given to the monetary authority? The answer to this time-honored question, in the monetarist spirit, is essentially none. Under the presumption that the monetary authority lacks an ability to forecast accurately or is able to forecast, at best, as well as economic agents, discretionary policy only creates an additional element of uncertainty that unnecessarily complicates economic agents' decision problems. Hence, the monetary authority should follow a strict rule, e.g., a constant growth rate rule.[1] Against the monetarist prescription, proponents for an activist rule for the monetary authority argue that the inflexibility of a strict rule precludes an optimal response to unanticipated disturbances.

To this already complicated question, recent developments in the literature have added more complexity, highlighting strategic considerations in the monetary control problem. When the market determined output and/or employment level is suboptimal due to some distortions existing in the economy such as income taxation, trade unions, and/or unemployment insurance, a benevolent monetary authority will try to raise employment or output by surprising agents with high inflation if temporary nominal rigidities are present. Rational, forward-looking agents, recognizing this incentive, set high rates of wage inflation to discourage the monetary authority from trying to reduce their real wage below their target level. Hence, even if the monetary authority is perfectly benevolent in that it maximizes social welfare, its policy might be inefficient; the equilibrium could be characterized by excessively high average inflation–an *inflationary bias*. As recognized since Kydland and Prescott's (1977) seminal paper, the efficient policy that avoids this bias might not be dynamically consistent.

Generally, when there is complete information, in the sense that individuals know

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the monetary authority's preferences and observe the realizations of the stochastic variables that constrain its choices, the reputational mechanism can serve to eliminate or, at least, partially diminish the extent of suboptimality arising from the dynamic inconsistency problem.[2] If, however, the monetary authority has some private information, the efficacy of the reputational mechanism is called into question. Specifically, as shown by Canzoneri (1985), when the information structure is incomplete so that individuals cannot verify that the monetary authority has not intentionally invalidated their expectations, reputational considerations might not be operational. Moreover, private information precludes the effectiveness of any commitment technology to force the monetary authority to adhere to the optimal rule unless there is a separate mechanism to force the monetary authority to truthfully reveal its private information.[3]

Given these problems associated with policymaker's private information, Canzoneri (1985) suggests a *legislative approach* as a possible solution.[4] The presumed commitment technology for this approach is partial in that it cannot force the monetary authority to truthfully reveal its private information. Nevertheless, this approach is particularly attractive since the legislated procedure can be specified in terms of variables–e.g., the growth rates of monetary aggregates–that are observed by all market participants. One example, studied by Canzoneri, is a two-period targeting procedure requiring that the average money growth rate per two periods equal the socially desired rate. More generally, provided that the procedure does not depend on the monetary authority's private information and the monetary authority can control perfectly the targeted variable, the procedure is operational.

This paper extends Canzoneri's analysis of a two-period targeting procedure to a multi-period setting to investigate the scope of flexibility, in terms of the number of targeting periods, that should be given to the monetary authority. For example, Congress could pass legislation mandating the monetary authority to announce a

targeting period, during which time the growth of the money stock must average the rate corresponding to the (given) socially optimal inflation rate. Such an extension permits the analysis to identify the key factors that influence the optimal choice of the time interval over which the monetary authority, facing a trade-off between output stability and inflation stability, must hit its target for money growth.

Under this procedure, the longer is the the targeting period, the greater is the degree of flexibility permitted in policy and the greater is the equilibrium inflationary bias in each period. The optimal targeting period embodies the optimal trade-off between the cost of the remaining inflationary bias and the loss of flexibility to accommodate the predictable component of money demand shocks - i.e. the monetary authority's private information - relative to the policy that is fully discretionary.

As the monetary authority's preference for inflation stability increases relative to its preference for output stability, the optimal targeting period becomes longer. The basic intuition for this result is that the monetary authority's incentive to create surprises decreases, thereby decreasing each period's equilibrium inflationary bias and, hence, increasing the degree of flexibility afforded by the N-period targeting procedure to react to its private information. As the monetary authority's preference for inflation stability becomes very large, however, the constraint imposed by the targeting procedure is no longer desirable (or necessary) because the inflationary bias that emerges in the full-discretionary solution becomes infinitesimal. In this case, the optimal target period is infinite. In the other extreme case where the optimal target period is one, the targeting procedure simplifies to a constant money growth rule. Such a rule eliminates the inflationary bias, but at the cost of sacrificing flexibility that would otherwise permit the monetary authority to react to its private information about money demand shocks. The constant money growth rule is more likely to emerge as the optimal targeting policy as the weight

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that the monetary authority attaches to inflation stability approaches zero, given the relative size of the monetary authority's private information to its incentives.

In what follows, the next section briefly presents the model of monetary policy with private information in a multi-period setting and analyzes the monetary authority's optimal, time-consistent monetary policy subject to the N-period average targeting constraint. Section 3 presents simulations of the model to illustrate how the parameters of the model,–particularly, the monetary authority's preference for inflation stabilization relative to that for output stabilization and the *value* of the private information (i.e., the variance of the predictable part of the disturbance to money demand that should be accommodated to stabilize inflation and output)–influence the optimal choice of the target period. The main finding of this exercise is that, given that a finite period targeting procedure dominates the full-discretionary policy, optimality implies extremely limited, if any, flexibility permitted in monetary policy. This finding is surprising in that it is not driven by any skepticism about the accuracy of the monetary authority's private forecast. As such, this paper provides further support to the importance of taking into account the credibility problem in addition to the monetary authority's forecasting ability when optimally designing feasible monetary rules. Finally, section 4 offers some concluding remarks, including possible extensions of the analysis.

2 A Model of Monetary Policy with Multi-Period Targeting

This section presents a simple economic model to investigate the efficacy of multi-period average targeting procedure to approach a better outcome than that achieved with full discretion when the monetary authority has private information. Following conventional practice, the analysis builds on a standard rational-expectations

supply function,

$$y_t = y^n + \theta(\pi_t - \pi_t^e) \qquad \theta > 0, \tag{1}$$

where π_t denotes the inflation rate, y^n, the natural level of output, and π_t^e, the wage setters' expectation of inflation conditional on information available at the end of period t-1.

The following quantity equation determines the equilibrium price level:

$$m_t - p_t = y^n - v_t, \tag{2}$$

where m_t and p_t equals the logs of the money supply and the price level and v_t is the log of the velocity of money, assumed to follow a random walk. The equilibrium inflation rate is obtained by taking the first-difference of (2),

$$g_t - \pi_t = \delta_t, \tag{3}$$

where $\delta_t = v_{t-1} - v_t$ and g_t equals the growth rate of money, the monetary authority's instrument.[5] δ_t is an *i.i.d.* random variable with a zero mean and a finite variance, σ_δ^2. When wages are set, δ_t is not known, i.e., $\delta_t^e = 0$. The expression in (3), then, implies that wage setters' expectation of inflation depends solely on the monetary authority's policy, g_t. This expectation, g_t^e, ultimately depends on the monetary authority's strategy.

To study alternative strategies for the monetary authority, the analysis to follow assumes that the monetary authority chooses its policy to maximize its expected N-period average utility:

$$U = E_0\{\frac{1}{N}\sum_{t=1}^{N} u_t\} \tag{4}$$

where, one-period utility in period t is given by

$$u_t = -(y_t - ky^n)^2 - s(\pi_t - \pi^*)^2, \quad k > 1,$$

$E_\tau\{\cdot\}$ is an expectations operator conditional on $t = \tau$ information, and $\infty > N \geq 1$ denotes the length of the targeting period. For $N = \infty$, the expected average utility is given by $E_t(u_t)$.[6] ky^n represents the log of the socially desirable output level.[7] π^* is the socially optimal inflation rate, and s is the weight the monetary authority attaches to its goal of inflation stability relative to its goal of output stability. Recalling that $\delta_t^e = 0$ and using (1) and (3), the monetary authority's one-period utility can be expressed as,

$$u_t = -(g_t - g_t^e - \delta_t - y^*)^2 - f(g_t - \delta_t - \pi^*)^2, \tag{5}$$

where, for notational simplicity, $f = \frac{s}{\theta^2}$ and $y^* = (k-1)\frac{y^n}{\theta}$.

After period t wages are set, the monetary authority chooses its policy, g_t. In contrast to wage setters, the monetary authority receives some information about the disturbance to the money demand equation (δ_t) after wages are set but before policy actions are taken. Specifically, it has a private forecast of this disturbance, $d_t = E_t\{\delta_t\}$ that satisfies

$$\delta_t = d_t + \epsilon_t, \tag{6}$$

where ϵ_t is an $i.i.d.$ disturbance realized after policy is implemented. This forecast error has a zero mean, a finite variance, σ_ϵ^2, and no correlation with d_t. Similarly, d_t is $i.i.d.$ with a zero mean and a finite variance, σ_d^2. Section 3 discusses the case when d_t is serially correlated. Although wage setters observe δ_t and π_t after g_t is set, they cannot distinguish the monetary authority's forecast, d_t, from the forecast error ϵ_t.[8]

Before deriving the optimal, time-consistent monetary policy with multi-period targeting, two benchmark solutions are presented for the purpose of comparison. The first solution, the efficient solution, is that which would obtain if there were some commitment technology that would permit the monetary authority to adhere to a contingent rule, while truthfully revealing its private information. The second

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solution, the full discretionary solution, assumes that the monetary authority takes wage setters' expectations as given. It is identical to the case where $N = \infty$, since an infinite-period targeting procedure is equivalent to no constraint on the monetary policy. As indicated below, even when $N = \infty$, reputational considerations are not relevant given the existence of the monetary authority's private information.

2.1 The Efficient Solution

Assuming a full commitment technology to force the monetary authority to truthfully reveal its private information and to adhere to a contingent rule so that it could essentially influence wage setters' expectations in a way that is consistent with its policy, the optimal monetary policy, denoted by $\hat{g}$, is given by

$$\hat{g}_t = \pi^* + d_t, \tag{7}$$

for $t = 1, 2, \cdots$, which yields the following expected average utility for the monetary authority,

$$\hat{U} = -(1 + f)\sigma_\epsilon^2 - y^{*2}. \tag{8}$$

Note that the money growth rule in (7) completely accommodates money demand shocks to stabilize inflation, but it does not attempt to create surprise inflation in a fruitless effort to increase output above the natural level.

2.2 The Full-Discretionary Solution[9]

Under an alternative assumption that the monetary authority does not consider the impact it can have on wage setters' expectations, it maximizes the expectation of (5) conditional on its forecast of the disturbance to money demand, subject to (6), taking g_t^e as given. The wage setters' expectation of the associated first order

condition implies $g_t^e = \pi^* + \frac{y^*}{f}$. By substituting g_t^e back into the first order condition, one can verify that the money growth rate under this regime, denoted by $\bar{g}$, is given by

$$\bar{g}_t = \pi^* + d_t + \frac{y^*}{f}. \tag{9}$$

Note that the monetary authority's private information is fully revealed in the outcome. Although the monetary authority can do no better than to set its policy according to (9), given wage-setters' expectations, the monetary authority's incentive to create surprise inflation generates an inflationary bias, $\frac{y^*}{f}$. Even if the monetary authority had no private information, this bias would emerge provided that it took expectations as given.

The inefficiency of this solution is revealed by comparing the expected average utility of the monetary authority, in this regime, given by

$$\bar{U} = -(1 + f)\sigma_\epsilon^2 - (1 + \frac{1}{f})y^{*2}, \tag{10}$$

to that obtained in the efficient regime, given by (8). The difference between (8) and (10), $\frac{y^{*2}}{f}$, captures the disutility of the inflationary bias.

2.3 The N-Period Targeting Solution

As is widely recognized, while the full-discretionary policy is not first-best, the efficient solution is not necessarily a feasible outcome in the absence of a commitment technology. That is, the monetary policy (7) is not incentive compatible in the sense that, once wages are set, the monetary authority's optimal policy no longer corresponds to (7). Rather, the monetary authority would like to set $g_t = \pi^* + d_t + \frac{y^*}{1+f}$. In addition, the monetary authority's private information obscures the role of reputational considerations to diminish the inflationary bias. Without a complete information structure, wage setters cannot verify that the monetary authority has

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followed the efficient policy, $\hat{g}$. Moreover, the monetary authority's private information precludes the effectiveness of legislation to require the monetary authority to implement policy according to (7). Even if the legislation were binding, the monetary authority would have an incentive to lie, claiming that its forecast of δ_t equaled $d_t + \frac{y^*}{1+f}$ to disguise the optimal cheating policy, given $g_t^e = \pi^*$, as the efficient policy.

As a possible resolution to the inefficiency of the inflationary bias when the monetary authority cannot credibly reveal its private information, Canzoneri (1985) studies a 2-period average targeting procedure, requiring $g_1 + g_2 = 2\pi^*$. This procedure is attractive not only in its simplicity but in that its independence of the monetary authority's private forecast makes it operational. As a generalization of his analysis, consider an extended average targeting procedure that requires

$$\sum_{t=1}^{N} \tilde{g}_t = \pi^* N, \tag{11}$$

where $0 < N < \infty$ and $\tilde{g}$ denotes the money growth policy under the N period targeting procedure. For $N = \infty$, there is no effective constraint on the conduct of policy.

To derive the optimal, dynamically consistent monetary policy under this average targeting regime, a backward solution concept is appropriate. Specifically, the monetary authority maximizes the sum of the expected value of (5) in $t = N$ and $t = N\text{-}1$ with respect to $\tilde{g}_{N-1}$ subject to the forecast d_{N-1} and (11), taking g_N^e and g_{N-1}^e as given. Repeating this exercise for $t = N\text{-}2$, $N\text{-}3$, $\cdots$, one can find that

$$\tilde{g}_t = \tilde{g}_t^e + \frac{(N-t)(1+f)}{N-t+(N-t+1)f} \, d_t \tag{12}$$

where

$$\tilde{g}_t^e = \frac{N\pi^*}{N-t+1} + \frac{(N-t)y^*}{(N-t+1)f} - \sum_{\tau=1}^{t-1} \frac{\tilde{g}_\tau}{N-\tau+1}$$

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for $t = 1, \cdots, N$.

To eliminate past $\tilde{g}$ so as to express the optimal policy only in terms of current and past d as well as the parameters of the model, (12) is used to find $\tilde{g}_1$ and sequentially used to find $\tilde{g}_t$, $t = 2, \cdots, N$, by substituting in past $\tilde{g}_t$. That is,

$$\tilde{g}_t = \Psi(t) - \sum_{\tau=1}^{t-1} \frac{\Psi(\tau)}{N - \tau} \tag{13}$$

where

$$\Psi(t) = \frac{N\pi^*}{N - t + 1} + \frac{(N - t)y^*}{(N - t + 1)f} + \frac{(N - t)(1 + f)}{N - t + (N - t + 1)f} \; d_t$$

for $t = 1, \cdots, N$. By rearranging (13) and simplifying, one can derive the optimal monetary policy subject to the N-period targeting constraint:

$$\tilde{g}_t = \pi^* + \frac{(N - t)y^*}{(N - t + 1)f} + \frac{(N - t)(1 + f)}{N - t + (N - t + 1)f} \; d_t$$

$$- \sum_{\tau=1}^{t-1} \left[\frac{y^*}{(N - \tau + 1)f} + \frac{1 + f}{N - \tau + (N - \tau + 1)f} \; d_\tau \right], \tag{14}$$

for $t = 1, \cdots, N$.

Expected average utility under this regime is given by

$$\tilde{U} = -y^{*2} - (1 + f)\sigma_\epsilon^2 - \frac{y^{*2}}{Nf} \sum_{t=1}^{N} \left(\frac{N - t}{N - t + 1} - \sum_{\tau=1}^{t-1} \frac{1}{N - \tau + 1} \right)^2$$

$$- \frac{f^2(1 + f)}{N} \sigma_d^2 \sum_{t=1}^{N} \left[\frac{1}{N - t + (N - t + 1)f} \right]^2 \tag{15}$$

$$- \frac{f(1 + f)^2}{N} \sigma_d^2 \sum_{t=1}^{N} \sum_{\tau=1}^{t-1} \left[\frac{1}{N - \tau + (N - \tau + 1)f} \right]^2.$$

Note that the sum of the first two terms in the above expression equals the expected average utility under the efficient solution. Hence, the last three terms reflect the inefficiency of the average targeting procedure.

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Assuming the optimal targeting period N^* is finite[10], it maximizes (15). For $N < N^*$, the average inefficiency is decreasing, while, for $N > N^*$, the average inefficiency is increasing as shown with an example in Figure 1. The horizontal line in the figure measures the normalized, average inefficiency of the full-discretionary solution when $f = 1.0$ and $\frac{y^*}{\sigma_d} = 1.35$, i.e., $\frac{y^{*2}f}{\sigma_d^2} = 1.82$. The inverted V-shaped curve measures the normalized, average inefficiency of a multi-period targeting over various N, showing that $N^* = 6$ for the chosen parameter values.

The monetary policy in (14) is dynamically consistent, like the full-discretionary solution. Note, however, that for finite N the inflationary bias is lower than that in the full-discretionary solution. From (13) or (14) in $t = 1$, for example, one can verify that the bias is $\frac{(N-1)y^*}{Nf}$, which is reversed in each of the subsequent N-1 periods, by increments of $\frac{y^*}{Nf}$; similarly, the bias in $t = 2$ is $\frac{(N-2)y^*}{(N-1)f}$ which is reversed in the subsequent N-2 periods, in increments of $\frac{y^*}{(N-1)f}$. It should be noted that the increments would not be of the same magnitude if there were discounting. In the case of no discounting, the net effect of the remaining inflationary bias on the monetary authority's utility is captured by the third term in (15). Because any period's inflationary bias, that must eventually be reversed over the remainder of the targeting period, increases as N increases, the loss in utility due to the remaining inflationary bias increases as N becomes large. Observe that this loss converges to $\frac{y^{*2}}{f}$ as N goes to infinity.

In contrast to the full-discretionary and the efficient solutions, the monetary policy in (14) involves only a partial accommodation of the current shock. The targeting procedure limits the monetary authority's flexibility to react to its information so as to stabilize inflation and output. But, as N approaches infinity, the accommodation is full. The effect of increasing the monetary authority's flexibility to react to its private information is partly captured by the fourth term in (15) which is decreasing in N. That is, by relaxing the monetary authority's constraint,

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increasing the length of the targeting period provides more leeway to achieve output and inflation stabilization goals.

The constraint (11), however, requires that the accommodation in every period be reversed in subsequent periods. The effect of this requirement can be observed easily in (13) or (14). In particular, as the constraint becomes more binding,– i.e., t approaches N–the monetary authority's reaction to the current shock approaches zero. The reaction to the shock in time t, d_t, is reversed in increments of $\frac{1+f}{N-t+(N-t+1)}d_t$ in each of the remaining N-t periods. Again, that the increments of the reversal of a given reaction to a time t shock are of equal magnitude is due to the assumption that the monetary authority has a zero discount rate. The fifth term in (15) reflects the cost of having to reverse earlier reactions to shocks. As N increases, that loss in utility increases. Combining the fourth and fifth terms of (15) yields the net effect of the flexibility permitted by the targeting procedure. As N becomes large enough, the value of flexibility permitted by the targeting procedure falls.

That the sum of the last three terms in (15) is increasing in magnitude in N for $N > N^*$ implies that the targeting procedure becomes more inefficient as N increases above the optimal targeting period. Nevertheless, the targeting procedure will dominate the full-discretionary solution ($N = \infty$) provided that the magnitude of the sum of those terms is less than $\frac{\nu^{*2}}{f}$, the disutility of the inflationary bias that would emerge in the full-discretionary equilibrium. Moreover, a multi-period targeting procedure will dominate a constant growth rule provided that the magnitude of the sum of those terms is less than $(1 + f)\sigma_d^2$. Note that a sufficient condition for N^* to be finite is that $(1 + f)\sigma_d^2 < \frac{\nu^{*2}}{f}$–i.e., a strict rule dominates the full-discretionary solution. Indeed, as shown in the next section, given that N^* is finite, it is most likely to be equal to one.

3 Optimal Targeting Periods: Simulations of the Model

The optimal degree of flexibility afforded by targeting procedure in terms of the length of the targeting period should depend on the monetary authority's ability to forecast (money demand disturbances that are not reflected in existing wage contracts)[11] and the importance of stabilization relative to the disutility arising from the credibility problem (inflationary bias). As in much of this literature, however, analytically deriving the optimal targeting period, the N^*, that maximizes expected average utility, (15), is not possible despite the simplicity of the model. This section summarizes the results of simulations that specify the two key parameters of the model, $\frac{\mu^*}{\sigma_d}$ and f–respectively, the weighted difference between the players' output goal relative to the magnitude of the predictable part of the shock and the ratio of the weight attached to inflation stability relative to output stability in the monetary authority's preferences, s, to the elasticity of output with respect to unanticipated inflation, θ. For various parameter values, N^* is reported in Table 1. Discrete jumps in N^*, as the parameter values vary, are due to the fact that changes in the parameter values are not sufficiently small.

A close inspection of the table reveals two important implications of the simulation exercise. First, for a given $\frac{\mu^*}{\sigma_d}$, as f increases, the optimal targeting period gets larger. That is, as the monetary authority's concern for inflation stability gets larger relative to its concern for output stability or the elasticity of output with respect to unanticipated inflation becomes smaller, the optimal targeting length increases. The basic idea behind this implication is rather intuitive: as f increases the monetary authority's incentive to push output beyond its natural level falls so that the inflationary bias that would emerge in the full-discretionary equilibrium falls. Accordingly, the scope of flexibility under the targeting procedure increases. For large values of f, the optimal targeting solution boils down to the full-discretionary

solution, in which there is complete flexibility. In this case, the inflationary bias that emerges under full discretion disappears so that the limits imposed by the targeting procedure are not necessary.

This implication is similar to that of Rogoff's (1985) analysis of the perverse policymaker though Rogoff distinguishes the policymaker's preference from that of the society and thereby gives institutional interpretation to the policymaker's preference, while the present analysis does not.[12] Nevertheless, as in Rogoff's, the inflationary bias that emerges in the full-discretionary outcome becomes less severe and social welfare is enhanced, as the monetary authority's dislike for inflation increases for given a social preference. The crucial distinction between the present analysis and that of Rogoff lies in the interpretation of flexibility. While Rogoff (1985) roughly interprets increasing the policymaker's relative preference for price stability as limiting flexibility in a one-period setting, the present multi-period analysis interprets increases in flexibility in terms of increasing N, finding that the more perverse the policymaker, - i.e., the larger f -, the greater are the advantages of full flexibility in monetary policy.

The second implication of the simulation exercise is that, for a given f, as $\frac{y^*}{\sigma_d}$ increases, the optimal targeting period becomes shorter. There are two forces at work here. As y^* increases for a given σ_d, the difference between the socially optimal output target and the natural level of output becomes larger; as a consequence, the inflationary bias that would emerge in the full-discretionary solution becomes larger, thereby detracting from the degree of flexibility afforded by the targeting procedure. Further, as σ_d falls for a given y^*, the expected value of reacting to current shocks (the monetary authority's private information) to stabilize inflation and output falls. Thus, the strict one-period targeting rule becomes optimal for sufficiently high values of $\frac{y^*}{\sigma_d}$. This implication further distinguishes our results from that of Rogoff (1985). Specifically, Rogoff finds that some flexibility in monetary policy is

almost always better than none (i.e., a constant money growth rule or, in terms of his analysis, an extremely perverse policymaker). In contrast, the present analysis finds that a constant growth rule (N^*=1) can emerge as the optimal policy for some values of the parameters. This distinction arises both from an explicit consideration of the policymaker's forecasting ability - i.e., the variance of the predictable part of money demand shocks that should be accommodated to stabilize inflation and output relative to the difference in the output goals - and use of a multi-period setting in contrast to Rogoff's one-period setting. Even if there were supply shocks as in Rogoff's (1985) model, this distinction would emerge

It is difficult to interpret the simulation results directly in terms of actual data because the difference in output goals is measured in (log) levels and the scale that would be appropriate is not clear. Nevertheless, Table 1 suggests that the full-discretionary solution generally dominates any finite targeting procedure.[13] But, provided that there is room for improvement by imposing a binding constraint on monetary policy, the table illustrates that $N^* = 1$. This result is rather interesting, considering the fact that, in many nations where the central banks have adopted some form of a monetary targeting procedure, the targeting period coincides with the wage contract period, typically a year. The result is also illustrated by Figure 2, which depicts regions for $N^* = 1, 2, 3, 4$ and $N^* \geq 5$ in terms of combinations of f and $\frac{y^*}{\sigma_d}$. Even with this limited opportunity set, the figure shows that the regions for which $N^* = 1$ and $N^* \geq 5$ are the largest areas among those under consideration. More generally, by sequentially increasing the opportunity set and deriving explicit regions for $N^* \geq 5$, (e.g., $N^* = 5$, $N^* = 6$, etc.) it is possible to see that N^* become progressively narrower as $N^* < \infty$ increases. Hence, assuming N^* is finite, the optimal degree of flexibility is likely to be extremely limited, if not entirely eliminated, and a constant money growth rule generally dominates all other average targeting procedures with finite N.

Assessing the empirical content of the simulation results is made more difficult without knowledge of the value of the parameter f. Remember, however, that $f = \frac{s}{\theta^2}$, the weight of inflation stability relative to output stability in the monetary authority's objective function divided by the square of output elasticity with respect to unanticipated inflation. This ratio is not likely to be very small if the monetary authority is concerned about inflation at least as much as about output levels and the output elasticity with respect to unanticipated inflation is not very high. If this is indeed the case, the simulation results would indicate that multi-period targeting procedures more than the one period are not likely to be optimal, implying that flexibility for the monetary authority should be extremely limited. This result is surprising, in that, although it appears to be in the monetarist spirit, it does not depend on any skepticism about the monetary authority's forecasting ability. Accordingly, this exercise provides further support to the importance of taking into account the credibility problem in addition to the monetary authority's forecasting ability when optimally designing feasible monetary rules.

One caveat to the above analysis should be noted, however. Specifically, the assumption that d_t is not serially correlated is a strong assumption. Indeed, the above extreme results might appear to be driven partly by the transitory nature of the monetary authority's private information. While the effect of the persistence of shocks to the growth of velocity on the targeting period is not obvious in the context of this model, such persistence is likely to increase the monetary authority's desire for maintained flexibility.

4 Concluding Remarks

This paper has investigated the efficacy of average monetary targeting to reduce the inflationary bias that otherwise emerges as a result of the monetary authority's

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incentive to surprise agents in an effort to increase output beyond its natural level. Reputational considerations and the imposition of a contingent rule, as reasonable methods of eliminating the bias while retaining flexibility for output and inflation stabilization, are called into question when the monetary authority has some private information and there is no mechanism to enforce a truthful dissemination of that information. Provided that the inflationary bias is sufficiently large, an average monetary targeting procedure to eliminate the bias will be optimal. As the targeting period gets longer, the amount of flexibility permitted by the procedure increases, but at a cost of a higher equilibrium inflationary bias. Hence, the optimal targeting period defines the optimal trade-off between the cost of limited flexibility and the cost of the remaining bias. Generally, if there is room for improvement with the average targeting procedure, a targeting policy with extremely limited flexibility seems to be the optimal policy.

As indicated earlier, that the optimal targeting period is very short might appear to be driven partly by the transitory nature of the monetary authority's private information. Thus, an interesting extension of the analysis, left for future research, involves giving the monetary authority's private information some persistence and examining how much such persistence will increase the monetary authority's desire for maintained flexibility. Also, given this persistence, the monetary authority might be able to employ Crawford and Sobel's (1982) concept of *cheap talk* to partly reveal its private information. Specifically, it could announce a target range that partially reveals the persistent (permanent) component of its private information. Accordingly, it could keep the equilibrium inflationary bias low while enhancing the scope flexibility permitted by the targeting procedure. While the target period, N, would be determined from the stationary part of the model, the level and width of target range would be determined every N periods on the basis of the persistent component of the monetary authority's private information.

Another possible extension would be to introduce different shocks, such as productivity shocks into the model, as Rogoff (1985) does. With a richer model specification in a multi-period setting, we can consider the relative merits of money, interest rate, inflation rate and nominal income targeting procedures and their respective implications for the determination of the optimal targeting period length.

FOOTNOTES

1. See Meltzer (1989) whose skepticism about the Fed's forecasting ability leads him to advocate a constant money growth rate rule. Leijonhufvud (1984) provides a detailed discussion about the uncertainty generated by discretionary policy under different monetary regimes.

2. See Barro and Gordon (1983) and Rogoff (1987). For a general discussion about dynamic inconsistency, see Hillier and Malcomson (1984). A necessary, but not sufficient condition for dynamic inconsistency is that the government has fewer instruments than objectives.

3. Canzoneri (1985) shows that Rogoff's (1985) *perverse* policymaker solution to the precommitment problem suffers from a similar criticism when the information structure is asymmetric.

4. For complimentary analyses of monetary policy with private information, see Cukierman and Meltzer (1986) and Stein (1989). In contrast to these analyses that mainly focus on maintained secrecy in monetary policy arising from private information, the present paper tries to specify an operational rule that improves upon the dead-lock situation arising from the credibility problem.

5. As indicated earlier, for the targeting procedure to work, the analysis must assume that the monetary authority can perfectly control g_t if that is its target. That the Fed chooses to target M2 (and M3) rather than the monetary base, over which it has more control, could be related to the secrecy problem. See, for example, Cukierman and Meltzer (1986) who show that the monetary authority might choose a less precise procedure for policy implementation so as to maintain some degree of ambiguity and keep its information private to some extent. The present analysis does not permit a meaningful distinction between M1, M2, M3 or the monetary base.

6. The implicit assumption here that the monetary authority does not discount the future is not strong. A discount factor less than 1 only complicates the analysis without providing much additional insight. (A copy of the solution in the case of discounting is available from the authors upon request.)

7. See Canzoneri (1985, pp. 1058-59) for a detailed discussion of the motivations for the assumption that $k > 1$.

8. Given the sequence of actions by wage setters and the monetary authority relative to the timing of the realization of the monetary authority's private information and the transitory nature of that private information, Stein's (1989) notion of *cheap talk* is not operational in the context of this model. (See Oh and Garfinkel (1989) for a brief discussion of why the two-dimensionality of the credibility problem in monetary policy obscures the relevance of the cheap talk mechanism regardless of the timing of events. To make cheap talk effective in this framework with a slight variation in the sequence of events, it is necessary to limit flexibility in monetary policy.) Section 4 discusses the possibility of extending the model to incorporate the possibility of cheap talk in the multi-period targeting procedure. It should be noted that the assumption that $\delta_t^e = 0$ is not crucial here. Even if wage setters had reasonable forecasts of d_t, provided that the monetary authority's forecast is private, the analysis to follow is relevant.

9. In this static framework, this solution is equivalent to the (one-shot) Nash solution. As discussed below, however, this solution more generally is interpreted as an infinite-period, average targeting procedure.

10. Although it is extremely difficult to write down a closed form solution for N^*, it is possible to verify that N^* can be infinite for a certain set of parameter specifications. (See section 3.)

11. In fact, provided that the forecasting technology is not perfect (i.e., $\epsilon_t \neq 0$), the assumption about the timing of the realization of private information makes

the degree of inaccuracy of the monetary authority's forecasting irrelevant. Rather, it is the possible magnitude of the predictable part of the shock that is crucial for the determination of N^*. However, one can easily translate this magnitude into the degree of accuracy by assuming a different timing sequence.

12. Focusing on this distinction between the policymaker's preference and that of the society, Lohman (1989) analyzes an interesting problem of what incentive structure should be imposed on central banks. Ignoring this distinction, Flood and Isard (1989) follow an approach similar to that of the present analysis. However, they study the case when there is a non-stationary shock, finding that the strict rule with an *escape clause* achieves a better outcome than the strict rule only. For a general survey on this and related issues, see Persson and Tabellini (1990).

13. Additional simulations confirm this interpretation of the table. Moreover, they show that , for $f \geq \frac{\nu^*}{\sigma_d}$, the full-discretionary solution dominates all finite targeting procedures with $N \leq 1000$.

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Table 1
Optimal Target Periods[1]

					y^*/σ_d					
f	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
0.2	55	∞	∞	∞	∞	∞	∞	∞	∞	∞
0.3	5	∞	∞	∞	∞	∞	∞	∞	∞	∞
0.4	2	9	∞	∞	∞	∞	∞	∞	∞	∞
0.5	1	3	13	∞	∞	∞	∞	∞	∞	∞
0.6	1	2	4	16	∞	∞	∞	∞	∞	∞
0.7	1	1	2	5	19	∞	∞	∞	∞	∞
0.8	1	1	1	3	6	22	∞	∞	∞	∞
0.9	1	1	1	2	3	7	25	∞	∞	∞
1.0	1	1	1	1	2	3	7	28	∞	∞
1.1	1	1	1	1	1	2	3	8	30	∞
1.2	1	1	1	1	1	1	2	4	8	32
1.3	1	1	1	1	1	1	1	2	4	9
1.4	1	1	1	1	1	1	1	2	2	4
1.5	1	1	1	1	1	1	1	1	2	2
1.6	1	1	1	1	1	1	1	1	1	2
≥1.7	1	1	1	1	1	1	1	1	1	1

[1] Strictly speaking, $N^*=\infty$ indicates that the full-discretionary solution dominates only those finite multi-period targeting procedures for $N \leq 200$.
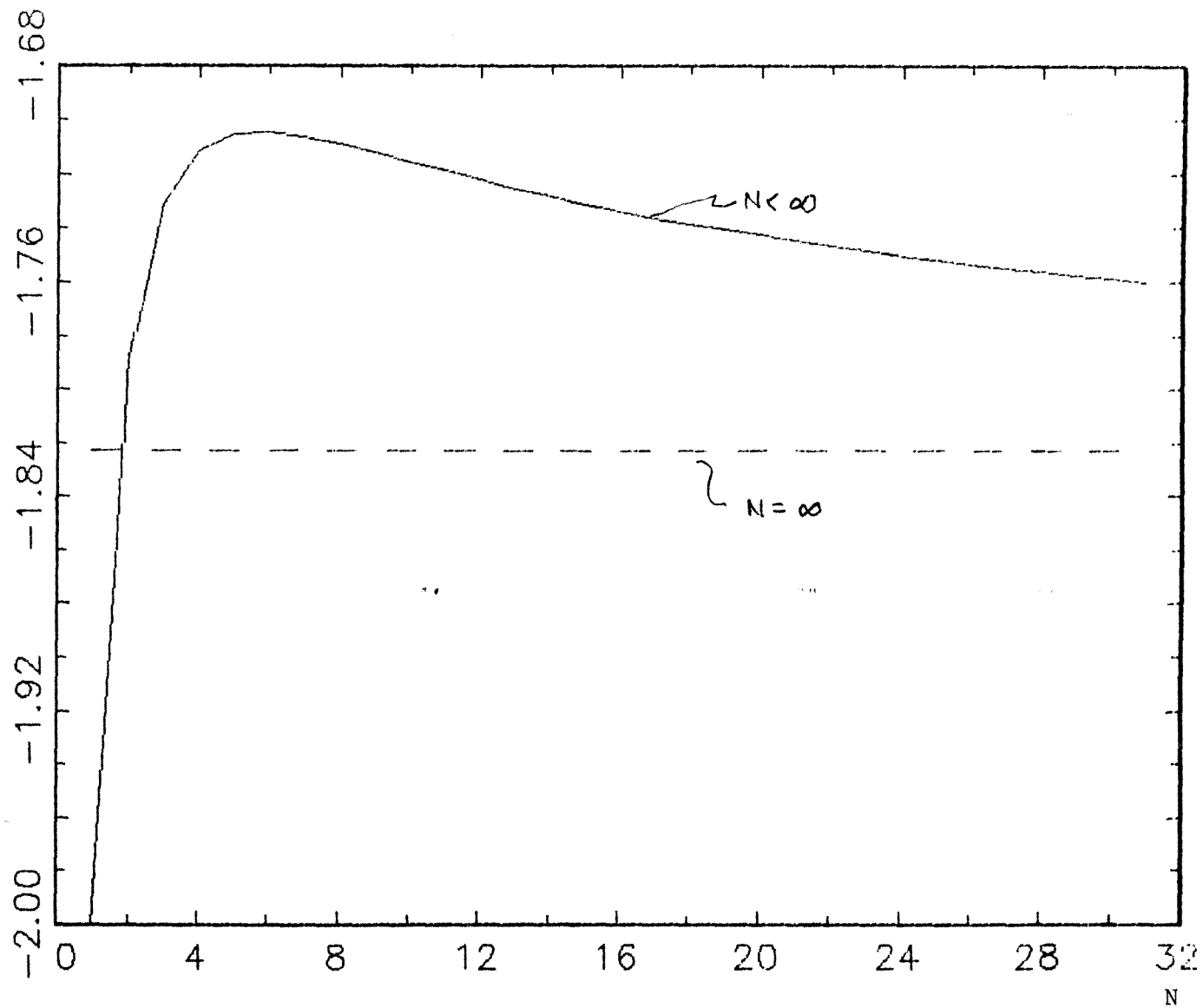
Normalized Inefficiency of Multi-Targeting Procedures
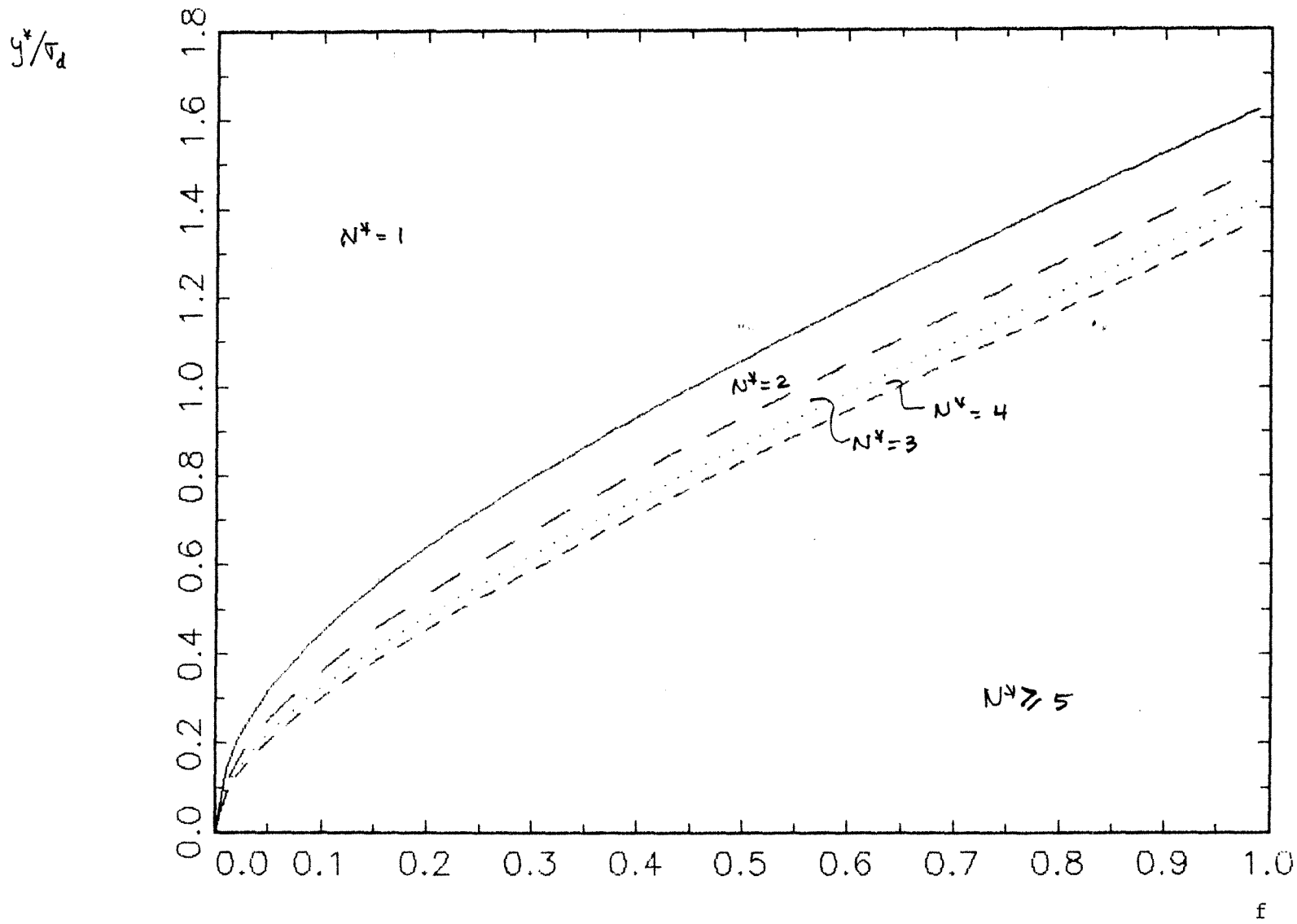

Figure 1

Optimal Targeting Periods

Figure 2