WORKING PAPER SERIES

When and How Much to Talk: Credibility and Flexibility in Monetary Policy with Private Information

Michelle R. Garfinkel
Seonghwan Oh

Working Paper 1990-004A
http://research.stlouisfed.org/wp/1990/90-004.pdf

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

When and How Much to Talk: Credibility and Flexibility in Monetary Policy With Private Information

June 1990

Abstract

This paper analyzes how noisy or imprecise announcements might partially remove the inefficiencies resulting from the credibility problem in monetary policy when the presence of non-verifiable private information adds another dimension to that problem. The analysis finds that imprecise or noisy announcements can be a meaningful form of communication only if it is possible to "tie" the hands of the monetary authority somehow. To the extent that it is otherwise efficient for policy to react to the monetary authority's private information, such announcements can be extremely costly in terms of the sacrifice in flexibility required to make them relevant. Surprisingly, the conditions under which the monetary authority can make more precise announcements are identical to those under which the monetary authority is less likely to prefer the noisy announcement equilibrium.

Michelle R. Garfinkel
Federal Reserve Bank of St. Louis
411 Locust Street
St. Louis, MO 63102

Seonghwan Oh
University of California
Los Angeles, CA 90032

We thank, without implication, Jean-Laurent Rosenthal, Guido Tabellini and the participants of the UCLA money workshop for helpful comments and discussions.

1 Introduction

To what extent should secrecy be permitted in the formulation and implementation of monetary policy? An argument against monetary policy secrecy follows easily from economic theory. Specifically, one could argue secrecy is not desirable as it limits the informational content of prices in financial markets and thereby detracts from an efficient allocation of resources.[1] Applying the seminal work of Crawford and Sobel (1982), however, Stein (1989) develops a theoretical explanation for secrecy. In his analysis, secrecy is an unavoidable consequence of the strategic aspects of policy. The basic idea is that, although the monetary authority would like to reveal its private information truthfully, it cannot do so precisely. The monetary authority's incentive, recognized by the market, to manipulate expectations whereby it can achieve a better outcome detracts from the credibility of its announcements to reveal its private information. But, by making noisy or imprecise announcements about its private information, the monetary authority can reveal this information credibly, though not perfectly. Because the announcement only partly communicates this information, some secrecy remains.

This paper further investigates the effectiveness and limits of noisy announcements by applying Crawford and Sobel's (1982) work to a slight variation of Canzoneri's (1985) more general economic framework. This application, which generalizes Stein's (1989) analysis, captures a well-known, fundamental trade-off that potentially emerges when the monetary authority possesses some private information relevant for policy–namely, a trade-off between discipline to prevent the monetary authority from pursuing suboptimal policies biased toward inflation[2] and flexibility to permit the monetary authority to react efficiently to disturbances in the economy.[3]

Such a trade-off is driven in the analysis by the way in which the essence of the credibility problem in monetary policy is characterized. First, the credibility problem

is two-fold in the sense that even if there were no private information, a credibility problem in monetary policy would remain because the efficient policy is not dynamically consistent; private information adds another dimension to the problem.[4] Second, the nature of this credibility problem is such that, without any restrictions on policy, the monetary authority's incentive to manipulate wage setters' expectations so as to create surprise inflation is independent of its private information. The present analysis finds that, in this case, noisy announcements alone are impotent even in partially resolving the credibility problem. The analysis is enriched by the assumption, borrowed from Canzoneri (1985), that the monetary authority's private information is never directly observed by the public so that its private information is not verifiable. This assumption precludes the possibility of reputational considerations or some commitment technology supporting the efficient outcome. Otherwise, as in Stein (1989), the credibility problem might be mitigated easily without sacrificing any flexibility.

Indeed, the present analysis argues that, given the characterization of the credibility problem briefly described above, combined with the assumption that the monetary authority's private information is never directly observed by the public, noisy announcements will be useful only under very restrictive conditions. Specifically, noisy announcements can be meaningful only if it is possible to *tie* the monetary authority's hands somehow. By limiting flexibility in policy, it is possible to link the monetary authority's incentive to manipulate expectations to its private information and thereby make noisy announcements believable. But, if it is otherwise beneficial for the monetary authority to react to its private information, noisy announcements can be extremely costly in terms of the sacrifice in flexibility required to make them meaningful. Thus, the analysis shows generally that noisy announcements need not always be preferred by the monetary authority. Moreover, the analysis shows that the conditions under which noisy announcements are more likely to be preferred are identical to those conditions under which the announcements are less informative.

This analysis suggests, then, that the trade-off between the benefits of discipline and flexibility in policy that is heightened by the presence of private information might not be mitigated with noisy announcements.

In what follows, the next section presents the basic framework to analyze monetary policy with private information and shows that, although monetary authority would like to reveal this information, it cannot do so truthfully and precisely. Section 3 derives the conditions under which noisy announcements can and cannot enhance the monetary authority's welfare. Finally, section 4 offers some concluding remarks, including a possible extension of the analysis.

2 A Model of Strategic Monetary Policy with Private Information

The analysis builds on a slight variation of Canzoneri's (1985) model, which provides a general framework for examining the implications of private information for monetary policy and characterizing the equilibrium with noisy announcements.[5] The supply function is a standard rational expectations one:

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

where y_t denotes the log of output in time t and y^n denotes the log of output corresponding to the natural rate of unemployment; π_t denotes the rate of inflation realized at the end of time t; and π_t^e denotes wage setters' expectations of inflation conditional on information available to the public at the beginning of time t as specified below.

The following simple quantity theory equation determines the equilibrium price level:

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

where m_t and p_t denote respectively the logs of the money supply and the price level in time t; and, v_t is an innovation to money demand 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. δ_t is an *i.i.d.* random variable with a zero unconditional mean and a finite variance, σ_δ^2.

To make the notion of secrecy operational in this model, assume that, in contrast to wage setters, the monetary authority has a forecast of this disturbance.[6] Its *private* forecast, $f_t \equiv E(\delta_t)$, satisfies

$$\delta_t = f_t + \epsilon_t, \tag{4}$$

where ϵ_t, the monetary authority's forecast error, has an expected value of zero, a finite variance, σ_ϵ^2, and no correlation with the forecast. In this section, f_t is assumed to be serially uncorrelated. (The case where f_t is serially correlated is discussed in section 4.) In contrast to Canzoneri (1985), the present analysis assumes this forecast is made just before wages are set. But, in the absence of any announcements, $\pi_t^e = g_t^e$. Moreover, although wage setters observe the disturbance to money demand, δ_t, after monetary policy is implemented and prices are determined, they cannot distinguish the monetary authority's forecast from its forecast error. This non-verifiability assumption enriches the analysis as will become obvious below.

To study the behavior of the monetary authority, the analysis assumes that the monetary authority has two goals: output and inflation stabilization. In period t, its utility is given by

$$u_t = -(y_t - ky^n)^2 - s(\pi_t - \pi^*)^2, \quad k > 1 \tag{5}$$

where $k > 1$ reflects the notion that the monetary authority desires to bring output beyond its natural level.[7] The parameter s is the weight the monetary authority

places on its objective of stabilizing inflation around its target level, π^*, relative to its objective of hitting its output target, ky^n.

Using (1) and (3), the monetary authority's utility in period t (5) can be written as

$$u_t = -(g_t - g_t^e - \delta_t + \delta_t^e - y^*)^2 - \phi(g_t - \delta_t - \pi^*)^2, \tag{6}$$

where, for notational simplicity, $y^* = (k-1)\frac{y^n}{\theta}$ and $\phi = \frac{s}{\theta^2}$. The monetary authority's problem, then, is to choose g_t to maximize the expected value of (6) given f_t. As shown below, the solution depends on how the monetary authority treats wage setters' expectations. As indicated above, the absence of any meaningful announcements implies $\delta_t^e = 0$.

2.1 The Efficient Solution

First consider the benchmark case in which there exists a full commitment technology to force the monetary authority to truthfully reveal through an announcement, for example, 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. Then, the optimal monetary policy, denoted by $\hat{g}_t$, is

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

for $t = 1, 2, \cdots$. Wage setters set $\pi_t^e = \pi^*$. With these expectations, the policy in (7) yields the following expected one-period utility to the monetary authority,

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

Note that the money growth rule in (7) completely accommodates the predicted component of 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 No Announcements: The Full-Discretionary Solution

Alternatively, suppose the monetary authority takes wage setters' expectations as given. That is to say, the monetary authority makes no announcements about its policy or about its forecast, as if it were ignoring any possible impact that it could have on expectations. In this case, the monetary authority chooses g_t to maximize the expected value (6) conditional on its forecast of the disturbance to money demand, subject to (3) and taking π_t^e as given. The wage setters' (unconditional) expectation of the associated first-order condition, with $\delta_t^e = 0$, implies $g_t^e = \pi^* + \frac{y^*}{\phi}$. By substituting get back into the first-order condition, one can verify that money growth under this regime, denoted by $\bar{g}_t$, is

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

for $t = 1, 2, \cdots$. Note that the solution concept employed here is identical to that which typically is referred to as the *one-shot, Nash* or the *full-discretionary* solution in the literature. The important feature of this policy is that it generates an *inflationary bias*, $\frac{y^*}{\phi}$.

The inefficiency of this solution is revealed by comparing the expected one-period utility to the monetary authority, in this regime, given by

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

to that obtained in the efficient regime, given by (8). The difference between (8) and (10), $\frac{y^{*2}}{\phi}$, captures the disutility of the inflationary bias. Without a commitment technology to force the monetary authority to truthfully reveal its private information, this inflationary bias is not easily mitigated.

2.3 Full Announcements: Cheating

Suppose, in contrast to the previous section, the monetary authority attempts to reveal its private information through (full) announcements to achieve the efficient solution and avoid the inflationary bias. As Canzoneri (1985) shows, however, making truthful (precise) announcements is not incentive compatible. Specifically, given its private information and its influence on wage setters' expectations, the monetary authority would always announce that it will adhere to the efficient policy:

$$\hat{g}_t^A = \pi^* + f_t^A, \tag{11}$$

where f_t^A is the monetary authority's announcement of its private forecast. But, given $g_t^e = g_t^A$ and $\delta_t^e = f_t^A$, the monetary authority has an incentive to lie about its forecast according to

$$f_t^A = f_t + \frac{y^*}{1+\phi}. \tag{12}.$$

By misrepresenting its forecast while following the announced policy in (11), the monetary authority could disguise its optimal cheating policy, given by

$$g_t^{CH} = \pi^* + f_t + \frac{y^*}{1+\phi}, \tag{13}$$

as the efficient policy. If such a cheating policy were possible, it could increase the monetary authority's utility by $\frac{y^{*2}}{(1+\phi)}$.

Of course, rational wage setters recognize the monetary authority's incentive to cheat; hence, as argued by Kydland and Prescott (1977), among others, wage setters would not expect the monetary authority to follow the efficient policy and would incorporate the inflationary bias into their expectation of monetary policy and, accordingly, into their expectations for inflation. The result is that full announcements are not credible and, consequently, not an effective method by which the equilibrium inflationary bias can be alleviated; the equilibrium with full announcements is identical to the full-discretionary solution characterized above.

It is important to note that the presence of private information limits the effectiveness of possible solutions to the credibility problem. Specifically, because the forecast is non-verifiable private information, a legislative approach depending on that information is not operational to achieve a better outcome than that in the full-discretionary solution. Similarly, in contrast to Barro and Gordon (1983), the monetary authority's private information obscures the relevance of reputational considerations in achieving a better outcome. Although wage setters can verify that the policy in (11) was implemented, they cannot verify that $f_t^A = f_t$ unless the private forecast were always perfect ($\epsilon_t = 0$ for all t) or directly observable.

3 A Constant Money Growth Rule and Noisy Announcements

That the monetary authority cannot make precise announcements about its private information does not necessarily imply that all announcements are worthless. Recently, Stein (1989) applies the analysis of Crawford and Sobel (1982) to show that the monetary authority can reveal its private information regarding its preferences about the behavior of the exchange rate partially through imprecise or noisy announcements. That is, the monetary authority announces a range in which its target for the exchange rate falls, rather than a specific point value. Stein refers to these announcements as *cheap talk*, for they costlessly reveal at least some of the monetary authority's private information. Here, Crawford and Sobel's analysis is applied to the present model to show more generally how secrecy can be partially removed through noisy announcements–i.e., announcements made by the monetary authority stating the range in which its private forecast falls. This application highlights the trade-off between discipline and flexibility in monetary policy by illustrating that such talk is not costless in this framework. That is, noisy announcements need not be cheap.

3.1 The Cost of Cheap Talk: An Example.

Although making imprecise announcements, in contrast to signaling, is costless in that no resources expended in the process, making this form of communication meaningful in the present context is costly. This cost, which distinguishes the present analysis from that of Stein, arises from the nature of the credibility problem in policy. As indicated in the previous section, the two-dimensional nature of the monetary authority's credibility problem implies that even if it were possible to make the monetary authority reveal its private forecast, an additional commitment mechanism would be necessary to support the first-best policy in (7). Similarly, the monetary authority's incentive to create surprise inflation would not disappear if it were to make noisy announcements about its private forecast. The monetary authority would always want to create surprise inflation given wage setters' expectations of δ_t conditional on the announcement, provided that their associated expectations for inflation were less than $\pi^* + \frac{y^*}{\phi}$. Accordingly, wage setters would incorporate this incentive into their expectations to discourage the monetary authority from creating surprise inflation. And, the resulting outcome would just be the full-discretionary equilibrium in section 2.2 without any announcements.

Moreover, without any restrictions on policy, the monetary authority's incentive to lie does not depend on its private forecast. This independence precludes the possibility of implicitly imposing a cost on the monetary authority if it were to misrepresent its private information. As a consequence, noisy announcements cannot be credible.

Given the nature of the monetary authority's credibility problem, limiting the flexibility permitted in policy is necessary to ensure that the announcements contain some information while allowing the monetary authority to avoid the inflationary bias. In other words, a rule must be imposed somehow to tie the hands of the

monetary authority. As indicated above, for this constraint to be effective, the rule or legislation must be independent of the monetary authority's private forecast. In this paper, it is assumed that the legislation specifies a constant money growth rule. Although a more general and less restrictive multi-period targeting rule could be legislated, Garfinkel and Oh (1990) find that, without any announcements, the strict constant growth rule (i.e., a one-period targeting procedure) is likely to be the optimal finite-period targeting policy regime.[8]

In what follows, suppose legislation requires

$$\tilde{g}_t = \pi^*. \tag{14}$$

Although this constant money growth rule eliminates the inflationary bias, it precludes any (otherwise efficient) accommodations to money demand disturbances. Expected utility under this regime without any announcements is given by

$$\tilde{U} = -(1+\phi)\sigma_\delta^2 - y^{*2}. \tag{15}$$

which will exceed that under the full-discretionary regime only if $\frac{y^{*2}}{\phi} > (1+\phi)\sigma_f^2$, where σ_f^2 denotes the variance of the private forecast.

This condition, which highlights the trade-off faced by the monetary authority in the presence of private information, balances the benefits of eliminating the inflationary bias against the costs of limiting flexibility permitted in monetary policy to do so. Because the legislated rule in (14) precludes any reactions to the predictable component of the disturbance, the variance of inflation and output increase by σ_f^2 and $\theta^2\sigma_f^2$, respectively.

Before examining the role of noisy announcements, it is important to note that, even with this rule, the monetary authority still could not precisely reveal its forecast. In particular, given $g_t = \pi^*$, the optimal announcement is given by

$$f_t^A = f_t + y^*. \tag{16}$$

The equation above illustrates once more that the credibility problem of monetary policy is two-fold in the presence of non-verifiable private information. Even when the monetary authority is required to follow a constant money growth rule, it cannot make precise and truthful statements about its forecast. But since its expected one-period utility would increase by σ_f^2 if it were able to make such statements, the monetary authority does not prefer full secrecy when it follows a constant money growth rule.

3.2 Noisy Announcements

By making noisy announcements about its forecast the monetary authority can reduce the variance of the forecast error of wage setters and thereby reduce the variance of output below that which obtains when it simply follows the constant money growth rule. With noisy announcements, then, the monetary authority can enhance its own welfare. Given that it follows the rule in (14), the monetary authority's incentive to manipulate expectations depends on its private forecast. This dependency implies that the monetary authority can influence expectations partly by announcing a range in which its forecast falls. The basic idea is as follows: upon an announcement, wage setters revise their expectation of δ_t from an unconditional mean of zero to an expected value conditional on f_t belonging to the announced range. Hence, the announcement affects expectations in a discrete way. In contrast to precise (or full) announcements, noisy announcements are credible in equilibrium because the monetary authority would have to incur a sufficiently large cost by announcing the incorrect range. This potential cost, determined endogenously, is driven by how the lie affects expectations as shown below.

For simplicity, following Crawford and Sobel (1982) in their example and Stein (1989), suppose that δ_t has a uniform distribution, bounded by $[-D, D]$. A general partition equilibrium of size n (i.e., with n subintervals) is characterized by $n-1$

dividing points $a_1, a_2, \cdots, a_{n-1}$, where $a_0 = -D$ and $a_n = D$ are the boundary conditions.

Given an announcement by the monetary authority, say the interval (a_{i-1}, a_i), and (14), wage setters will form expectations according to the following:

$$\pi^e(a_{i-1}, a_i) = \pi^* - \frac{a_{i-1} + a_i}{2}. \tag{17}$$

With this influence on wage setters expectations, it is important to ensure that the monetary authority will announce the correct range. For example, if $f_t \in [a_{i-1}, a_i]$, the monetary authority, wanting to overstate its forecast, should not announce the interval (a_i, a_{i+1}). To guarantee that the monetary authority will not misrepresent the range in which f_t falls, it must always be indifferent between announcing the ranges, (a_{i-1}, a_i) and (a_i, a_{i+1}) when $f_t = a_i$, for $i = 1, 2, \cdots, n-1$. Formally, this condition, called the *arbitrage condition*, is written as

$$\tilde{U}[(a_{i-1}, a_i), f_t] = \tilde{U}[(a_i, a_{i+1}), f_t] \tag{18}$$

or equivalently,

$$E[\frac{a_{i-1} + a_i}{2} - a_i - \epsilon_t - y^*]^2 = E[\frac{a_i + a_{i+1}}{2} - a_i - \epsilon_t - y^*]^2, \tag{19}$$

where $f_t = a_i$. Given the monotonicity of a_i, this condition can be satisfied only if the partitions satisfy

$$a_{i+1} = 2a_i - a_{i-1} + 4y^* \tag{20}$$

for $i = 1, 2, \cdots, n-1$. Noting that $a_0 = -D$, the solution to this second-order difference equation can be expressed in terms of a_1:

$$a_i = a_1 i + D(i-1) + 2i(i-1)y^* \tag{21}$$

for $i = 1, 2, \cdots, n$.

The subintervals, as defined by the partitions in (20), make the cost of overstating the value of f_t sufficiently large to induce the monetary authority to announce the correct range for all f_t. From (19) or (20), one can verify that the positioning of the partitions in the whole interval $[-D, D]$ is such that for smaller f_t the announcement is more precise – i.e., informative. The intuition here is that, in equilibrium, when the disturbance is smaller (more negative), the monetary authority's announcement is more revealing in that it is less likely to be contaminated by the monetary authority's incentive to overstate the value of the forecast. Thus, the implicit cost imposed by the partitions to induce the monetary authority to announce the correct range can be smaller for smaller f_t. Conversely, for larger f_t, the monetary authority can communicate less precisely. Since its announcement is more likely to reflect its incentive to surprise wage setters with larger f_t, the monetary authority must be disciplined more strongly by being able to communicate only in more ambiguous terms. In fact, when f_t is larger, the monetary authority has a greater desire to reveal some information about f_t rather than none. Hence, at the same time it wants to communicate the most, the monetary authority can do so least precisely.

The largest possible n – that is, the finest partition equilibrium – is the largest integer i such that $i(i-1)y^* < D$, which is simply the smallest integer, n, greater than or equal to

$$\frac{-1+\sqrt{1+\frac{4D}{y^*}}}{2} \tag{21}$$

The expression above reveals that as y^* decreases relative to D, the largest possible n can be larger so that there can be more partitions. Conversely, as the output goals of the monetary authority and wage setters diverge, there is less room for making the equilibrium informative. In a different context, Sobel (1988) shows that cheap talk cannot work when there is a sufficiently large wedge between the two players' goals. Indeed, in the present model, when y^* exceeds $\frac{D}{2}$, there can be no meaningful

announcements; in this case, the largest possible n equals one.

In contrast to Stein's (1989) analysis in which there are a countable infinity of equilibria, in the present analysis there are a finite number of equilibria since the *conflict of interest* parameter, y^*, is an exogenously given constant. In what follows, the discussion focuses on the equilibrium with the largest number of partitions among all those partition equilibria of size n that are feasible, because, as shown below, the monetary authority strictly prefers (in an ex-ante sense) partition equilibria with more steps. (See Crawford and Sobel's (1982) theorem 5.)

Although a constant money growth rule is not the first-best policy in that it does not permit efficient reactions to the predictable component of money demand disturbances, it does allow the monetary authority to make noisy announcements and enhance its welfare, provided that the difference between the output goals of wage setters and the monetary authority, captured by the term y^*, is not too large. To calculate the expected one-period utility, note first that a_1 can be solved using (20) and the boundary condition $a_n = D$:

$$a_1 = \frac{(2-n)D - 2n(n-1)y^*}{n} \tag{22}$$

Combining (22) and (20) yields

$$a_i = \frac{2Di}{n} - D + 2y^*i(i-n) \tag{23a}$$

$$a_i - a_{i-1} = \frac{2D}{n} + 2y^*(2i-n-1) \tag{23b}$$

Finally, using (23b) and (6), the monetary authority's expected one-period utility can be written as

$$\begin{aligned} \tilde{U} &= -\sum_{i=1}^{n} \int_{a_{i-1}}^{a_i} [(-\delta_t + \delta_t^e - y^*)^2 + \phi\delta_t^2] dF(\delta_t) \\ &= -\frac{y^{*2}(2+n^2) + D^2(\phi + \frac{1}{n^2})}{3}, \end{aligned} \tag{24}$$

where $F(\delta_t)$ denotes the distribution function of δ_t and the assumption that δ_t is uniformly distributed has been used. From (24), one can establish that the monetary authority's expected one-period utility is increasing in n, for $n < \sqrt{\frac{D}{y^*}}$. Hence, the monetary authority would like to make more precise announcements the larger is the variance of δ_t and the smaller is y^*. But, since the largest possible n determined by the restriction in (21) is less than $\sqrt{\frac{D}{y^*}}$, the monetary authority can only maintain the maximum degree of precision in its announcements that does not jeopardize their credibility.

Comparing (24) to the monetary authority's expected one-period utility when it follows the constant money growth rule but makes no announcements, given by (14) where $\sigma_\delta^2 = \frac{D^2}{3}$ under the specifications made above for the distribution of δ_t, indicates that noisy announcements with n subintervals are always useful if $y^* < \frac{D}{n}$. But this requirement is always satisfied by the condition that a partition equilibrium of size n is feasible. (See equation (21).)

3.3 Noisy Announcements Need Not Be Cheap

As argued in section 3.1, noisy announcements alone cannot be a meaningful policy tool in the present context. If, however, the monetary authority's private information were modeled as in Stein's (1989) analysis, noisy announcements could effect a more efficient outcome than the full-discretionary solution without a cost and, hence, be referred to as *cheap talk*. For example, suppose that the monetary authority's target rate of inflation, π^*, in (5) were private information, varying among different policymakers, but that f_t were known by all. Cheap talk about π^*, then, would enhance costlessly the monetary authority's welfare above that obtained in the full-discretionary regime without any announcements. Even in this case, however, cheap talk would not support the efficient outcome since the monetary authority's incentive to generate surprise inflation remains.[9]

In the present framework, noisy announcements implicitly impose a cost, requiring limited flexibility in policy, *e.g.*, a constant money growth rule. Unless the private information were verifiable, limiting flexibility in policy is necessary to diminish the equilibrium inflationary bias. Thus, noisy announcements are not cheap talk in the present analysis. Although, as shown in the previous section, noisy announcements will improve upon the outcome with a strict constant growth rule, given the limits on flexibility required to make noisy announcements meaningful, they will not always be preferred over the full-discretionary policy by the monetary authority. Indeed, a stronger condition must be satisfied for a constant money growth rule with noisy announcements to dominate the full-discretionary policy. From (10) and (24), the monetary authority's expected one-period utility in the full-discretionary regime will be less than that with noisy announcements and a constant money growth rule provided that

$$-(n^2\phi+1)\sigma_f^2+(n^2-1)\sigma_\epsilon^2+n^2(\frac{1}{\phi}-\frac{n^2-1}{3})y^{*2}>0 \tag{25}$$

Although this condition is weaker than that for the strict constant money growth rule without announcements to dominate the full-discretionary policy, it restricts the scope of noisy announcements in monetary policy substantially.

To see how the monetary authority's preferences for the constant money growth rule with noisy announcements depends on the degree of accuracy of its forecast, define $\alpha^2 \equiv \frac{\sigma_f^2}{\sigma_\delta^2}$ where $0<\alpha<1$. Noting that $\sigma_\epsilon^2=(1-\alpha^2)\sigma_\delta^2$, the condition in (25) can be written as

$$(\frac{1}{\phi}-\frac{n^2-1}{3})y^{*2}>\frac{(\alpha^2(\phi+1)-1+\frac{1}{n^2})D^2}{3}. \tag{26}$$

As the accuracy of the monetary authority's forecast falls (i.e., as α moves from one to zero), the expected benefit of maintained flexibility in policy permitting reactions to the information falls relative to the expected gain from eliminating the inflationary

bias. Hence, as α approaches zero, the monetary authority is more likely to prefer the constant money growth rule with noisy announcements. Conversely, as α approaches one, the full-discretionary regime is more likely to be preferred.

In fact, the expression in (26) implies that as α goes to one, a sufficient condition for the full-discretionary policy to dominate a constant money growth rule with noisy announcements is $\phi \geq \frac{3}{(n^2-1)}$, for $n > 1$. Since this condition is least likely to be satisfied for $n = 2$, noisy announcements will not be advantageous to the monetary authority if $\phi \geq 1$ as α approaches one. To interpret this result, recall that $\phi = \frac{s}{\theta^2}$: if the weight the monetary authority attaches to its goal of inflation stability exceeds the square of the elasticity of output with respect to unanticipated inflation, θ^2, then noisy announcements will not be preferred over the full-discretionary policy by the monetary authority. As ϕ increases, the monetary authority's willingness to act on its incentive to create surprise inflation becomes smaller, thereby reducing the possible benefits of eliminating the (smaller) inflationary bias relative to the costs of the lost flexibility necessary to make noisy announcements meaningful.

More generally, the condition in (25) implies that noisy announcements will more likely be preferred over no announcements with full flexibility in monetary policy the smaller is the accuracy of the monetary authority's forecast (the value of flexibility in monetary policy) and the larger is the difference between the output goals of the monetary authority and wage setters (the magnitude by which the monetary authority would like to overstate the value of f_t for a given θ).

This seemingly contradictory result underscores the implication of the two dimensional nature of the incentive problem in this framework. As in Stein (1989), when noisy announcements are examined alone, they can be more informative as the difference between the monetary authority's output goal and that of wage setter decreases relative to the variance of the money demand disturbance. (See equation (21)). When noisy announcements are examined in a broader context wherein there

exists a trade-off between flexibility and discipline, however, this result must be qualified. In particular, although announcements can be more informative as y^* decreases, the cost of the lost flexibility required to make them credible, at the same time, becomes larger relative to the benefit of avoiding the inflationary bias. Hence, if noisy announcements are observed in equilibrium, they are not likely to be particularly informative.

It should be noted that by examining noisy announcements in conjunction with a strict money growth rule, the analysis has in some sense focused on the lower bound of noisy announcements. Nevertheless, examining noisy announcements in conjunction with a less restrictive policy rule would not change the results qualitatively. For example, the above analysis would not be qualitatively affected by employing a more general multi-period targeting procedure rather than a simple constant money growth rule. As in Garfinkel and Oh (1989), the targeting procedure would partly tie the hands of the monetary authority, leaving some flexibility to permit the monetary authority to react to its private information. Although this less restrictive rule cannot perfectly eliminate the inflationary bias, combined with noisy announcements, it might yield a better outcome than that analyzed here but not substantially.

4 Concluding Remarks

This paper has investigated the feasibility of reducing the degree of secrecy in monetary policy. Although the monetary authority cannot make precise statements about its private information, it can make noisy announcements. As in Stein (1989) where the credibility problem is one-dimensional and the monetary authority's incentive to misrepresent its private information depends on that information, this form of communication is costless in the sense that no resources are expended in the process. But, with the more general characterization of the credibility problem presented here,

noisy announcements are costly in terms of the flexibility that must be sacrificed to make them meaningful. It should be noted, however, that not all flexibility needs to be abandoned from policy. Rather, to make noisy announcements an effective form of communication, imposed policy rules cannot specify explicit reactions to the monetary authority's private information. Nevertheless, to the extent that flexibility in policy is limited, noisy announcements might be considered a costly method of partially resolving the credibility problem. Indeed, the analysis predicts that if a noisy announcement equilibrium were observed, the announcements might not be especially informative.

One possible extension of the analysis left for future research, would be to model δ_t and the private information, f_t, as having a persistent component. In this extension, where f_t is serially correlated, the monetary authority could transmit a noisy signal about the persistent component of f_t through its policy in time t to influence next period's inflationary expectations. In this case, however, noisy announcements used in an effort to update inflationary expectations upon the realization of f_{t+1} could not be credible unless flexibility in policy were limited somehow. But if flexibility were limited through, for example, a multi-period average money growth rule, noisy announcements could serve as a complimentary form of noisy communication.

Footnotes

1. See Goodfriend (1986) for a useful critique of the arguments made for maintained secrecy in monetary policy by the Federal Open Market Committee.

2. An inflationary bias in policy potentially arises when the monetary authority has an incentive to create surprise inflation, taking advantage of temporary nominal rigidities in the economy in an effort to augment output. Provided that economic agents suspect that the monetary authority will act on its incentive to create surprises, the equilibrium can be characterized by an inflationary bias.

3. See Canzoneri (1985), Flood and Isard (1988), and Garfinkel and Oh (1990). Interpreting the degree of flexibility in policy in a slightly different way, Rogoff (1985) shows how this trade-off between flexibility and discipline can arise without the presence of private information. Persson and Tabellini (1990) provide a useful discussion about this trade-off.

4. In Stein's (1989) analysis, where the efficient outcome would obtain if there were no private information, this trade-off does not arise.

5. As will become evident, the only difference is in terms of the sequence of events. The change made in the timing of the model is necessary to analyze the role of noisy announcements.

6. It is not crucial that wage setters do not make a forecast of the money demand disturbance. Even if they had a fairly accurate forecast, the analysis below is relevant provided that the monetary authority's forecast is inside information.

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

8. As discussed below, by studying noisy announcements with this strict rule, the analysis focuses on the lower bound of the possible value of such announcements. Employing a less restrictive rule, such as a multi-period targeting procedure, does

not change the analysis to follow qualitatively, however. See Garfinkel and Oh (1990) for a general discussion about the attractiveness of the legislative approach to resolve the credibility problem partly when the monetary authority possesses is private information. Note that reputational concerns might be able to substitute, at least to some extent, for a commitment technology to induce the monetary authority to follow a constant money growth rule.

9. Note that noisy announcements can be credible when π^* rather than f_t is the private information because, in this case, the monetary authority's incentive to lie depends on its private information. Although this alternative formulation of the problem is similar to Cukierman and Meltzer (1986), the process of communication in that analysis is not cheap talk. Because the monetary authority partially signals information about its randomly changing preferences through policy actions rather than mere words, it is not costless. Nevertheless, as in the alternative formulation of the problem with non-verifiable private information, the noisy form of communication in Cukierman and Meltzer need not support the efficient outcome.

References

Barro, Robert J., and David Gordon, "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, July 1983, 12, pp. 101-22.

Canzoneri, Matthew B, "Monetary Policy Games and the Role of Private Information," *American Economic Review,* December 1985, 75, pp. 1056-70.

Crawford, Vincent and Joel Sobel, "Strategic Information Transmission," *Econometrica*, November 1982, 50, pp. 1431-51.

Cukierman, Alex and Allan Meltzer, "A Theory of Ambiguity, Credibility and Inflation under Discretion and Asymmetric Information," *Econometrica*, September 1986, 54, pp. 1099-128.

Flood, Robert and Peter Isard, "Monetary Policy Strategies," *NBER Working Paper No. 2770*, November 1988.

Garfinkel, Michelle R. and Seonghwan Oh, "Strategic Discipline in Monetary Policy with Private Information: Optimal Targeting Periods," *UCLA Working Paper No. 584*, January 1990.

Goodfriend, Marvin, "Monetary Mystique: Secrecy and Central Banking," *Journal of Monetary Economics*, January 1986, 17, pp. 63-92.

Kydland, Finn and Edward Prescott, "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy*, June 1977, 85, pp. 4730-91.

Persson, Torsten and Guido Tabellini, *Macroeconomic Policy, Credibility and Politics*, forthcoming, (London-Paris-New York: Harwood) 1990.

Rogoff, Kenneth, "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics*, November 1985, 100, pp. 1169-89.

Sobel, Joel, "How (and When) to Communicate to Enemies," *UC San Diego Working Paper No. 88-36*, 1988.

Stein, Jeremy C., "Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements," *American Economic Review*, March 1989, 79 pp. 32-42.