When and how much to talk
Credibility and flexibility in monetary policy with private information

Michelle R. Garfinkel*,a, Seonghwan Ohb

*Department of Economics, University of California–Irvine, Irvine, CA 92717, USA
bDepartment of Economics, Seoul National University, Seoul, 151-742, Korea

(Received September 1991; final version received February 1995)

Abstract

This paper analyzes the role of noisy or imprecise announcements in mitigating the basic credibility problem in monetary policy. Based on a model where the monetary authority's private information gives rise to an unavoidable trade-off between flexibility and credibility, the analysis finds that noisy announcements can serve as a meaningful form of communication to make that trade-off more favorable. However, such talk is not cheap. The analysis predicts that those central banks who can speak more precisely are those who are less likely to speak at all.

Key words: Noisy announcements; Monetary policy games

JEL classification: E50; E61

*Corresponding author.

We thank, without implicating, Jean-Laurent Rosenthal, Stergios Skaperdas, Guido Tabellini, an anonymous referee, and the participants in seminars at the University of California–Los Angeles, the University of California–Irvine, Hong Kong University of Science and Technology, Michigan State University, Indiana University–Bloomington, Stanford University, Texas A&M University, and the Federal Reserve Bank of Dallas for useful comments on earlier drafts of this paper.
1. Introduction

Few would deny the notion that central bank secrecy is pervasive. Although central banks of many developed nations often make statements about policy, these statements are not particularly precise. Moreover, central banks of other nations do not speak at all. Nonetheless, our understanding of the sources of central bank secrecy is somewhat limited.

This paper develops a positive analysis of verbal communication and secrecy in monetary policy. Falling within the scope of a relatively small literature that deals with the desirability and feasibility of communication by policymakers, the analysis is most closely related to those of Stein (1989) and Cukierman and Meltzer (1986a). Like Stein (1989), the present analysis applies Crawford and Sobel's (1982) methodology to study how noisy or imprecise announcements can allow the monetary authority to reveal its private information truthfully despite its general incentive to lie. However, this analysis builds on a more general model of monetary policy featuring the familiar credibility problem that arises whether or not the monetary authority has private information and, if left unresolved, generates an inflationary bias. The presence of nonverifiable private information – namely, a private forecast about money demand disturbances – adds another dimension to the basic credibility problem, giving rise to an unavoidable trade-off between credibility to reduce the inflationary bias and flexibility permitting the monetary authority to fulfill its stabilization role. Because the monetary authority’s informational advantage severely restricts the set of feasible solutions to the basic credibility problem, it seems natural to conjecture that there is an important role for communication in policy.

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1 See Mayer (1987), for example, who documents evidence of the pervasiveness of secrecy in the Federal Reserve; the Federal Open Market Committee’s (FOMC) short-term goals and intermediate targets as well as the minutes of the FOMC meetings. Also see Goodfriend (1986).

2 For example, the width of the annual targeting ranges announced by the Federal Reserve for money growth (in recent years, three to four percentage points) is too large to reveal the Fed's policy intentions perfectly. As discussed by Cukierman (1992, Ch. 14), monetary announcements made by other central banks are also characterized by some degree of ambiguity, varying across nations and time. However, the considerable attention these announcements attract from financial market participants as well as from the news media suggests that they are not without meaning.

3 See Rogoff (1987) and Persson and Tabellini (1990) who survey the literature that generally concerns strategic considerations in monetary policy with and without private information.

4 See Canzoneri (1985) and Garfinkel and Oh (1993) who discuss the practical importance of this trade-off for policymakers. Flood and Isard (1989) show how a trade-off between credibility and flexibility can emerge in the absence of private information when there are 'seldomly experienced' shocks to the economy and the distributional properties of these shocks are not well-defined. Also see Rogoff (1985) and Lohmann (1992), who interpret the degree of flexibility in policy in a slightly different way.
Like Cukierman and Meltzer (1986a), this analysis characterizes the equilibrium degree of precision in communication by the monetary authority aiming to reduce the inflationary bias. However, whereas in that analysis information can be transmitted via actions under full discretion, commitment or equivalently limited flexibility is a precondition for meaningful communication in the present analysis where secrecy has no relevance under full discretion. Given limits on flexibility, the monetary authority’s incentive to lie remains but is bounded such that it might be able to reveal its private forecast truthfully even if partially—specifically, by announcing a range in which its forecast falls.

The analysis shows that these noisy announcements, though not cheap talk, can make the trade-off between credibility and flexibility more favorable to the extent that they reveal the monetary authority’s private forecast. The basic idea here is that, even under a monetary rule, the monetary authority can stabilize employment (though not inflation) by influencing expectations. The equilibrium degree of precision of the announcements, as determined by the minimum of degree of noise generally required to make them incentive compatible (given limits on flexibility), depends negatively on the severity of the basic credibility problem. Hence, as long as that problem is not too severe, truthful though noisy communication is feasible. However, the sacrifice in flexibility necessary to make noisy announcements meaningful implies that the monetary authority need not find it optimal to talk even when it is feasible. Indeed, the analysis finds that noisy announcements to exchange flexibility for credibility are more likely to be preferred when the severity of the basic credibility problem is large relative to the value of the monetary authority’s private information to stabilize output and inflation (i.e., the accuracy of its private forecast). Thus, noisy announcements are more likely to be made by those central banks whose announcements must be less informative (or noisier) generally, to be credible.

While showing that noisy announcements have a wider application than that suggested by Stein’s (1989) analysis of cheap talk, the present analysis offers an alternative interpretation of the observed pervasiveness of central bank secrecy.

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Note that, with the alternative form of communication studied by Cukierman and Meltzer (1986a), limits are self-imposed on policy to reduce the inflationary bias. Though self-imposed, these limits are costly insofar as they imply less than efficient responses to innovations in the monetary authority’s private information. In a related paper, Cukierman and Meltzer (1986b) analyze the two types of communication simultaneously but treat the precision of the verbal announcements as exogenously given. In any case, as discussed by Stein (1989, p. 33), words alone cannot be meaningful in the context of that model.

Cukierman and Liviatan (1991) show that, when the private sector is not perfectly informed about the policymaker’s ability to commit, a positive probability that the policymaker is dependable (i.e., can commit perfectly) partially supports the credibility of precise preannouncements. Yet the positive probability that the policymaker is weak (i.e., cannot commit) implies that these announcements are not precise from the private sector’s perspective.
and ambiguity. Of course, like Stein, the present analysis suggests that some central banks remain silent simply because the credibility problem they face is sufficiently severe to preclude any truthful communication. However, the present analysis also suggests that some of the silent central banks are among those who can speak most precisely but choose not to speak. Although this interpretation is similar in spirit to Cukierman and Meltzer's (1986a) theory of ambiguity, the sources of ambiguity in the two analyses are quite different. Specifically, in Cukierman and Meltzer (1986a), maintaining partial secrecy means that the monetary authority can engineer inflation surprises when most desirable. Here, by contrast, the ambiguity stems from the incentive compatibility constraints that make this form of communication noisier when most desirable. While central banks might exhibit a preference for ambiguous communication generally, those that actually speak as well as some that do not would prefer to speak without any noise but simply cannot in a credible manner.

In what follows, the next section presents the model on which the analysis is based and derives the implications of the basic credibility problem that would emerge even if the monetary authority had no private information. After discussing how the problem is complicated by the nonverifiable nature of the monetary authority's private information, Section 3 studies the role of noisy announcements in mitigating the basic credibility problem. Section 4 offers some concluding remarks, suggesting how we might determine whether observed noisy announcements are made primarily to reduce the inflationary bias or are cheap talk.

2. A model of strategic monetary policy with private information

The analysis builds on a slight variation of Canzoneri's (1985) model of monetary policy with private information. Though simple, the model is sufficiently general to illustrate the implications of private information for monetary policy and to characterize the equilibrium with endogenously determined noisy announcements. The supply function is a standard rational-expectations one:

\[ y_t = y^n + \theta(\pi_t - \pi^n_t), \quad \theta > 0, \]

where \( y_t \) denotes the logarithm of output in time period \( t \) and \( y^n \) denotes the logarithm of the natural level of output; \( \pi_t \) denotes the inflation rate realized at the end of time period \( t \) and \( \pi^n_t \) denotes the wage setters' expectation of inflation conditional on information available to the public at the beginning of time period \( t \) as specified below.

\[^7\] Also see Lewis (1991) who extends their analysis to show how institutions designed optimally by members of society will not minimize secrecy.
The following simple, permanent-income-based quantity equation (Friedman, 1956) determines the price level:

\[ m_t - p_t = y^n_t - v_t, \]  

(2)

where \( m_t \) and \( p_t \) equal, respectively, the logarithms of the money stock and the price level in period \( t \) and \( v_t \) is a money demand innovation, assumed to follow a random walk. From (2), one can see that the equilibrium inflation rate is determined, in part, by the growth rate of money, \( g_t = m_t - m_{t-1} \), the monetary authority's instrument. That is,

\[ g_t - \pi_t = \delta_t, \]  

(3)

where \( \delta_t = v_{t-1} - v_t \) is an i.i.d. random variable with zero mean and a finite variance \( \sigma^2_\delta \).

In this model, policy secrecy stems from the monetary authority's private information concerning this money demand disturbance, \( \delta_t \). Specifically, it has a private (rational) forecast, \( f_t \), satisfying the following:

\[ \delta_t = f_t + \epsilon_t, \]  

(4)

where \( \epsilon_t \) denotes the monetary authority's forecast error, assumed to have an expected value of zero, a finite variance \( \sigma^2_\epsilon \), and no correlation with the forecast.\(^8\)

The analysis assumes in contrast to Canzoneri (1985) that this forecast is made just before wages are set. This assumption permits a role for noisy announcements to influence wage setters' expectations. But, in the absence of any announcements, the wage setters' expectation of this disturbance, \( \delta^*_t \), equals zero so that \( \pi^*_t \) equals their expectation of money growth, \( g^*_t \).\(^9\) Moreover, although wage setters can infer the realized value of \( \delta_t \) from (3) after monetary policy is implemented and inflation is determined, they cannot distinguish the monetary authority's forecast from its forecast error. This nonverifiability assumption enriches the analysis as will become evident below.

\(^8\) Although secrecy could be modeled in terms of the monetary authority's preferences, the approach adopted here is the most convenient way to capture the ongoing nature of secrecy in policy. Differences in the results that would emerge if the monetary authority's private information were about its preferences as modeled in Stein (1989) are discussed below in Section 4.

\(^9\) Without changing any of the results to follow qualitatively, the (rational) forecast could be modeled as a noisy indicator of \( \delta - \) that is, \( f = \delta + u \), where the noise, \( u \), satisfies \( E[u] = 0, E[u^2] = \sigma^2_u \), and \( E[u\delta] = 0 \). Note that, under either specification, since \( \delta \) is i.i.d., the forecast must be serially uncorrelated, implying that there is no role for policy signals in this context.

\(^10\) Note that, even if wage setters had a fairly accurate forecast of \( \delta \), the complications introduced by the monetary authority's private forecast would remain under the assumption that the forecast is truly inside information. For the Fed, this assumption seems reasonable since the forecasts prepared by the Board of Governors' staff prior to each of the FOMC's policy meetings are not made available to the public for five years.
To study the behavior of the monetary authority, the analysis assumes that the monetary authority has two goals: output and inflation stabilization. Its one-period utility is given by

\[ w_t = -(y_t - ky^n)^2 - s(n_t - \pi^*)^2, \quad k > 1, \]  

where \( s \) is the weight the monetary authority attaches to its objective of stabilizing inflation around its target rate, \( \pi^* \), relative to its objective of stabilizing output around its target, \( ky^n \). The assumption that \( k > 1 \) reflects the notion that the monetary authority has a desire to stimulate output beyond its natural level.\(^{11}\)

Since the structure of the model is essentially static, time notation is suppressed in what follows. Using (1) and (3), the monetary authority’s one-period utility (5) is rewritten as

\[ u = -(\theta + \sigma^2 - \delta + \delta^* - \pi^*)^2 - \phi(\theta - \delta - \pi^*)^2, \]  

where \( u = w/\theta^2 \), \( \phi = s/\theta^2 \), and \( \delta^* = (k - 1)y''/\theta \). In each period, the monetary authority chooses \( \theta \) to maximize the expected value of (6) given \( f \). As shown below, the solution depends on how the monetary authority treats wage setters’ expectations, i.e., \( g^e \) and \( \delta^e \).

### 2.1. The efficient solution

First consider the benchmark case in which there exists a full commitment technology that somehow forces the monetary authority to reveal its private information truthfully and to adhere to a contingent rule. In this case where the monetary authority’s policy choice simultaneously determines wage setters’ expectations, its optimal monetary policy, \( \hat{\theta} \), is given by

\[ \hat{\theta} = \pi^* + f. \]  

With \( \pi^e = \pi^* \), the policy in (7) yields the following expected one-period utility for the monetary authority:

\[ \bar{U} = -(1 + \phi)\sigma^2 - \pi^2. \]  

\(^{11}\) See Canzoneri (1985, pp. 1058–1059) for a detailed discussion of the possible interpretations of this assumption – one that is important for explaining the emergence of an inflationary bias. These interpretations build on distortions presumed to exist in the economy that influence labor decisions so as to depress average equilibrium (or the natural) level of output below the level considered to be optimal from the monetary authority’s perspective. But also see Cukierman (1992, Ch. 3) who, in questioning this equilibrium approach to motivate the assumption that \( k > 1 \), offers an alternative approach based on the presence of unions which keep the wage above that which clears the market. Also note that, like most existing analyses on policy stabilization, the present analysis abstracts from real shocks to output. See Cukierman (1992, Ch. 15) who considers the case where the monetary authority has a temporary information advantage concerning a real (serially correlated) shock to employment.
Note that the money growth rule in (7) – i.e., the efficient or first-best policy – completely accommodates the predicted component of the money demand shock to stabilize inflation around the monetary authority’s target rate, $\pi^*$, but does not attempt to increase output above the natural level.

2.2. No announcements: The full-discretionary solution

Now suppose that the monetary authority takes wage setters’ expectations as given. In this case, the monetary authority chooses $\delta$, treating $\pi^c$ as fixed, to maximize the expected value of (6) conditional on $f$. With $\delta^c = 0$, the wage setters’ expectation of the associated first-order condition implies that $g^c = \pi^* + \pi^*/\phi$. Thus, equilibrium money growth under this regime, $\bar{\delta}$, is given by the following:

$$\bar{\delta} = \pi^* + f + \pi^*/\phi, \quad (9)$$

which, like the efficient policy in (7), fully accommodates the predicted component of $\delta$.

The important feature of this policy, typically referred to as the one-shot, Nash, or the full-discretionary solution in the literature, is that it generates an inflationary bias, $\pi^*/\phi$. The bias reflects the monetary authority’s incentive to create surprise inflation and wage setters’ incentive to discourage such surprises. This solution’s inefficiency is revealed by comparing the monetary authority’s expected one-period utility in this regime, given by

$$U = -(1 + \phi)\sigma^2 - (1 + 1/\phi)\pi^2, \quad (10)$$

to that obtained in the efficient regime, given by (8). The difference between (8) and (10), $\pi^2/\phi$, measures the disutility of the inflationary bias. As shown by Kydland and Prescott (1977) among others, this bias would emerge in the full-discretionary solution even if there were no private information. Thus, in this regime, policy secrecy would seem to be irrelevant.

3. A constant money growth rule and noisy announcements

However, without a commitment technology forcing the monetary authority to reveal its private information truthfully, the bias is not easily mitigated. As shown in Canzoneri (1985), the presence of nonverifiable private information enhances the monetary authority’s ability to act on its incentive to create surprise inflation and thereby weakens the effectiveness of the resolutions to the credibility problem that have been proposed in the literature. Specifically, neither legislation nor reputational considerations can support the first-best policy that avoids the inflationary bias while allowing efficient policy responses to the forecast, $f$. The fundamental problem is that the constraints imposed by
these resolutions, which require that the monetary authority truthfully reveal \( f \), are nonbinding; if the monetary authority's announcements (whether precise or imprecise) were believed by wage setters, the monetary authority would have an incentive to misrepresent its private information so as to disguise its policy as the first-best one. Without being able to verify the monetary authority's private information, costly limits on policy are generally necessary to reduce the inflationary bias in equilibrium.\(^\text{12}\)

Nevertheless, communication with words to relieve the credibility problem remains a possibility. Following the logic of Crawford and Sobel (1982) and Stein (1989), this section shows that the monetary authority can reveal its private information credibly though partially through imprecise or noisy announcements. In this application, the monetary authority announces a range in which its private forecast falls, rather than a specific value. If the monetary authority were to lie, it would have to claim that its forecast was in another range. The equilibrium determination of the number and sizes of ranges is such that, a lie (if told) would have to be too large to be considered an attractive alternative to telling the truth. In equilibrium, then, the monetary authority has no incentive to lie.

Crawford and Sobel (1982) and Stein (1989) among others refer to these announcements as cheap talk, for they potentially reveal some of the monetary authority's private information at no cost. However, in the context of the present analysis where secrecy has no relevance under full discretion, noisy announcements alone (i.e., cheap talk) cannot be meaningful. Specifically, without any restrictions imposed on policy, the extent to which the monetary authority is willing to manipulate wage setters' expectations in an effort to create surprise inflation does not depend on its forecast. Generally, this independence precludes the possibility of implicitly imposing a cost on the monetary authority if it were to misrepresent its (nonverifiable) private information.\(^\text{13}\)

Limits on the scope of flexibility permitted in policy to respond to the private forecast are a precondition for truthful communication. While allowing the monetary authority to avoid the inflationary bias, such limits create a link between the monetary authority's private information and its incentive to lie. With this link, the monetary authority's incentive to lie is bounded, giving rise to

\(^{12}\) For more details concerning the incentive incompatibility of precise announcements see Canzoneri (1985). Note that Canzoneri suggests a reputational solution, along the lines of Green and Porter (1984), requiring neither verification of the monetary authority's private information nor any limits on flexibility in policy to reduce the inflationary bias partially; but this solution similarly involves a cost in terms of an excess variability in economic outcomes relative to that obtained under the first-best policy.

\(^{13}\) As discussed below in Section 4, however, cheap talk could be meaningful if the monetary authority's private information were modeled as in Stein (1989); but, even in this case, words alone could not relieve the basic credibility problem.
the possibility of making noisy announcements truthful. At the same time, this communication serves as an imperfect substitute for flexibility through its influence on expectations and, thus, on output. As such, it reduces the cost of limiting flexibility to reduce the inflationary bias.

3.1. Limits on flexibility

Consider first the implications of limiting flexibility in policy without any communication. To make the limits binding, the rule or legislation must be independent of the monetary authority's private forecast. For convenience, the analysis focuses on a constant money growth rule:

\[ \tilde{g} = \pi^* \]  \hspace{1cm} (11)

While this rule eliminates the inflationary bias, it prohibits any otherwise efficient accommodations to money demand disturbances. Because legislating a more general and less restrictive multi-period targeting rule is feasible in this context, the analysis to follow based on the strict rule in (11) identifies only the lower bound of the potential value of noisy announcements. However, employing a less restrictive rule, such as a multi-period targeting procedure, would not change the results to follow qualitatively.

A comparison of the monetary authority's welfare in this regime without any communication to that obtained in the full-discretionary regime most clearly reveals the fundamental trade-off between credibility and flexibility that emerges when the monetary authority has private information. Under the regime where the monetary authority adheres to the rule in (11) but makes no announcements, its expected one-period utility is given by

\[ \bar{U} = -(1 + \phi)\sigma^2_\delta - y^{*2} \]  \hspace{1cm} (12)

which would exceed that under the full-discretionary regime (10) only if

\[ y^{*2}/\phi > (1 + \phi)\sigma^2_f \]

where \( \sigma^2_f = \sigma^2_\delta - \sigma^2_\epsilon \) denotes the variance of the private

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14 If \( \pi^* \) were changing over time and observed by all, the rule could be modified easily to permit some flexibility - i.e., allow policy to respond to those changes - without detracting from the credibility of noisy announcements discussed below. For a general discussion about the appeal of the legislative approach alone to resolve the credibility problem partly when the monetary authority possesses some nonverifiable private information, see Garfinkel and Oh (1993). Of course, 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, but only when the rule is incentive compatible in an \textit{ex ante} sense.

15 See Garfinkel and Oh (1993) who analyze a general multi-period targeting procedure. With this procedure that partly ties the hands of the monetary authority, the average equilibrium inflationary bias can be reduced; but, by leaving some flexibility for the monetary authority to react to its private information, this procedure cannot completely eliminate the bias in equilibrium.
forecast. This condition balances the benefits of eliminating the inflationary bias against the costs of limiting flexibility permitted in policy to do so. Because the legislated rule in (11) precludes any reactions to the predicted component of the money demand disturbance, the variances of inflation and output increase respectively by \( \sigma_f^2 \) and \( \theta^2 \sigma_f^2 \).

Nonetheless, with such limits on policy, the monetary authority prefers not to maintain complete secrecy. If it were possible for the monetary authority to reveal its forecast truthfully and precisely, it could reduce the variance of wage setters’ inflation forecast error and, thus, the variance of output; in this case, the monetary authority’s expected one-period utility would increase by \( \sigma_f^2 \) to

\[
U^* = - (1 + \phi)\sigma_f^2 - \phi \sigma_f^2 - \psi^2. \tag{13}
\]

But, even with this constant money growth rule, the monetary authority could not reveal its forecast precisely. In particular, if wage setters were to believe its (precise) announcement, then given \( g = g_e = \pi^* \) it would lie about \( f \), overstating its value by \( \psi^* \). However, its objective to minimize positive as well as negative deviations of output from its target means that noisy announcements can be meaningful. In particular, given the limits imposed on policy flexibility (11), the monetary authority’s incentive to stimulate output above the natural level and, thus, its incentive to overstate the value of \( f \) are bounded by its output stabilization goal.\(^{16}\) Although the appeal of noisy announcements with limits on flexibility is bounded by the monetary authority’s objective to stabilize inflation as shown below in Section 3.4, the next section shows that truthful but noisy communication is feasible given those limits on flexibility.

3.2. Noisy announcements

To show how noisy announcements can be made incentive compatible given (11), the analysis follows Crawford and Sobel (1982) in assuming that \( f \) has a uniform distribution over \([-F, F]\). In addition, \( \epsilon \) has a uniform distribution over \([-e, e]\). Thus, from (4), \( \delta \) is distributed over \([-D, D]\), where \( D = F + e \).\(^{17}\) Under these assumptions, a general partition equilibrium of size

\(^{16}\) If, as assumed in Cukierman and Meltzer (1986a, b), the monetary authority wanted to stimulate output (rather than stabilize output around a target) above \( \psi^* \), then secrecy would be of no relevance even with limits on flexibility (11); in this case, noisy announcements could not be made incentive compatible.

\(^{17}\) More specifically, the specifications made for \( f \) and \( \epsilon \) imply that the density function of \( \delta \), denoted here by \( h(\delta) \), has three distinct segments on \([-D, D]\). Assuming that \( F > e \), these segments are given by

\[
h(\delta) = (\delta + D)/4Fe \quad \text{if} \quad -D \leq \delta \leq e - F, \quad h(\delta) = 1/2F \quad \text{if} \quad e - F < \delta \leq F - e, \quad \text{or} \quad h(\delta) = (D - \delta)/4Fe \quad \text{if} \quad F - e < \delta \leq D. \quad \text{If} \quad e > F, \quad \text{the implied distribution of} \ \delta \ \text{would be similar with} \ e \ replaced \ by \ F \ \text{and} \ F \ replaced \ by \ e. \ \text{In any case, the distribution of} \ \delta \ \text{conditional on} \ f \ \text{is uniform} \quad \text{i.e.,} \quad h(\delta|f) = 1/2e \quad \text{with an expected value of} \ f \ \text{and a variance of} \ e^2/3. \]
(i.e., with \( n \) subintervals or ranges) is characterized by \( n - 1 \) partitions: 
\[ a_1 < a_2 < \cdots < a_{n-1}, \]
where \( a_0 = -F \) and \( a_n = F \) are the boundary conditions. Upon a credible announcement by the monetary authority stating the range in which its forecast falls, say \((a_{i-1}, a_i)\), wage setters revise their expectation of \( \delta \) from the unconditional mean of zero to an expected value conditional on \( f \) belonging to that range, 
\[ \delta^e(a_{i-1}, a_i) = (a_{i-1} + a_i)/2. \]
In turn given (11), wage setters' expectation of inflation is formulated as follows:
\[ \pi^e(a_{i-1}, a_i) = \pi^* - (a_{i-1} + a_i)/2. \quad (14) \]
This announcement, if credible, affects wage setters' expectations in a discrete way; and, from (1) and (3) given \( \delta \), this influence translates into a discrete movement in output.

With this discrete influence on output, the announcement scheme can be made incentive compatible by structuring the partitions to make the monetary authority indifferent between announcing the ranges \((a_{i-1}, a_i)\) and \((a_i, a_{i+1})\) for \( f = a_i \), \( i = 1, 2, \ldots, n - 1 \). Formally, this arbitrage condition is written as
\[ \mathcal{U}[\delta(a_{i-1}, a_i), f] = \mathcal{U}[\delta(a_i, a_{i+1}), f], \]
whenever \( f = a_i \), for \( i = 1, 2, \ldots, n - 1 \). Since the announcement does not affect actual inflation, the condition can be simplified using (6), (11), and (14) as follows:
\[ E[-((a_{i-1} - a_i)/2 - \varepsilon - y^*)^2] = E[-((a_i - a_{i+1})/2 - \varepsilon - y^*)^2], \quad (15) \]
for \( i = 1, 2, \ldots, n - 1 \), where \( E[\cdot] \) denotes the expectations operator taken over the distribution of the monetary authority's forecast error, \( \varepsilon \).

While the monetary authority generally wants to increase output above the natural level and so generally has an incentive to overstate the value of \( f \), this incentive is limited by the rule in (11) and the monetary authority's goal to stabilize output. The arbitrage condition identifies these limits for a given \( n \) by equating the monetary authority's preference for announcing the lower range \((a_{i-1}, a_i)\) which moves expected output below its target to its preference for announcing the higher range \((a_i, a_{i+1})\) which moves expected output below its target to its preference for announcing the higher range \((a_i, a_{i+1})\) which moves expected output above its target. To see how this condition works, let \( A_i(f) \) denote the expected deviation of \( y \) from the monetary authority's target conditional on \( f \) given (11) and wage setters' expectation, \( \delta^e \), as it depends on the announcement \((a_{i-1}, a_i)\). Using (1), (3), and (11), we have
\[ A_i(f) = \varepsilon(\delta^e(a_{i-1}, a_i) - f - y^*). \]
Then, from the arbitrage condition,
\[ -A_i(f) = A_{i+1}(f) > 0 \]
for \( f = a_i \) and the monetary authority is indifferent between announcing the two adjacent ranges. Since \( A \) is decreasing in \( f \) given the announcement, \( (-A_i(f))^2 < (A_{i+1}(f))^2 \) for \( f < a_i \). That is to say, overstating the announcement produces a larger expected deviation of output from the monetary authority's target than that produced by telling the truth and is therefore deemed undesirable. Similarly, since \( (-A_i(f))^2 > (A_{i+1}(f))^2 \) for \( f > a_i \), the monetary authority has no incentive to understate the value of its forecast.
Thus, provided the partitions, $a_i$, satisfy (15), noisy announcements are incentive compatible.

Given the monotonicity of $a_i$, the arbitrage condition (15) implies that the partitions are determined from the following second-order difference equation:

$$a_{i+1} = 2a_i - a_{i-1} + 4y^*,$$

for $i = 1, 2, \ldots, n - 1$. Using the two boundary conditions, $a_0 = -F$ and $a_n = F$, one can verify that the solution to (16) is given by

$$a_i = \frac{2Fi}{n} - F + 2y^*i(i - n),$$

for $i = 0, 1, 2, \ldots, n$. With the limits of the monetary authority's willingness to lie identified by (15) given (11) and $n$, the partitions in (17) ensure that a false announcement, through its discrete influence on wage setters' expectations, produces a discrete movement in expected output sufficiently above (or below) the monetary authority's target to make lying undesirable for all feasible $f$.

Because the monetary authority's output target exceeds the level of output that obtains when wage setters' expectations are correct (i.e., the average or natural level of output), the arbitrage condition requires that the lengths of the ranges $(a_{i-1}, a_i)$, given by

$$a_i - a_{i-1} = \frac{2F}{n} + 2y^*(2i - n - 1),$$

increase as $i$ approaches $n$. This requirement implies that those announcements regarding larger realizations of $f$ must be less precise - i.e., more ambiguous. When $f$ is larger, however, the monetary authority has a greater desire to reveal some information about the forecast rather than none. Conversely, the monetary authority can talk more precisely about smaller realizations of $f$, but its desire to do so is also smaller. In any case, by making the cost of overstating the value of $f$ sufficiently large, the arbitrage condition implies that the monetary authority's optimal noisy announcement, given it follows the rule in (11), is simply the correct one.

### 3.3. The informative value of noisy announcements

The informative value of this form of strategic communication stems from its ability to influence wage setters' expectations and thereby stabilize output in equilibrium. From (18), as $n$ rises given $F$, the size of each of the subintervals falls implying less noise and, thus, less secrecy in equilibrium. Hence, given $F$, the parameter $n$ - i.e., the number of partitions in that equilibrium - reflects the informative value of noisy announcements.
The arbitrage condition, however, implies an upper bound on $n$. Because $a_i > -F$ for any finite $n$, the solution in (17) implies that a partition equilibrium of size $n$ is feasible only when $n(n - 1)y^* - F < 0$. The largest possible $n$—i.e., the finest partition equilibrium—is the largest integer strictly less than the larger of the two roots of that equation, $\frac{1}{2}(1 + \sqrt{1 + 4F/y^*})$. Subtracting 1 from this root, the largest possible $n$ can be stated equivalently as the smallest integer greater than or equal to

$$< \frac{1}{2}(1 + \sqrt{1 + 4F/y^*}) >.$$  \hspace{1cm} (19)

As revealed by (19), the upper bound on $n$ is determined by the conflict of interest parameter, $y^*$, given $F$. As the output goals of the monetary authority and wage setters converge, given $F$, the expression in (19) increases, implying that there can be more partitions. Conversely, as $y^*$ increases relative to $F$, there is less room for making the equilibrium informative. In fact, when $y^* > F/2$, the only integer greater than or equal to the expression in (19) is one; in this case, there can be no meaningful announcements.\(^\text{18}\)

Given $y^*$, which for any fixed $F$ determines the maximum amount of information that can be revealed with noisy announcements, there are a finite number of equilibria. In what follows, the discussion focuses on the equilibrium with the largest number of partitions among all those equilibria of size $n$ that are feasible, because the monetary authority strictly prefers (in an ex ante sense) partition equilibria with more steps.\(^\text{19}\)

This preference can be seen by calculating the monetary authority's expected one-period utility generally for any feasible $n$. Let $H(f)$ and $H(e)$ denote respectively the cumulative distribution functions of $f$ and $e$. Then, using (15), the monetary authority's expected one-period utility (6) with limits on flexibility (11) and noisy announcements can be written as

$$\bar{U} = - \sum_{i=1}^{n} \int_{-e}^{e} \int_{a_{i-1}}^{a_{i}} (\frac{1}{2}(a_{i-1} + a_{i}) - f - e - y^*)^2$$

$$+ \phi(f + e)^2 dH(f) dH(e),$$

which, using (18), simplifies to

$$\bar{U} = \frac{1}{2}(y^*2(2 + n^2) + F^2(\phi + 1/n^2)).$$  \hspace{1cm} (20)

\(^\text{18}\) Also see Crawford and Sobel (1982) and Sobel (1988) who show, in slightly different contexts, that cheap talk cannot work when there is a sufficiently large wedge between the two player's goals.

\(^\text{19}\) See Crawford and Sobel (1982, Theorem 5) who show this inclination in a more general setting. It should be noted that in Stein's (1989) analysis, where the conflict of interest parameter is not fixed but, rather, is positively related to the monetary authority's target for the exchange rate—i.e., its private information—there is a countable infinity of equilibria.
for any feasible \( n \). By comparing (20) evaluated at \( n \) with (20) evaluated at \( n - 1 \), one can see that the monetary authority's expected one-period utility is increasing in \( n \), for \( n(n - 1) < F/y^* \) — this is, for any feasible \( n \). Thus, although the monetary authority would prefer no noise in communication given (11), as revealed by a comparison of (20) evaluated at any feasible \( n \) with (13), the monetary authority can maintain only the maximum degree of precision that is feasible.

Provided that the conflict of interest parameter, \( y^* \), is not too large, noisy announcements allow the monetary authority to make use of its private forecast of money demand disturbances to influence wage setters' expectations of inflation. This influence substitutes in part for flexibility in policy to stabilize output. To the extent that noisy announcements can reveal the monetary authority's private information, they reduce the costs of limiting flexibility to buy credibility — i.e., to eliminate the inflationary bias.

By virtue of the costly sacrifice in flexibility required to make noisy announcements meaningful, however, such talk is not cheap. In particular, the constant money growth rule (11) prevents the monetary authority from pursuing its inflation stabilization goal whether or not the monetary authority talks credibly. As such, noisy announcements with limits on flexibility (11) might not be incentive compatible in an \textit{ex ante} sense.

3.4. The appeal of noisy announcements when such talk is not cheap

Using (10) and (20) with \( \sigma^2 = F^2/3 \), one can verify that 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 if and only if the following condition is satisfied:

\[
-(\phi + \frac{1}{n^2})\sigma^2 + \left(\frac{1}{\phi} - \frac{n^2 - 1}{3}\right)y^* > 0, \tag{21}
\]

for feasible \( n \) [see Eq. (19)]. While this condition evaluated at any feasible \( n > 1 \) is weaker than that for the strict constant money growth rule without communication to dominate the full-discretionary policy, it reveals that the appeal of mitigating the credibility problem with noisy announcements and the constant money growth rule is limited.

The appeal is limited not only by the amount of noise in the announcements, but also by the monetary authority's inflation stabilization goal; such announcements, regardless of their noise, cannot reduce the costly effect of limiting flexibility on inflation stability. From (21), a necessary (but not sufficient) condition for noisy announcements with the constant money growth rule to dominate the full-discretionary solution is that the monetary authority's expected one-period utility under the constant money growth rule with perfect
communication (13) exceed that in the full-discretionary regime (10): \( \phi \equiv s/o^2 < y^*/\sigma_f \). As the monetary authority attaches more importance to its goal of inflation stability relative to its output stabilization goal (i.e., an increase in \( s \) given the elasticity of output with respect to unanticipated inflation, \( \theta \)), the perceived cost of limiting flexibility rises for any feasible \( n \) given \( \sigma_f^2 \). At the same time, an increase in \( \phi \) reduces the monetary authority willingness to act on its incentive to create surprise inflation, implying a smaller inflationary bias under the discretionary regime given \( y^* \) and, thus, a decrease in the possible benefits of limiting flexibility in policy.

From (21) assuming that this necessary condition is satisfied (i.e., \( \phi < y^*/\sigma_f \)), it is clear that limits on flexibility (11) with noisy announcements become more appealing relative to the full-discretionary policy as \( y^* \) increases relative to \( \sigma_f \), for any feasible \( n > 1 \). An increase in the accuracy of the monetary authority’s forecast (i.e., an increase in \( \sigma_f \) given \( \sigma_F \)) increases the cost of sacrificing flexibility. An increase in the wedge between the output goals of the monetary authority and wage setters implies a larger inflationary bias in the full-discretionary regime (given \( \phi \)) and, thus, an increase in the possible benefit of limits on flexibility relative to the costs given \( \sigma_f \). This result obtains despite the negative effect of an increase in \( y^* \) relative \( \sigma_f \) on the largest feasible \( n \).

Indeed, the seemingly contradictory influence of \( y^* \) on the value of noisy announcements highlights the importance of considering the credibility problem and the flexibility problem jointly. Specifically, like Stein (1989) who studies the credibility problem alone, the present analysis finds that the general informational content and, thus, the value of these announcements (given limits on flexibility) are inversely related to the conflict parameter \( y^* \) for fixed \( \sigma_f \). However, in light of the trade-off between credibility and flexibility, this result must be qualified. In particular, although the announcements must be noisier as \( y^* \) rises relative to \( \sigma_f \), the benefit of avoiding the (larger) inflationary bias, at the same time, increases relative to the cost of sacrificing flexibility required to make this form of communication meaningful. Hence, if noisy announcements to relieve the basic credibility problem are observed in equilibrium, they are not likely to be particularly informative.

4. Concluding remarks

This paper has investigated both the desirability and the feasibility of communication via words in monetary policy when the monetary authority’s non-verifiable private information gives rise to an unavoidable trade-off between reducing the inflationary bias and fulfilling its output and inflation stabilization role. Extending Stein’s (1989) analysis of cheap talk, the present analysis finds that the monetary authority can make imprecise statements about its private information to relieve its credibility problem, even when this problem is not one
which disappears in the absence of such an informational asymmetry. In the context of this model where secrecy has no relevance under full discretion, words alone are not meaningful. This finding, however, does not generally rule out the possibility of meaningful cheap talk as studied by Stein (1989). Under an alternative assumption that the monetary authority’s private information concerns its target rate of inflation, \( \pi^* \), rather than its forecast, noisy announcements alone about \( \pi^* \) could be meaningful; in this case, cheap talk could enhance the monetary authority’s welfare above that obtained in the full-discretionary regime absent any communication. Nonetheless, such talk alone could not attenuate the basic credibility problem.

On a normative level, the analysis reinforces the notion that imposing limits on the scope of flexibility in policy is desirable. That is, even when there is a clear role for policy to stabilize output, such limits on policy may be warranted as they are necessary to maintain the public’s confidence in the monetary authority’s commitment to keep inflation low. At the same time, the analysis identifies a richer role for noisy announcements than that identified by Stein – namely, to make the trade-off between credibility and flexibility more favorable. To the extent that noisy announcements are informative, they serve as a partial substitute for flexibility in policy to stabilize output and thereby reduce the costs of imposing discipline on policy. Though not cheap, such talk can augment the appeal of ‘rules’ as a partial resolution to the credibility problem.

On a more positive level, the analysis implies that, because such talk is not cheap in this context, some central banks will choose to remain silent even if it is possible for them to speak with little noise. Indeed, the analysis finds that such communication with limits on policy is most desirable under those conditions that, at the same time, require it to be noisier to be credible – specifically, when the credibility problem is most severe. The analysis predicts, then, that those central banks who actually choose to speak are those who are forced to speak most ambiguously among all central banks who can communicate with words.

Underscoring the importance of studying the flexibility and credibility problems jointly, this finding suggests how we might determine whether noisy announcements are made predominantly to reduce the inflationary bias or are simply cheap talk. In particular, we would observe a continuum of central banks differing by the precision of their announcements if such talk were primarily cheap; otherwise, we would observe roughly two types of central banks: those that speak only in extremely ambiguous terms and those that do not speak at all.\(^{20}\) This prediction is not predicated on an assumed benefit inherent in policy secrecy. Rather, some central banks who can speak remain silent to preserve their stabilization role, and the other central banks who remain silent as well as

\(^{20}\) Of those central banks that do not speak, however, some will have a monetary rule in place while others will not.
those who speak would prefer to speak precisely, but can speak only with noise if at all.

References


