Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements

By Jeremy C. Stein*

This paper examines the problem faced by the Federal Reserve in announcing its private information about its future policies. Because it would like to manipulate expectations and pursue a time-inconsistent policy, the Fed cannot reveal its policy objectives precisely and credibly. It can, however, communicate some information about its goals through the "cheap talk" mechanism of Crawford and Sobel: making announcements that are imprecise, and only give ranges within which these goals may lie.

The Federal Reserve has drawn repeated criticism from some circles for its unwillingness to make precise statements about its policy objectives. Included among the critics are many members of Congress—in April 1984 a bill was introduced in the House that proposed "prompt disclosure of certain decisions of the Open Market Committee of the Federal Reserve System." (H.R. 5459, 1984). The Fed has also been the target of a recent lawsuit (*Merrill v. Federal Open Market Committee*, which it finally won in 1981) that sought to make the minutes of FOMC meetings immediately available to the public.[1]

It is not that the Fed never makes *any* policy statements. Rather, the common complaint is that these statements are vague, or difficult to interpret. For example, the Fed chairman might be quoted as saying that he believes the dollar should fall further, but, at the same time, he might be unwilling to specify exactly what he considers to be the "ideal" level. Casual empiricism suggests that bond and exchange market traders pay careful attention to such pronouncements, even while bemoaning the uncertainties associated with trying to interpret them.

This paper presents a theoretical explanation for what Marvin Goodfriend (1986) has documented and dubbed "monetary mystique": The tendency of the Fed to be less than wholly forthcoming about its policy objectives. The basic idea is this: in general, it will be desirable for the Fed to preannounce its future policies, so that markets can react as swiftly as possible. However, it may be impossible for the Fed to make any announcement that *precisely and credibly* communicates its private information about its objectives. Were the Fed able to make a precise claim, it would have an incentive to lie to the public, since by manipulating expectations it can achieve more efficient outcomes than by telling the truth. Knowing this, the public will never believe any Fed pronouncements, and the Fed appears stuck in the unpleasant position of never being able to communicate any information about its future policies.

One way for the Fed to overcome this problem is to make imprecise announcements. For example, rather than claiming that its target for the dollar is exactly 150 yen, it might make some statement to the effect that it has a target somewhere in the 150–170 range. As will be made clear shortly, the Fed will not have the same incentives to manipulate expectations when it is restricted to making less precise announcements. This is because its ability to do such manipulation is now rather crude, and it can wind up

*Graduate School of Business Administration, Harvard University, Boston MA 02163. I am indebted to Bob Gibbons for very enlightening conversations. I have also received helpful comments from two anonymous referees.

[1]The current practice is for these minutes to be released with a 7-week delay.

hurting itself more than helping when it attempts to fool the public.

The model used here is an application of the concept of cheap talk which was introduced in an abstract setting by Vincent Crawford and Joel Sobel (1982), and later studied in the context of bargaining games by Joseph Farrell and Robert Gibbons (1986) and Steven Matthews (1987). Cheap talk differs from information transmission via the costly signaling mechanism first described by Michael Spence (1973) in that it is free—announcements can be made at no cost.

Because sorting of types cannot be done through exogenous cost differences as in the signaling models, cheap talk will not work in many situations where signaling does. Loosely speaking, cheap talk cannot have meaning if all types would prefer to send the same message. For example, in Spence's original education model, everyone would like the labor market to believe that he is a worker with the highest ability. Thus cheap talk has no role; it can never be credible. In contrast, in the model to be seen here, while all "types" of Feds may wish to manipulate expectations, they do not all wish to manipulate them in the same way—one type would most prefer an expectation of policy x, and another type would most prefer an expectation of policy y. This allows cheap talk to communicate some information, although in contrast to the separating equilibria seen in signaling models, this communication is only partial—some uncertainty remains after the cheap talk.

In terms of the macroeconomic literature, this paper is most closely related to those on reputations and time-consistent monetary policy under asymmetric information, as exemplified by the works of David Backus and John Driffill (1985); Robert Barro (1986); Alex Cukierman and Allan Meltzer (1986); and Takeo Hoshi (1987).[2] In each of these papers, it is assumed that the Fed's preferences are private information. These preferences are typically taken to be defined over inflation and output tradeoffs. A "strong" Fed is one that would be willing to sacrifice a great deal of output in order to tame inflation; while a "weak" Fed is one that is less inclined to do so. All types would, of course, like to be able to convince the public that they are the strongest sort of Fed, since this would lead to the lowest expectations of future inflation. Consequently, announcements about preferences are not credible—words alone carry no weight. Instead, only actions are informative, and there will be a tendency for certain types of Feds to behave more "strongly" than they would in a one-period world, in order to influence the public's beliefs about them.[3]

In the model developed here, the Fed's policy preferences are also private information. However, the uncertainty confronting the public is of a different nature. The question is not how strongly the Fed is committed to the particular goal of zero inflation. Instead, the public does not know what one of the goals is—it does not know the level of the exchange rate most desired by the Fed. This difference is crucial. Although there is still a time-consistency problem in that the Fed will generally wish to misrepresent its exchange rate target, not all types will want to misrepresent themselves in the same way. (In contrast to the case above, where all want to pass themselves off as being the strongest anti-inflation type.) This feature is what allows costless announcements to credibly communicate some (though not all) of the Fed's private information. Thus the Fed's words, in addition to its actions, can be a

[2]These papers are in turn part of a larger body of work on the general problem of time consistency in government policies, which was spawned by Finn Kydland and Edward Prescott (1977). See Stanley Fischer (1986) for a survey of this material.

[3]The formal models vary across the papers. Backus and Driffill, and Barro, for example, use the multi-period approach of David Kreps and Robert Wilson (1982) wherein the weak Fed mimics the strong Fed for the first several periods of the game. In contrast, Hoshi employs a Spence-type signaling model in a two-period setting. In his model, the strong Fed separates itself from the weak Fed by acting even tougher on inflation in the first period than it otherwise would. Hence in Hoshi's model, it is the strong Fed whose behavior is altered by informational concerns, while in Backus and Driffill and Barro, it is the weak Fed whose behavior is affected.

valuable source of information regarding future policies.

The paper is organized as follows: Section I introduces the two-period macroeconomic model to be studied. In this section it is shown that policy pre-announcements are desirable, yet unfortunately cannot be credible when they attempt to be precise. Section II studies cheap talk equilibria, in which the Fed's first period announcements convey some, but not all, information about the monetary policy it plans to pursue in the second period. Section III briefly touches on some qualifications and extensions of the simple model. Section IV summarizes and offers conclusions.

I. The Macroeconomic Model

The value of policy pre-announcements and the credibility problems faced by such announcements can be captured in a highly simplified two-period open economy model. This section starts by laying out the assumptions of the model. These assumptions will then be examined critically.

The Fed is assumed to care about two variables in the economy: the one-period real interest rate i_t, and the real exchange rate, e_t. Its target level for the interest rate is known to be zero in both periods. Its target for the exchange rate is unknown, although it is common knowledge that this target T will be the same in both periods and will be drawn from a distribution that is uniform on the interval $(-\overline{T},\overline{T})$. The Fed's utility function is given by

$$(1)\quad U=-(e_1-T)^2-(e_2-T)^2-i_1^2-i_2^2.$$

This formulation embodies the Fed's distaste for interest rates that differ from zero and exchange rates that differ from T. The targets for these two variables need not be compatible—a monetary policy that achieves the desired "internal balance" corresponding to a zero interest rate will not in general also generate the preferred "external balance" of an exchange rate equal to T. For example, the Fed may wish to lower the dollar so as to improve the trade balance, but may also fear that the monetary ease required to do so will overstimulate the domestic economy and lead to increased inflation.[4] Indeed, one could equivalently specify the Fed's utility function in terms of output and the trade balance as in Jeffrey Frankel and Katherine Rockett (1988)—in the type of macro model developed below, either pair of variables can provide a complete description of the state of the economy.

The Fed's only policy action takes place at time 2, when it makes a monetary injection of M_2. (Section III considers the case where injections are allowed at time 1 also, and where such injections may be used as a costly signaling device by the Fed.) The expectation of M_2 as of time 1 will be denoted M_2^e.

Interest rates and exchange rates are related to monetary policy via a simplified version of Dornbusch's (1976) sticky-price model, which is outlined in equations (2)–(4):

$$(2)\quad p_1=p_2=0;\quad p_3=M_2,$$

$$(3)\quad i_t=-(M_t-p_t);\quad \bar{i}=0,$$

$$(4)\quad e_t=E_t(e_{t+1})-i_t;\quad \bar{e}=0.$$

Equation (2) asserts that prices are completely rigid over periods 1 and 2, fixed at their initial value of zero. Prices do finally adjust at time 3 to take account of the time 2 monetary injection, moving the interest rate back toward its steady-state level of zero. It should be emphasized that the somewhat degenerate nature of price stickiness assumed here—prices are constant for two periods and adjust fully thereafter—is in no way responsible for the results. All that is required is *some* stickiness, so that monetary policy can have real effects on interest rates and exchange rates. The formulation employed by Dornbusch (1976), where prices adjust smoothly but gradually toward a steady-state level, would lead to similar con-

[4] Rudiger Dornbusch (1980) provides more motivation for the utility function assumed here, discussing in greater detail the "policy dilemma" involved in trying to achieve internal and external balance simultaneously (see pp. 41–43).

clusions, albeit at the expense of more cumbersome notation.

Equation (3) is a credit market condition, which relates the interest rate to the level of real balances. Constants of proportionality are suppressed, again for the purposes of economizing on notation. Equation (4) is a consequence of uncovered interest parity, with an implicit assumption that the foreign interest rate is exogenously fixed at zero.

The steady state of the model is characterized by real interest rates and exchange rates equal to zero. As mentioned above, the only monetary injection is at time 2. Thus $i_1 = 0$, and $i_2 = -M_2$: the period 2 injection lowers real interest rates, due to the stickiness of prices. Equation (4) can be used to determine exchange rates recursively. First, $e_2 = E_2(e_3) - i_2$. If no further monetary injections are anticipated, the full adjustment of prices by time 3 implies that $E_2(e_3)$ will equal the steady-state value of zero.[5] Correspondingly, we will have $e_2 = -i_2 = M_2$. It bears repeating that the full return to steady state by time 3 (which is simply a device for tying down e_2) is inconsequential here. A slower price adjustment would imply a larger exchange rate impact of monetary policy (see Dornbusch, 1976, for comparative statics) but would lead to the same basic conclusions.

Given e_2, as well as the fact that $i_1 = 0$, it must be that $e_1 = E_1(e_2) = M_2^e$. Hence one can rewrite the Fed's utility function as:

$$(5) \quad U = -(M_2^e - T)^2 - (M_2 - T)^2 - M_2^2.$$

As noted above, the same type of reduced-form utility function results if the initial arguments are the trade balance x, and output y, instead of e and i, so long as one can write $x = x(e, y)$ and $y = y(i, x)$.

[5]The assumption that no further monetary injections are anticipated after time 2 implicitly says that if the game is to be repeated, it will be repeated with a Fed whose targets are drawn independently from those in this play of the game. This way, the expectation of T (and hence of any further policy action) reverts back to the *ex ante* level of zero. The model could also be adapted to a situation where draws of T are correlated over time, so that a high M_2 leads to future expectations of positive monetary injections. See Section III for more on repeated games.

It is assumed that the Fed is unable to precommit itself to the policy that it announces at time 1. Therefore, it must be the case that the policy it chooses is optimal from the point of view of time 2. This implies

$$(6) \quad M_2 = T/2.$$

At time 2, the Fed will trade off its desire to set $M_2 = 0$ for internal balance against its wish to have $M_2 = T$ for external balance. If the Fed could pick M_2 and M_2^e separately, without a time-consistency requirement, it would choose $M_2^e = T$. This is the source of the credibility problem with respect to time 1 announcements—the Fed would like to trick exchange speculators into believing that its monetary policy will be larger in absolute magnitude than is actually planned. By overstating the magnitude of future policy, the Fed can costlessly meet its first-period exchange rate target of $e_1 = T$.

The model is clearly an *ad hoc* one. In order to provide some motivation for its use, it is worth examining its assumptions critically, to see what role they will play in the later analysis.

A few of the assumptions are relatively innocuous, and are made primarily for the sake of tractability. These include the quadratic utility function (which is ubiquitous in the time-consistency literature) and the uniform distribution for T.

There are three features of the model that are, on the other hand, crucial. These are:

i) *The Fed Has Significant Private Information*. As noted earlier, this assumption has been used in several previous papers. The private information paradigm also seems to be necessary to understanding the lawsuit and congressional bill referred to in the introduction—if the Fed does not have important private information, what is the purpose of trying to make public the proceedings of FOMC meetings? The widespread use of "Fed watchers" by investment firms further suggests that the assumption is an operationally relevant one.[6]

[6]See, for example, Goodfriend, 1986, pp. 63–64.

The model does not make clear exactly what the source of the private information is. One possibility is that the preferences or constituencies of Fed members are unknown. To the extent that they are very concerned with the export sector, they will tend to favor lower exchange rates at the expense of other goals. However, the public does not know exactly how intense this concern is.[7] Alternatively, it might be that the Fed's tastes are known, but that it receives important data not available to the public, such as internal forecasts of trade figures that are relevant to determining an appropriate exchange rate. In reality, it is likely that both factors are at work: the public is probably uncertain about both the preferences of Fed members and about the information that they are using in making their decisions.

ii) *Time-Inconsistent Policies Would Lead to Higher Utility than Time-Consistent Ones.* This feature is very familiar and of obvious importance. The only point worth noting is that it appears here in a somewhat novel setting, an interest rate vs. exchange rate tradeoff, as opposed to the more commonly described inflation vs. output choice. As emphasized below, there is nothing particularly special about the former type of utility function. Others would do also.

iii) *The Fed's Private Information Is Such that Not All Types Would Like to Create the Same Expectations.* This is the only place where this model departs significantly from previous literature. In the other papers cited above, all types of Feds wish to create the lowest possible inflation expectations. Here, while different types do wish to create time-inconsistent expectations about exchange rates, they have varying preferences over such expectations. While this assumption seems most natural in an exchange rate context, it could also be argued for in a variety of other settings. For example, one could return to the inflation-output model used by Matthew Canzoneri (1985) and make a minor modification. Canzoneri assumes that Fed utility is given by $U = -(y - k\bar{y})^2 - (\pi - \pi^*)^2$; where y is output; $\bar{y}$ is the level of output sought by wage setters; π is inflation; π^* is the optimal rate of inflation; and $k > 1$. Canzoneri points out that π^* need not equal zero. If this is indeed the case, and the actual level of π^* is private information, this model will also have cheap talk equilibria. Some types of Feds may not want to understate π^* by too much, if they actually would prefer a nonzero inflation rate.

A fourth noteworthy assumption embedded in the model here is that the game is a one-shot affair. This is the same assumption used by Hoshi in his signaling model of monetary policy. However, it differs from many of the infinite horizon and finite-but-long horizon approaches employed by others who have studied related games.[8] Section III will touch on the issue of longer horizons and repeated games.

Given the setup described above, the Fed's credibility gap leaves it in an unfortunate dilemma, which is summarized in the following proposition:

PROPOSITION 1: (*i*) *The Fed would be better off if it could reveal its true target T to the public at time* 1. (*ii*) *However, if the Fed attempts to make a precise announcement of its target, this announcement will not be believed.*

If the Fed could reveal its true target T, exchange speculators would force the first-period exchange rate to a point $e_1 = M_2^e$, which from equation (6) equals $T/2$. If, on the other hand, the Fed is unable to reveal its target, the *ex ante* expectation of $T = 0$ results in $e_1 = 0$. Clearly, the former case, in which the exchange rate moves halfway toward its desired target, is the preferred one.

[7]Cukierman and Meltzer (1986) frame their model in this fashion. They provide further arguments for thinking of the Fed as a body with unknown political alliances. In fact, they argue that not only are Fed preferences unknown, they also evolve randomly over time. If this is the case, there will always be significant private information, even when the game is repeated over time and the public attempts to make inferences about the Fed's preferences.

[8]The papers of Robert Barro and David Gordon, 1983; Canzoneri, 1985; and Cukierman and Meltzer, 1986, feature infinite horizon models. Barro's, 1986, as well as that of Backus and Driffill, 1985, employs a finite horizon.

However, consider what target would be announced by a Fed whose true target is T. If $T \leq \overline{T}/2$, the Fed would announce a target $T^a = 2T$—it would overstate its actual target by a factor of two. This would result in (if the announcement were precisely believed) an expected monetary policy of $M_2^e = T^a/2 = T$ from equation (6). If $T > \overline{T}/2$, the announcement would be $T^a = \overline{T}$, the maximum overstatement possible. Because the Fed can never be counted on to tell the truth, it is thus unable to reveal its target, in spite of the benefits that such revelation would entail.

II. Cheap Talk Equilibria

This section examines cheap talk equilibria, in which the Fed makes announcements that only partially communicate its private information about its target T. Before proceeding, however, a preliminary example is taken up, to illustrate the principle that allows cheap talk to be credible. The principle is this: while the Fed will have a desire to overstate its target, there is a limit to this desire—unlike in a typical signaling model, the Fed will not always wish to claim the highest type possible.

A. *A Preliminary Example*

Suppose that instead of the uniform distribution on $[-\overline{T}, \overline{T}]$ there are only four possible targets: T_1, T_2, $-T_1$, and $-T_2$, with $T_1 < T_2$. Are there situations in which the Fed can be counted on to reveal its target truthfully?

The answer is yes, if T_2 exceeds T_1 by a sufficient amount. First note that the only meaningful truth-telling constraints are that a T_1 not attempt to pass himself off as a T_2, and (symmetrically) that a $-T_1$ not attempt to pass himself off as a $-T_2$. Types T_2 and $-T_2$ will never lie, since they cannot overstate the absolute magnitude of their targets.

A T_1 type who lies and claims T_2 will (if he is believed) generate an exchange rate of $e_1 = T_2/2$. If T_2 is sufficiently close to T_1, this exchange rate may be closer to the actual target of T_1 than the exchange rate of $T_1/2$ that arises when the truth is told. In such a case, T_1 cannot be counted on to tell the truth. By symmetry, neither can $-T_1$. Hence the information the Fed can reveal is limited. It can credibly state whether it prefers exchange rates to rise or fall—that is, it can state that its target is positive or negative—but is unable to be more precise.

However, if T_2 is large enough relative to T_1, the announcement becomes credible. In such a case, a false announcement of T_2 would cause exchange rates to overshoot the actual target of T_1 by an intolerable amount, so that it becomes preferable to tell the truth and accept the smaller exchange rate movement of $T_1/2$.

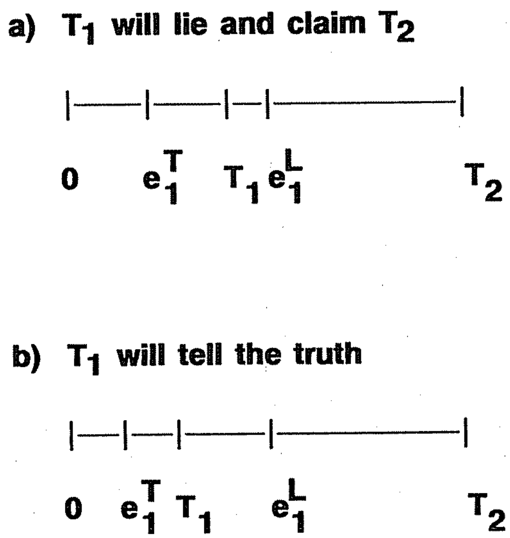

FIGURE 1. EXAMPLE WITH TWO POSSIBLE TARGETS

Figure 1 illustrates. In a), T_2 and T_1 are close enough so that the exchange rate induced by lying, $e_1^L = T_2/2$, is closer to the target of T_1 than the exchange rate induced by telling the truth, $e_1^T = T_1/2$. In b), the situation is reversed—lying causes such a large overshooting of the target that the truth is preferred.

It is easy to calculate just how far apart T_1 and T_2 need to be for truthful revelation. A type T_1 will be indifferent between lying and telling the truth when: $(T_1 - T_2/2)^2 = (T_1 - T_1/2)^2$, or when $T_2 = 3T_1$. Thus if $T_2 \geq 3T_1$, the Fed can credibly reveal its target.

B. *Partition Equilibria*

In the case where types are uniformly distributed on the interval $[-\bar{T}, \bar{T}]$, the Fed's announcement game will have a multiplicity of Bayesian Nash equilibria, each of which corresponds to a partitioning of the interval into a number of subintervals. The Fed observes its target, and then announces which subinterval the target lies in. This amounts to a partial, or noisy communication of its true target—rather than revealing T precisely it just gives a range.

The exchange market speculators are Bayesians, and they revise their prediction of T from its *ex ante* value of zero to its expectation conditional on its being in the announced subinterval. In equilibrium, the Fed has no incentive to lie about which subinterval its target lies in. Some truthful information communication is possible because of the crudeness of the Fed's ability to manipulate expectations in a partition equilibrium. If the Fed wants to lie, it has to claim that it is in a different subinterval. This changes expectations by a *discrete* amount—if the Fed wants to lie, it has to tell big lies, rather than small ones. And, as suggested by the preceding example, such big lies can be less attractive than telling the truth.

The exact structure of a partition equilibrium will be determined by the requirement that the Fed always report truthfully which subinterval its target lies in. The focus here will be on equilibria which are symmetric about zero. A symmetric equilibrium can be fully described by the n-dividing points $a_1 \cdots a_n$ which lie between zero and $\bar{T}$, and which partition the interval $[0, \bar{T}]$ into $n+1$ subintervals. (By symmetry, the interval $[-\bar{T}, 0]$ is partitioned by the points $-a_1 \cdots -a_n$.)

Figure 2 illustrates some possible equilibria. In a), there is no information transmitted at all—there are no partitions. In b) the only dividing point is zero, so there are two subintervals. In c), the point a_1 splits the right side into two parts, and $-a_1$ does the same for the left side, so there are a total of four subintervals. In d), the points a_1 and a_2 lead to a total of six subintervals.

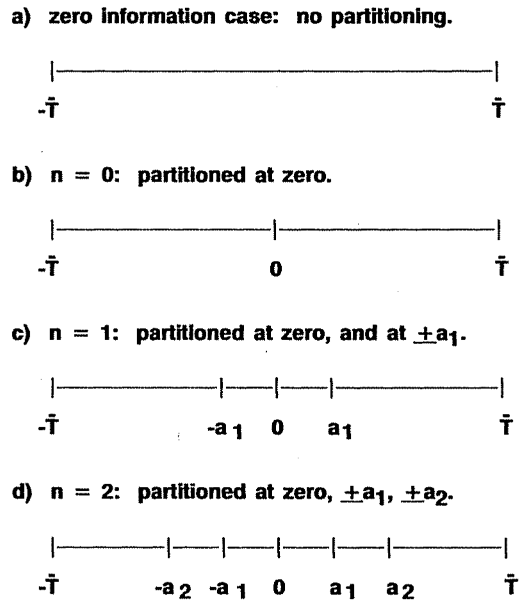

FIGURE 2. POSSIBLE PARTITION EQUILIBRIA

In order for there to be truth-telling, it is required that a Fed with a target in the subinterval (a_{i-1}, a_i) prefer to report that subinterval rather than the subinterval (a_i, a_{i+1}).[9] This will be satisfied if a Fed with a target equal to a_i is indifferent between reporting the two subintervals. (This is the so-called "arbitrage condition" from Crawford and Sobel.)

If the subinterval (a_{i-1}, a_i) is reported, the estimated type is

$$T^e(a_{i-1}, a_i) = \frac{a_{i-1} + a_i}{2}. \tag{7}$$

The exchange rate is therefore given by

$$e_1(a_{i-1}, a_1) = \frac{a_{i-1} + a_i}{4}. \tag{8}$$

Similarly, if the subinterval (a_i, a_{i+1}) is reported, the exchange rate is

$$e_1(a_i, a_{i+1}) = \frac{a_i + a_{i+1}}{4}. \tag{9}$$

[9] It should be noted that there is no need to check for misreports that entail claiming too low an absolute value of T, since the Fed never has any incentive to lie in that direction.

For a Fed with a target of a_i to be indifferent between (8) and (9) means that

$$(10)\qquad a_i - \frac{(a_{i-1}+a_i)}{4} = \frac{(a_i + a_{i+1})}{4} - a_i.$$

This can be rewritten as the following second-order difference equation

$$(11)\qquad a_{i+1} = 6a_i - a_{i-1}.$$

There are also boundary conditions that must be satisfied. When there are n-dividing points between 0 and $\bar{T}$, it must be the case that

$$(12)\qquad a_0 = 0; \qquad a_{n+1} = \bar{T}.$$

For example, when $n=1$, the dividing point is $a_1 = \bar{T}/6$—the right side is divided up into the subintervals $(0, \bar{T}/6)$ and $(\bar{T}/6, \bar{T})$, with a symmetric partition on the left side. When $n=3$, the dividing points are $a_1 = \bar{T}/204$; $a_2 = 6\bar{T}/204$; and $a_3 = 35\bar{T}/204$.

In any given equilibrium, the subintervals have a noteworthy property—they get increasingly longer as we move further away from zero. The more information the Fed wishes to communicate (in terms of a T that differs from the *ex ante* expectation of zero) the less precisely it can do so. This is because the temptation is always to report double the true target, so that Feds with larger T's have a greater motivation to lie about their targets. Hence those with larger T's must be disciplined the most strongly, by only being able to communicate in the crudest terms. In contrast, if the Fed wants to announce a target that only differs slightly from zero, it is able to do so with relative precision.

C. *Equilibrium Selection*

Given the analysis to this point, it appears that there are a countable infinity of equilibria—one can associate a partitioning scheme with every nonnegative integer n. This is in contrast to the Crawford and Sobel model, where there are a finite number of equilibria. This distinction arises from the one fundamental difference between the two models: in theirs, there is a "conflict of interest" parameter which is an exogenous *constant*. This parameter determines the maximum amount of information that can be communicated—the larger the conflict, the smaller the number of partitions into which the interval can be divided. Here, the conflict of interest is measured by $T/2$, the amount by which the Fed would like to mislead speculators about its target. $T/2$ is not a constant, but rather, gets small as T does. Hence, for small values of T, there is very little conflict, and the intervals can be made very small.[10]

At first glance, it would seem that this infinity of equilibria runs directly counter to the spirit of Crawford and Sobel, where the central point is that there is a limit to the amount of information that can be communicated by cheap talk. However, this is not the case. While it is true that adding partitions does increase the precision with which information about "*very small*" *values* of T is communicated, there are limits to how much information can be transmitted about larger values of T. This idea is formalized in the following proposition:

PROPOSITION 2: *As i gets large, the relationship between adjacent dividing points stabilizes*:

$$\lim_{i\to\infty} \frac{a_i}{a_{i+1}} = \left[6\left(1 - \sum_{j=1}^{\infty} 1/36^j\right)\right]^{-1} = .17157.$$

The proposition is an immediate consequence of the difference equation in (11), and can be derived by repeated substitution. It says that no matter how many dividing

[10]This feature would disappear if the model were changed to the variant of Canzoneri's inflation-output tradeoff discussed in Section I. It is straightforward to demonstrate that such a model maps exactly into the Crawford–Sobel "constant conflict parameter" framework, where the conflict parameter is a function of the difference between wage setters' optimal output $\bar{y}$, and the Fed's optimum of $k\bar{y}$.

points there are, the last subinterval will still contain approximately 83 percent of the total $(0, \overline{T})$ interval. The second to last subinterval will contain 83 percent of the remaining 17 percent, or about 14 percent. Adding an extra dividing point further partitions the first subinterval (that starting at zero) but leaves more distant subintervals essentially the same size. Thus even the "limiting equilibrium" (i.e., that with the number of dividing points n, tending to infinity) is characterized by significant imprecision in the ability with which the Fed can communicate its private information.

The proposition is important, because as Crawford and Sobel point out, there is a strong presumption that the equilibrium with the finest attainable information structure is the relevant one. *Ex ante*, expected utility increases with the number of subintervals—this is just a generalization of part (i) of Proposition 1, which stated that the Fed would prefer perfect revelation to none at all. Hence one could argue that for the model developed here, the limiting equilibrium is the appropriate solution concept.

III. Extensions and Qualifications

A. *Longer Horizons*

The model examined above was cast as a one-shot game. In reality, the game is likely to be repeated. One might think that lengthening the horizon could dramatically alter the conclusions—the Fed might be able to credibly announce its information precisely if it wished to develop a reputation for "honesty" that would be valuable in future periods.

One approach is to assume that the game is repeated an infinite number of times. If this is the case, an equilibrium of the type originally developed by James Friedman (1971) (and later applied by Barro and Gordon in a monetary policy context) can be supported. The Fed reveals its target precisely in each play of the game. So long as it is never caught lying, the public continues to believe it. If, on the other hand, the Fed were to lie, the public would punish it by refusing to believe it on subsequent plays of the game. Given this structure, the Fed never lies.

While this equilibrium concept "solves" the communication problem, it rests crucially on two somewhat implausible assumptions. The first is that of an infinite horizon. As soon as it is relaxed, the Friedman equilibrium "unravels" and the multi-period game becomes equivalent to the one-shot game discussed above. The second important assumption needed to support the perfect communication equilibrium is that the public can observe when the Fed lies. However, this is likely to be difficult to do, since the realized value of the money supply is at best a noisy indicator of Fed actions. Even if M winds up being substantially different from the value pre-announced by the Fed, the Fed can claim that it was telling the truth and that forces beyond its control were responsible for the deviation.[11]

In order to change the nature of the game in a finitely repeated setting, one would have to add a second sort of asymmetric information and appeal to the results of Kreps and Wilson (1982) and those of Joel Sobel (1985). Suppose that there are two types of Feds: "normal" ones and "honest" ones. The honest ones are simply unwilling to lie about their targets, no matter what the consequences for their utility. In such a world, it might pay for a normal type of Fed to mimic an honest one during the early stages of the game by truthfully revealing its targets. Again, it should be stressed that in addition to the odd assumption about honest types, this approach would also require that lying by the Fed be directly observable by the public.

In sum then, while it is theoretically possible to construct longer horizon models where the ability of the Fed to communicate its private information is improved, such mod-

[11]See Cukierman and Meltzer, 1986, for more on imperfect monetary control. One might speculate that if the amount of noise is relatively small, an equilibrium analogous to that developed by Edward Green and Robert Porter, 1984, could be sustained, with periods of improved communication interrupted by periods of "credibility breakdown."

els require strong assumptions. If these assumptions are regarded as unreasonable, the notion of imprecise announcements retains its validity.

B. *Signaling with Current Monetary Policy*

Thus far, the discussion has focused solely on the information contained in announcements of future policies. While such announcements may well be an important method of communication, they are not the only one. As emphasized in the previous works on monetary policy under asymmetric information, the Fed's current actions may also say something about its future intentions. In the context of this model, current actions are represented by the monetary injection at time 1, M_1, which has been omitted from the analysis to this point.

If M_1 is used to convey information, it will be via Spence-type costly signaling, much as in Hoshi's model. In the absence of cheap talk, a separating signaling equilibrium would involve each type injecting an amount $M_1(T)$ greater in absolute magnitude than the first-best level of $T/4$ that would prevail under symmetric information.

It is possible that a richer model could be developed that allowed for both cheap talk and signaling, thereby capturing the idea that both the words and the actions of the Fed can communicate meaningful information. This problem is a difficult one, and it is not addressed here. However, it does seem intuitively likely that even when signaling through actions is an available alternative, words may be used as well, since they have the potential to transmit some information at no cost.

IV. Summary and Conclusions

This paper has presented a model which is consistent with the existence of meaningful yet imprecise talk on the part of the Federal Reserve. The Fed would like to pre-announce its policies so as to generate the swiftest possible market reactions. It is, however, constrained in doing so: it cannot make precise announcements, because it would have an incentive to manipulate speculators and aim for a time-inconsistent policy.

The problem can be partially resolved through the use of announcements that only specify broad ranges within which the Fed's targets may lie. By restricting itself to such ambiguous statements, the Fed gives up the ability to manipulate expectations in all but a very crude way. This in turn allows it to communicate some information in a credible fashion.

One interesting prediction of the model is that the Fed will tend to be more vague when it wishes to announce large revisions in its objectives. Small changes, on the other hand, can be stated more precisely.

The model provides a theoretical explanation for monetary mystique complementary to that offered by Cukierman and Meltzer. They focus on the information conveyed by Fed *actions*, and show that the Fed may wish to precommit to imperfect monetary control mechanisms that make its actions less informative. In contrast, this paper looks at the information transmitted by the *words* of the Fed. Yet the basic conclusion of imperfect communication is similar.

From a policy perspective, the analysis casts doubts on the arguments of those who would like to force the Fed to reveal more about its objectives, perhaps by releasing FOMC minutes immediately or by having the published minutes be more comprehensive and precisely worded.[12] If it is known that detailed minutes will immediately become a matter of public record, there will be an increased temptation for Fed governors to posture for the sake of the public by proclaiming an excessively high T. (Similarly, in an inflation-output setting, there would be a temptation to posture by overemphasizing the evils of inflation.) This

[12] Currently, the Fed makes available after seven weeks its Record of Policy Actions, which contains the Domestic Policy Directive. It has been argued that this Directive is "inherently vague and cannot always be accurately interpreted." (See Goodfriend, p. 73.) In 1976, the Fed discontinued its Memoranda of Discussion, which since 1936 had provided detailed written minutes of FOMC proceedings and could presumably convey more information about member preferences and objectives than the Directive alone.

in turn would cause the minutes to be of dubious informational value, as it would be hard to sort out the true preferences of the governors from the posturing. The fact that Fed objectives cannot be credibly and precisely announced seems to be an inevitable consequence of the economics of the situation, and may be difficult to just legislate away.

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