

Some Economic Observations Regarding Communication About Policy*

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Abstract

Recent theories of strategic communication are relevant to central banks' communication with the public. Distinct issues pertain to communication about the bank's past and current actions, intended future actions, assessments of future economic conditions, and overall policy preferences. Regarding assessments of future conditions, there is a time consistency issue regarding truthful reporting. Whether or not truthful, informative reporting is always time consistent is an open question. Some theoretical issues surrounding a central bank's reports about its policy preferences are not yet resolved.

1 Introduction

During the past few decades, central bankers around the world have changed their practice fundamentally, from avoidance (in many cases) of disclosure of information regarding central bank policies, expectations and actions, to enthusiastic embrace of such disclosure, at frequent intervals and in substantial detail. This "transparent" regime has been in effect long enough, in enough countries, that sufficient data are now available to compare the non- and pro-disclosure regimes both within countries and across countries. Applied economists have been enterprising in the study of these data. The study of central-bank communication has become sufficiently well researched that Blinder et al. [2008] have written a monograph-length survey of it.

However, the applied research on this topic has predominantly involved theoretical and statistical analysis of reduced-form models. Such an approach cannot address some fundamental questions, and following it exclusively may result in those questions not even being framed. For example, what is the nature of the information that is being disclosed?

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Consider, for example, public release of inflation forecasts by a central bank. This type of disclosure is the subject of a celebrated study by Romer and Romer [2000]. The authors describe their findings as showing that the central bank has significant information, not possessed by private forecasters, regarding macroeconomic conditions. However they do not consider an equally plausible possibility, that the information conveyed by the announcement of the central bank's forecast has to do mostly with the bank's own intentions, rather than with the state of aggregate demand and supply/technology in the economy. That is, a statement by a central bank that inflation will accelerate may be an implicit announcement that the central bank has begun (or will imminently begin) to relax its monetary policy, and that it envisions maintaining a relaxed policy stance for a significant period of time. Once the public—with rational expectations—receives this information, prices may begin to rise with a lead—rather than with a lag—relative to the execution of specific policy actions.¹

The difference between these two interpretations of Romer and Romer's results matters a great deal for thinking about why it is desirable (or, possibly, undesirable) for a central bank to make public inflation forecasts, regardless of whether the same answer is reached in either case. Arguably a forecast contains some information about *both* macroeconomic conditions and the central bank's intentions, but, to examine the logic of the respective arguments, suppose that it contains only one type of information or the other. If a forecast provides information exclusively about macroeconomic conditions, then the following considerations are relevant to assessing the welfare implications of announcing forecasts.

1. There is a strong presumption that information about macroeconomic conditions is privately beneficial to agents in the economy, and that these individual private benefits correspond to an overall public benefit.
2. Because central bank forecasters are providing a free substitute for commercial forecasts, release of forecasts by the central bank is likely to deter private investment in forecasting. This substitution of public investment for private investment is beneficial, *prima facie*, if the central bank has a comparative advantage over private forecasters. Moreover, because information is essentially a public good, it is likely to be under-provided by private producers. Hence, even if the central bank has to make additional investment to produce forecasts for public disclosure, arguably that investment is publicly beneficial.
3. In the long run, the public can monitor the forecasting performance of the central bank if the forecasts are made public.² Such monitoring might provide a desirable incentive for the central bank to invest optimal resources and effort in making accurate forecasts.

¹Romer and Romer test statistically whether private agents can infer some information possessed by the central bank, but that is not disclosed directly, from observation of central-bank actions that are disclosed. They do not test the implication, that future central-bank actions can be predicted more accurately from an inflation forecast than from another statistic that is an equally good predictor of overall macroeconomic conditions, of the alternate interpretation suggested here.

²Note that a lag in disclosure would not impair the quality of monitoring, though.

Consider how each of these considerations would be modified, if forecasts were implicit announcements of the central bank's policy intentions, rather than containing objective macroeconomic information.

1. Information about the intentions of the central bank would be privately beneficial. However, to the extent that the central bank is a strategic agent, disclosure of its intentions might conceivably reduce the effectiveness of its policy. The possibility of a gap between private benefit and public cost is a substantially more salient issue in this case, than if the central bank merely announces a forecast based on macroeconomic information.
2. Without having a "mole" placed within the central bank, private forecasters cannot readily substitute for information about central bank intentions that the central bank itself would supply. Information about macroeconomic conditions and about central bank intentions are as likely to be complementary as to be substitutable. Therefore it is not clear what would be the effect of information disclosure by the central bank on the level of private investment in macroeconomic forecasting, or on the relationship between the equilibrium level and the optimal level of such investment.
3. Ex post comparison between inflation forecasts and outcomes would not monitor the competence or diligence of the central bank, if the bank's announcement is a disguised announcement of its intent rather than being a genuine statistical forecast. However, in a regime in which the government provides informal guidance to the central bank regarding the politically desired rate of inflation but does not determine a quantitative target, inflation-forecast announcements by the central bank might facilitate dialogue that would improve mutual understanding between the government and the central bank.³

The upshot is that, imagining a discussion of Romer and Romer's results and their policy implications, it is easy to envision how people with contrasting views of the information content of central-bank-forecast announcements might misunderstand what one another are saying, and might even not recognize that some misunderstanding existed. From this perspective, my goal is to provide a framework of discussion that will minimize such misunderstandings.

The plan of the paper is as follows. Expectations are discussed in section 2. Various types of information that the central bank might communicate are discussed in section 3 (extending the discussion above). Section 4 provides a model of the incentives of a central bank to announce truthfully the information that it possesses about economic conditions, and of the conditions under which the public will believe the central banks' announcements. Issues regarding a central bank's communication of its policy preferences and intentions are discussed in section 5. Three realistic elaborations of the basic model are briefly discussed in section 6, namely: (i) costly or limited resources for communication; (ii) communication by a monetary-policy committee, and (iii) communication to a heterogeneously informed public. Some general conclusions for both policy makers and

³Sargent [1986] has emphasized the crucial importance of such accurate, mutual understanding.

researchers (including some suggestions for avoiding confusion in thinking and discussion) are suggested in section 7.

2 Expectations

The rational-expectations model was introduced into macroeconomics about four decades ago. It has been the most widely accepted theory of expectations in most of the ensuing period. Essentially, decision makers are modeled as Bayesian-rational agents in a dynamic environment.

- Agents are forward looking. They make and implement contingent, temporally consistent plans that maximize the expected utility of their resulting consumption streams.
- In response to arrival of new information, agents revise their belief in a statistically optimal way. Initial and revised beliefs are represented by probability measures (the agent's *prior probability* and *posterior probability*, respectively).
- Just like preferences in the theory of an economic agent in a certain environment, the prior probability of an agent in an uncertain environment is modeled as being an exogenous characteristic of the agent.
- Posterior probabilities of events are derived from prior probabilities via *Bayes' Rule*. That is, the relation between initial beliefs and revised beliefs is a matter of the rules of probability theory.
 - An agent cannot choose his revised belief strategically, given the information that he has received. He can choose ex ante what investments to make in acquiring information, but he cannot ignore “inconvenient” information ex post, once it has been acquired.
 - Posterior probability must be the same as prior probability on average (*martingale property*). This relationship tightly constrains the ability of a central bank to manipulate (or “manage”) expectations of the public. A central bank can delay people's revision of their expectations by declining to reveal information that it possesses, but it cannot do much else. Specifically, it cannot manipulate the average value of public expectations in the long run.

No theoretical model is a perfect reflection of reality. Indeed, an important role of a theoretical model is to provide a judicious simplification that enables people to focus on major, “first-order” effects when analyzing a complicated situation or evaluating policy options in such a situation. Currently, no other model of expectations (and of their evolution in dynamic, strategic situations) provides a serious alternative to the Bayesian model in this regard.⁴ Specifically, I am not aware of any demonstration that, an an

⁴Hansen and Sargent [2001], Strzalecki [2007], and Maccheroni et al. [2006] exemplify the serious efforts that some researchers are making to provide such alternatives, however.

actual economy, the implications of economic models based on a population of Bayesian-rational agents fail in a systematic way that would lead policy makers to make mistakes if they trusted those models.⁵ For this reason, the discussion to be provided here will focus exclusively on a Bayesian analysis. In any event, I believe that the conclusions to be reached in this paper are robust ones that would also be reached, perhaps with modest differences in detail, if the analysis were based on any other reasonable formalization of rational belief and decision under uncertainty.

3 What information might a central bank communicate?

In the introduction I suggested that an inflation-forecast announcement, which on its face is a report of conditions external to the central bank, might alternately be an implicit signal of the bank’s own policy stance. I pointed out that the issue of which of these types of communication is occurring arises in analyzing how the communication works and in assessing whether or not it is beneficial. An even more basic point to be drawn from the example is that the information being communicated cannot be determined naively by parsing the text of the communication. An announcement that purports to be a report of broad conditions in the economy might be exactly that, but it might also be understood by both the central bank and the public to be “code language” for something very different. In the case of a new type of communication, such as the inception of inflation-forecast announcements by a central bank that has not made public forecasts in the past, there is no pre-existing fact of the matter. In this case, the central bank and the public will converge—perhaps directly, but perhaps only through a potentially frustrating process of trial and error—to one shared understanding or the other about what the announcements really mean.

There are two commonsense principles that may be of some help in assigning meanings to messages. First, communication of a type of information must be supported as a strategic equilibrium between the central bank and the public. If the central bank would always have incentive to “babble” randomly rather than speaking informatively about some topic, and if some sort of systematic, informative communication from the bank to the public seems to be occurring, then the communication must be commonly understood to be about a different topic (regardless of the literal interpretation of the “code language”). Second, if a central bank is not obligated to communicate about a topic, and if there is an informative-communication equilibrium but the bank’s objective is better met by a no-communication equilibrium, then communication about that topic

⁵It is easy to elicit behavior that conflicts with Bayesian rationality in laboratory situations. That evidence is analogous to evidence from the psychology of perception, where it is easy to induce subjects to make mistaken judgments based on optical illusions. The laboratory evidence about perception does not cause people to worry that, for instance, automobile drivers have collisions because they misjudge one another’s positions or velocities due to optical illusions. Applying the same standard of evidential relevance to errors of cognition as to errors of perception, one should be skeptical of projecting failures of Bayesian rationality from artificially constructed laboratory situations to practical economic situations. Some experimental economists claim a laboratory experiment to be an economic environment just like any other, but I respectfully disagree.

will not occur because the central bank would rather exercise its option to remain silent.⁶

Given that criteria exist for discriminating among possible topics of communication, what might the reasonable candidates for those topics be. There are at least four such candidates.

1. Past and current policy decisions and operational actions
2. Information, objectives, and intentions of the central bank
 - (a) Information about economic conditions
 - (b) Broad policy preferences and attitudes toward trade-offs
 - (c) Specific plans (including contingent plans) for future actions

Classes 1 and 2 reflect the distinction between two types of private information: *imperfect information* and *incomplete information*.⁷ An imperfect-information environment is one in which some agent takes actions that others cannot observe, while an incomplete-information environment is one in which some agent has characteristics (including the state of the agent's knowledge) that others cannot observe.

Two decades ago, when the trend toward more informative communication got under way, imperfect information (class 1) was the first to be disclosed. For example, in the United States, the Federal Open Market Committee began to disclose after each meeting the federal-funds-rate target that they had just set. Previously market participants did not receive this information explicitly, but counterparties with whom the Fed executed trades to implement monetary policy could infer the target from the terms at which those trades could be executed.

Particularly since the federal-funds market is an over-the-counter market, information acquired by the most active, direct counterparties did not immediately flow to the broad public. However, in view of the ample evidence for the “efficient markets hypothesis” in diverse financial markets there is every reason to believe that an accurate picture became quickly and widely available to sophisticated market participants.⁸ Those are the agents whose explicit knowledge of the target might matter for the effectiveness of monetary policy, and whether it takes a minute or a week for them to figure it out should not make much difference—even a week is much shorter than the interval between FOMC meetings. Thus, although the setting of a new monetary-policy target affects financial markets more suddenly and dramatically if the decision is announced than otherwise, it seems unlikely

⁶Even in the case that a central bank is explicitly obligated to communicate (for example, by a legislative requirement), the bank may be able effectively to remain silent by babbling (or, as Alan Greenspan was often described as having done, mumbling).

⁷In situations where all agents' preferences are identical, communication about intended or recommended actions can be useful even when there is no private information about either conditions or preferences. An example is when an orchestra conductor counts beats, to enable all of the musicians to start playing simultaneously and at the same tempo. However, in the context of communication by a central bank, it is reasonable to focus on private-information situations.

⁸In principle, the efficient markets hypothesis is also relevant to incomplete information regarding the central bank. Intuitively, however, would be more difficult to infer such information from prices than to infer a specific central-bank action that is taken deliberately to affect a specific price. The discussion of incomplete information below will abstract from the possibility of doing so.

that the disclosure of such imperfect information increases the effectiveness of monetary policy.⁹ I will henceforth focus on incomplete information (class 2).

4 Communicating about economic conditions

4.1 A private-information environment

The puzzles about a central bank communicating its information about economic conditions are:

1. Why would the central bank *not* want to communicate such information, given the presumption that its use is publicly beneficial?¹⁰
2. If the bank does communicate the information, then why would the public not believe it?

An answer to question (1) obviously implies an answer to question (2). That is, if the public believes that the central bank possesses accurate information about economic conditions but has incentive to “babble” rather than to communicate it informatively, then the public will discount what the bank tells it. To answer question (1), an opinion is sometimes imputed to central bankers that the public would somehow “over-react” to news about the economy. The meaning of this answer depends on the answer to the further question, “Over-react relative to what benchmark?”

One possible response to this follow-on question is that the public would over-react relative to how a rational, Bayesian agent would react, so that the central bank must “manage the expectations” of the public by withholding information that it would have been beneficial to give to a rational, Bayesian public. As I have discussed in section 2, I do not think that adopting such an idea is advisable from a scientific perspective.

In this section I will consider two alternate responses, both of which presume that the benchmark of appropriate reaction to information has to do with economic efficiency. That is, private agents each react to information in a way that is privately optimal for them, but their collective decision is socially suboptimal. There must be a negative externality among the private agents, in order for such a situation to occur. I will discuss that externality in the abstract, but it could be represented concretely by a model of a macroeconomic “coordination failure” such as such as Cooper and John [1988] and others have formulated.

One reason why the the central bank might not want to communicate its information is that the public ascribes low prior probability to the event that an externality situation exists. Thus, if the central bank does not provide information to them, they may be

⁹The old monetary-policy regime conferred informational quasi-rents on large market “players” who dealt directly with central banks. Regardless of whether or not monetary policy is made more effective by disclosing policy decisions and operations to the public, there is a distributional argument for making such disclosure.

¹⁰While there is not a completely general result to this effect, Diamond [1967] shows that information improves welfare in a model environment of multiplicative technological uncertainty.

willing to take a small risk of exposure to the externality in order to reap with high probability the benefits of cooperation/coordination. Offsetting the intrinsic value of information (on which Diamond [1967] focuses) in enabling agents to choose the best among cooperative actions, then the bank runs the risk of triggering defection among private agents whenever its information raises their posterior probability that exposure to externality is a relevant concern. The bank cannot report “good news” without also conveying “bad news” if it is known by the public to be informed in either event, since its silence will be interpreted as bad news. Thus the bank’s best course may be not to report any information at all.¹¹

The bank might not want to communicate its information, at least all of the time, if such communication were not time consistent. Then, in practice, the bank’s best strategy would be one that maximizes the information that it provides subject to a time-consistency constraint. Such a situation, in which there are recurrent episodes of central bank secrecy, may occur even if private agents’ prior probability of an externality event is high.

To investigate these two possibilities, consider an environment in which there are two states, Γ and Δ . There are two private agents, A and A' , in which each has the action set $\{c, d\}$. Call c *cooperation* and call d *defection*.

If A takes action x and a' takes action x' in state $\Sigma \in \{\Gamma, \Delta\}$, then A and A' receive payoffs $u(x, x', \Sigma)$ and $u(x', x, \Sigma)$ respectively. In state Γ , the game is a coordination game in which both players want to match each other’s strategies and prefer mutual cooperation to mutual defection. In state Δ , the game is a prisoner’s dilemma game in which defection is the dominant strategy. The payoffs are such that defection dominates cooperation in expected utility if the two states are equally probable. Specifically, the payoffs $u(x, x', \Gamma)$ and $u(x, x', \Delta)$ are given by the entry in row x and column x' of the following matrices.

$$u(x, x', \Gamma) = \begin{bmatrix} c & d \\ c & 2 & 0 \\ d & 0 & 1 \end{bmatrix}.$$

$$u(x, x', \Delta) = \begin{bmatrix} c & d \\ c & 2 & 0 \\ d & 6 & 1 \end{bmatrix}.$$

These payoffs imply that, if the two states are equally probable, then expected payoffs are given by the matrix

$$\frac{u(x, x', \Gamma) + u(x, x', \Delta)}{2} = \begin{bmatrix} c & d \\ c & 2 & 0 \\ d & 3 & 1 \end{bmatrix}.$$

In particular, defection dominates cooperation in this case, as was stated above, and the expected-payoff matrix is a prisoner’s dilemma.

¹¹The analysis below abstracts from the intrinsic value of information. If such value were taken into account, then not to report good news would raise a time-consistency problem. I believe that a strategy for the bank that resembles one studied below might partially resolve that problem.

In fact it is easy to calculate that, if one agent believes that the other will cooperate, then the agent with that belief will weakly (resp. strictly) prefer cooperation to defection if and only if his subjective probability of state Γ is at least (resp. greater than) $2/3$. That is,

$$p \lesseqgtr \frac{2}{3} \iff pu(c, c, \Gamma) + (1 - p)u(c, c, \Delta) \lesseqgtr pu(d, c, \Gamma) + (1 - p)u(d, c, \Delta).$$

This equivalence means that, when agents have identical beliefs, having subjective probability of Γ being at least $2/3$ is a sufficient condition for cooperation to be a Nash equilibrium in a single play of the game, and it is a necessary condition for cooperation to occur with positive probability in any Nash equilibrium. Note that, because mutual defection is a Nash equilibrium of a single play of the game in either state, it is also a Nash equilibrium for any probability mixture of the states.

A word about the interpretation of this game between private agents is in order, before proceeding to study the information and incentives of the central bank. While a 2-player game is being studied for simplicity, player A should be interpreted to be a single agent and player A' should be interpreted to be the “representative agent” in the rest of the population. Each individual agent should be regarded as being anonymous. His history of play is his private information and, in particular, other agents cannot condition their future treatment of him on how he plays today. Consequently, regardless of how patient (and therefore susceptible to intertemporal incentives, if their actions were observable) agents may be, every equilibrium of the infinitely repeated game is simply a history-dependent sequence of single-play equilibria.

Suppose that agents play this game at each date and that the state is a Bernoulli($1/2$) process $\Sigma = (\Sigma_0, \Sigma_1, \dots)$. That is, that the state Σ_t is independently distributed over time, with probability $1/2$ at each date of being Γ . Suppose also that agents receive a common signal $\hat{\sigma} \in \{\gamma, \delta\}$ at each date that is correlated with the current state but is independent of future states. To be precise, suppose that, $P[\Sigma_t = \Gamma \mid \hat{\sigma}_t = \gamma] = \hat{a}_t$ if $\Sigma_t = \Gamma$ and $\hat{\sigma}_t = \gamma$, and also if $\Sigma_t = \Delta$ and $\hat{\sigma}_t = \delta$, and that this probability is $1 - \hat{a}_t$ otherwise. Call \hat{a}_t the *accuracy* of signal $\hat{\sigma}_t$. If $\hat{a}_t > 2/3$, then there is an equilibrium in which agents cooperate at t if they receive signal γ and they play d at t if they receive signal δ .

Now suppose that $\hat{\sigma}_t$ is the report of the central bank about a signal σ_t of accuracy a that it privately observes. The bank decides at each date t whether to report its signal truthfully, in which case $\hat{\sigma}_t = \sigma_t$ and $\hat{a}_t = a_t$ or to “babble” by making a random report independent of Σ , in which case $\hat{a}_t = 1/2$.¹²

The bank’s strategy is a rule for deciding whether to report truthfully or to babble. In the case of some rules, such as “Report truthfully at even dates and babble at odd

¹²It will be sufficient here to consider such purely random babbling, although the bank would also have other strategies that involve partially informative reporting. Another way for the bank to make a completely uninformative report would be to a specific report with probability 1, regardless of the actual state. The difference between such a strategy and babbling is that the opposite of the equilibrium report would be unambiguously off the equilibrium path, while private agents are unable to detect with certainty a departure from the babbling equilibrium. Part of the definition of equilibrium is that each agent’s prior belief is that the other agents play their equilibrium strategies with probability 1, so if an equilibrium strategy of the bank induces each finite message sequence with positive probability, then the private agents’ posterior probability that the bank is playing its equilibrium strategy always remains 1.

dates,” private agents will always know whether or not the bank is basing its report on its actual signal.¹³ In that case, the agents will take action c when the bank sends report $\hat{\gamma}$, will take action d when the bank sends report $\hat{\delta}$, and will take actions that are Nash with respect to prior expected utility when the bank babbles. Specifically, agents will defect when the bank babbles if $P(\Gamma) < 2/3$ and they will cooperate when the bank babbles if $P(\Gamma) > 2/3$.

4.2 The incentives of the central bank

Now consider the incentives of the central bank, which acts to maximize agents’ collective welfare. Agents act symmetrically in an equilibrium, and the bank prefers that they cooperate rather than defect. Thus, if it could commit to a communication rule, the bank would always report the truth if $P(\Gamma) < 2/3$ and would always babble if $P(\Gamma) > 2/3$. In the latter case, the bank’s rule induces the agents always to cooperate, which is the bank’s ideal outcome. Thus no issue of time consistency can arise.

However, always to report truthfully is not time consistent if $P(\Gamma) < 2/3$. To be precise, it is not a perfect Bayesian equilibrium for the bank always to report truthfully and for private agents to cooperate if and only if the bank sends report $\hat{\gamma}$. Such a situation would be time inconsistent because, given how the agents respond to its reports, the bank would deviate from its strategy by reporting $\hat{\gamma}$ regardless of the truth. Then, following their strategies, the agents would always cooperate, which the bank prefers to the equilibrium outcome in which the agents only cooperate some of the time.

A Bayesian perfect strategy profile, resembling the *trigger-strategy equilibrium* studied by Green and Porter [1984], can be constructed that induces truthful reporting some of the time, if the bank is sufficiently patient and its signal is sufficiently accurate.¹⁴ Private agents cooperate when the bank makes report $\hat{\gamma}$, but if they learn that the bank’s report is false, then they defect during some interval of time (which Green and Porter call a *reversionary episode*, regardless of the bank’s reports, and the bank babbles during this interval.¹⁵ Cooperation conditional on the bank’s report resumes after the interval has ended. The risk of triggering a reversionary episode tends to enforce truthful reporting, since the bank, observing an accurate signal, maximizes its chance to match the actual state of the economy by reporting truthfully rather than deceptively. The central bank attains lower expected utility at each date during a reversionary episode than during the “normal” phase of the equilibrium, and the total expected loss is approximately proportional to the length of the episode if the bank is patient (and can thus outweigh the temporary utility loss from defection by private agents when it reports $\hat{\delta}$ if the episode is long).

¹³In the case of some other rules, such as “Report $\hat{\gamma}$ when signal γ is received, but babble when signal δ is received,” agents do not know whether or not the bank is basing its report on its signal. (Note that the bank’s report may randomly coincide with its signal, even when it is not based on the signal.) Equilibria involving such strategies will not be studied here.

¹⁴Abreu et al. [1986, 1990] characterize efficient equilibria in environments of complete, imperfect information. Cole and Kocherlakota [1997] consider environments with incomplete information. Mailath and Samuelson [2006] provide a clear, thorough, current exposition of this research area in game theory.

¹⁵In order for the agents’ strategies to be feasible, they must learn the true state at the end of each date, after they have taken their actions.

This trigger-strategy equilibrium is somewhat counter intuitive. In equilibrium, reversionary episodes are triggered only when the bank reports its signal truthfully but the signal does not match the state that occurs. Thus, reversionary episodes “punish” the bank for honest forecasting mistakes. The central bank babbles during each reversionary episode in order to make it optimal for the private agents to defect, even though (a) if the private agents follow their strategies of defecting during the episode, the bank would do as well to report truthfully as to babble, and (b) if those agents believed that the bank were telling the truth, then they would continue to cooperate whenever it sent report $\hat{\gamma}$.¹⁶

It has been argued above that it cannot be a perfect Bayesian equilibrium for the central bank always to report truthfully *and* for private agents always to pay attention to the bank’s report. Nevertheless, it can possibly be an equilibrium for the central bank always to report truthfully but for private agents sometimes to disregard its report. I conjecture that such an equilibrium can occur if the accuracy of the central bank’s signal is a stationary Markov process, higher at some dates than at others. When the recent “track record” of the central bank in forecasting inflation is poor, private agents will infer that the bank is “going through an inaccurate phase” and will disregard its reports. Nevertheless, as long as the accuracy of its signal is above the minimum of its support, the bank will report truthfully so that private agents will not (on average) infer that it is even lower than it actually is.¹⁷ If the minimum of the support is not an atom of the stationary distribution of accuracy, then the bank will make truthful reports almost surely. When the recent track record of central bank reporting is sufficiently good, then private agents will infer that the bank’s current signal is probably accurate, and they will cooperate when they receive report $\hat{\gamma}$. However, high accuracy of the bank’s signal must not be too persistent, or else the private agents’ posterior belief in its high accuracy will sometimes approach 1 so closely that the bank will have incentive to “liquidate some reputational capital” by falsely reporting that it has observed signal γ . That is, for such a model parametrization, truthful reporting will not always be time consistent.

4.3 How plausible is the theory?

This section has concerned a theory of central bank reporting on economic conditions that imputes Bayesian rationality to both the bank and the private agents who receive its reports, but according to which, nevertheless, externalities among the private agents and the bank’s strategic relationship to those agents complicate the issues of whether or not reporting is in the agents’ interest and of how much scope there is for the bank to make credible reports. The theory has the following implications.

1. It is not time consistent (that is, a perfect-Bayesian-equilibrium strategy) for the

¹⁶In the oligopoly environment that Green and Porter study, the trigger-strategy equilibrium is also subject to the criticisms that reversionary episodes are always triggered by “innocent” conduct and that, ex post when the condition is met for such an episode to begin, the oligopolists could mutually benefit by re-negotiating to avoid it. (These two criticisms are logically independent of one another.) At least, though, in that environment, each oligopolist has a strict incentive to defect during the reversionary episode if the others are going to defect. Condition (a) states that the equilibrium described here lacks that strict-self-enforcement property.

¹⁷The argument would resemble Grossman [1981].

central bank always to report informatively and truthfully, if private agents always believe it to be doing so and if minimizing the occurrence of externalities is a principal goal of the bank.

2. Under the following conditions, there can be a two-regime equilibrium, in which which recurrent episodes of truthful reporting, believed by the private agents, alternate with episodes in which reporting is either uninformative or else, despite being truthful, is not taken seriously by the private agents.
 - (a) The prior probability of an externality situation is high.
 - (b) At least some of the time, the central bank's information is accurate, and the high level of accuracy is persistent (although not necessarily completely so) over time.
 - (c) Future gains are weighed heavily, relative to a possible current gain, in the bank's policy preference.
3. If the accuracy of the central bank's information about the economy varies over time, then perfect Bayesian equilibrium can involve the bank always reporting truthfully, but its information sometimes being discounted by the public.

In my view, assumption (3), that the accuracy of the central bank's information varies over time, is the most plausible of these assumptions. If the real structure of the economy occasionally changes in ways that are not directly observable, then there are recurrent periods (just after the changes occur) when the central bank understands the economy less well than in the steady state. In contrast, assumption (2b), that the central bank's information is substantially accurate at its best, does not seem very plausible. There is a particular problem if, in order to account for central banks' greater willingness to disclose inflation forecasts in the past decade or two, it must be assumed that their ability to make a nontrivial prediction of inflation has become better in that period. In fact, the evidence is to the contrary.¹⁸ Another problem, if this theory is to be used to explain the movement toward disclosure of information about impending inflation, is that the relevance of this information to a possible externality among private agents is not clear. Rather, the coordination-failure "stories" that economists tell about such externalities typically have to do with information about the real state of the economy. The specific information that those stories would suggest to be relevant has to do with forecasting turning points of the business cycle—another notoriously difficult statistical problem that, even when their understanding of the economy is at its best, central banks probably do not solve with very high accuracy.

In summary, it is not clear *ex ante* whether or not the model presented in this section can fit the facts. That question can be decided only after economists have structurally estimated or calibrated a version of the equilibrium model, and have either found or else failed to find parameters such that equilibrium is consistent with the data.

¹⁸Cf. Atkeson and Ohanian [2001], Stock and Watson [2007].

5 Communicating about the central bank itself

In the previous section, it was assumed to be common knowledge that the central bank's preferences coincide with those of the public. It was shown that, despite this coincidence of preferences, a privately informed central bank can suffer a time consistency problem that prevents socially optimal, truthful revelation from being an equilibrium.

In another model environment where the central bank can suffer from time inconsistency, Rogoff [1985] showed that it can be optimal to make the central bank not share the public's preferences—specifically, to ensure (for example, by selecting a governor with a personal aversion to inflation) that it will be more averse than the public to inflation. Rogoff models an environment with perfect and complete information, so the issue of central bank communication does not arise there, but Rogoff's general point applies also to private-information environments. An inflation-averse central bank would presumably want to convince the public of its character. The question is, can any communication strategy succeed in distinguishing credibly an inflation-averse central bank from one that is less so (or, in general, in distinguishing credibly one type of central bank from another)?

An explicit theory of the environment just described would be specified in formal terms similar to the model in the previous section. Rather than fully specifying such a theory here, I will only summarize the main features that it must possess.

- Some externality or distortion causes the market-determined level of economic activity to be below its socially optimal level if the central bank conducts ex-ante efficient monetary policy, tempting the central bank to be time inconsistent.
- The central bank has private information regarding the strength of its inclination to resist such temptation (that is, regarding its type).
- The central bank has an opportunity to communicate with the public, and this opportunity can be used to report (truthfully or not) its type.
- After the central bank has reported, both it and the public take actions. The action that is optimal for the bank depends on both its actual type and the public's action, which in turn depends on the public's belief about the bank's type.

Both the central bank's information about economic conditions studied earlier and its information about its own policy preferences studied here are private, and both are instances of incomplete information rather than of imperfect information. Nevertheless there are several important differences between the model in section 4 and the model envisioned here.¹⁹

1. Here the central bank takes a substantive action, as well as making a report.
2. The bank's private information in section 4 concerned transient conditions (i.i.d. in the extreme formulation of the model), while Rogoff regards the bank's policy preference as being a persistent attribute of the bank.

¹⁹In fact, on a Bayesian understanding of preference under uncertainty, the bank's private information about its probability assessment of economic conditions can be subsumed under private information about its policy preferences.

3. Especially because reporting concerns a persistent attribute or state of affairs, the central bank has the opportunity to communicate repeatedly with the public.

Opportunity for repeated communication should broaden the scope for central communication to be effective.²⁰ On the other hand, it is intuitively clear that specifying the central bank to have a persistent type and to take substantive actions that can be publicly observed or inferred will restrict the scope for beneficial verbal communication. The reason is that, except when a new central bank is founded (as in the case of the ECB a decade ago) or when a major change is made in organization or senior personnel (particularly, the appointment of a new governor) or when a situation without close historical parallel is encountered (as in the case of the 2001 terrorist attack in the U.S.), the public possesses a body of revealed-preference evidence about the central bank that arguably provides information that is more credible and more precise than speeches, white papers, or press releases can provide. A central bank that previously has taken modestly costly measures, when necessary, to keep the price level or the inflation rate within a narrow band, does not much need to tell the public verbally what that band is or to assure the public verbally that it is willing to take necessary actions when a challenging situation arises. A central bank with a track record of timidity or procrastination in undertaking modestly costly policies or in meeting small challenges, will have great difficulty to raise public confidence in itself by engaging in cheap talk when a large challenge arises.

Situations in which the public does not have a base of revealed-preference information about the central bank do arise from time to time. Then important practical questions arise about how the central bank should best inform the public about its policy objectives and its plans or dispositions toward actions. The extent to which even the best conceived communication strategy can be effective is not known. The economic theory of communication in strategic situations has not yet been developed enough to address those questions by adapting a standard model as was done in section 4.²¹ Results about strategic equilibrium with communication tend to be quite sensitive to specific features of the model environment being studied, and an environment with all of the four features specified above has not yet been studied. Moreover, to get a determinate result, some equilibrium refinement typically has to be adopted, and economists' thinking is not completely settled regarding which refinements are the most appropriate ones to impose in various environments.

In this state of relative ignorance, the only sure advice that can be given is that it is prudent to minimize the need for the central bank to communicate about itself to the public, and to minimize the sensitivity of the public's inferences from communication to details of how the communication is framed. A central bank with an unambiguous policy mandate, articulated either in legislation or via instructions from legislators received in some periodic, public consultation, is fortunately situated. If the governor does not hold (and is known by the public not to hold) economic views that are at variance with the central bank's institutional mandate, then operational independence will increase the confidence of the public that the central bank will adhere to its mandate and not be deflected by political interference.

²⁰Aumann and Hart [2003] study formally the role of repeated communication in "cheap talk" situations.

²¹Farrell and Rabin [1996] and Sobel [2007] provide accessible surveys of the relevant theory.

6 Some complicating factors

6.1 Constrained communication

Policy makers, the general public, and even analysts in the financial-market community have finite capacity to understand, absorb, and understand messages from the central bank. When those constraints bind, the central bank must think especially hard about what is the most significant information to provide. Knowing that what the central bank chooses to announce is a result of such a thought process, private agents should draw inferences that would not be warranted if there were no capacity constraints.²² For example, on its face, an announcement of an interest-rate target is uninformative about the bank's opinions about financial stability. However, if the bank can only make an announcement about one topic or the other, then the public may infer from an interest-rate-target announcement being made that the bank currently has a low level of concern about financial stability. Otherwise, it would have made some announcement about that topic instead.

Sher [2008] has shown that such a communication constraint can be an additional reason, independent of the one identified in section 4, why the central bank might make time-inconsistent decisions regarding communication.

6.2 Communication by a monetary policy committee

Earlier in this paper, the monetary policy maker has been modeled as being a single agent. However, in many central banks, policy is set by a committee. In this situation, if the bank issues an inflation forecast, then exactly whose assessment of the future path of inflation is being reported? Is it the governor's assessment, or the median voter's assessment, or some weighted average of the assessments of several committee members? In principle, perhaps each member's assessment should be reported separately. In central banks where the norm is for the individual members of the policy committee to speak freely in public about their individual views, this ideal is approximated even though the format of the "official" inflation forecast may not be a compendium of individual forecasts.

6.3 Heterogeneous beliefs among private agents

The modeling and discussion in this paper have presumed that the central bank is the only privately informed agent. When various private agents have disparate private information as well, and especially when that information is correlated with the information of the central bank, . For example, each private agent might receive a private signal of inflation that is informative, but is subject to some error, and is correlated imperfectly with the central bank's information. An agent who receives a low signal will believe that inflation will probably be low, and will also believe that the central bank has probably received

²²Several researchers, notably Glazer and Rubinstein [2006] and Sher [2008], have studied this issue in depth.

a low signal as well, and an agent who receives a high signal will believe the opposite. Thus, not only do the agents have disparate beliefs about the state of the economy, but they have disparate beliefs about the beliefs of the central bank. Communication by the central bank may have a beneficial role in re-establishing agreement among the agents in equilibrium—a role that would not exist under the parsimonious modeling assumptions made here.

It might be thought that disparate information among private agents might be conducive to coordinating expectations by resolving indeterminacy of equilibrium, and might thus simplify some issues surrounding central bank communication. A body of research about various aspects of central-bank policy has relied on “global games” reasoning to show how equilibrium is unique. However, that research has abstracted from the endogeneity of a public signal—the price. Taking account of that endogeneity, Hellwig et al. [2006] have shown that equilibrium can persist despite heterogeneity of private agents’ information. Thus there is no ground to suppose that an environment with heterogeneous private signals would necessarily be advantageous for the central bank.

7 Conclusion

The study of central bank communication in this paper provides some theoretical support for three substantive conjectures.

1. Efficient-markets theory suggests that communication by a central bank about its past and current actions (that is, communication to resolve imperfect information) will have only limited effect, to the extent that private agents are able to infer those actions fairly accurately and quickly from prices and other market data in any event.
2. There are time-consistency issues pertaining to a central bank’s policy about communication, as well as to its substantive policies.
3. The most favorable condition for there to exist an equilibrium in which truthful revelation is a time-consistent policy for the central bank is a situation in which the bank’s private information is neither highly accurate nor highly inaccurate, and in which there are persistent fluctuations of accuracy within the middle range.

I have suggested here that, with regard to communication about policy preferences and other persistent attributes of the central bank itself, theory has not reached a mature stage at which reliable conclusions can be drawn. For the time being, economists and others should resist temptation to make strong claims about this topic, which would go beyond what can be reasonably supported.

In the discussion of communication, two distinctions have been drawn that are likely to be helpful to observe in the course of subsequent discussion. One distinction is between imperfect information and incomplete information, that is, between private information about agents’ actions and about their beliefs or attributes. The other distinction, which pertains to incomplete information, is between information about fairly transient facts

(such as the facts about an economy that are typically the subject of “current analysis” by economists and forecasters within the central bank) and persistent ones (such as, in a typical case, the policy stance of the bank itself.)

Analysis in this paper has departed from typical analysis of central bank communication by treating “transparency” as a policy that is arguably beneficial and feasible to implement in the current conditions under which many central banks operate, but that may not have been beneficial or feasible under former conditions. This contrasts with a view of transparency as being a policy that is always feasible and beneficial, but that was only recently discovered to be so. Central banks have been no less fortunate in earlier decades than in the current and immediate past ones, in having had had some insightful and innovative leaders. If a new equilibrium involving greater central-bank transparency began to emerge a decade or two ago, then the possibility that this change in endogenous outcome reflects a change in exogenous conditions—rather than reflecting a discovery that past central bankers missed the opportunity to make—is worthy of serious consideration. The discussion at the end of section 4, in particular, points toward a research program of trying to identify what that change may have been.

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