Transparency versus Tone: Public Communication with Limited Commitment*

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Abstract

Communication of public information is an integral aspect of policy-making by central banks and governments. We study public communication by a policymaker who cannot fully commit to a disclosure policy. The policymaker chooses not only the *transparency* of its communication (i.e., the precision of the public signal), but also its *tone* (i.e., the mean of the signal). Without commitment, the policymaker faces a trade-off between being informative and being manipulative. We show that an informative equilibrium exists if and only if the policymaker's incentives are perfectly aligned with those of the individuals. When there is a conflict of interest, the optimal communication is always completely *uninformative*. This is not necessarily because the public signal is imprecise, but may be because the policymaker's tone is overly optimistic or pessimistic—in equilibrium, the policymaker may *babble precisely*. We also show that tone can be crucial to the effectiveness of policy interventions in the absence of commitment.

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1 Introduction

> Since I've become a central banker, I've learned to mumble with great coherence...
>
> If I seem unduly clear to you, you must have misunderstood what I said.
>
> — Alan Greenspan, 1987.[1]

In stark contrast to the above quote from his predecessor, Bernanke (2013) emphasizes the crucial role of transparency in communication for effective monetary policy. These comments highlight the importance of, and the lack of consensus about, optimal disclosure policy. Managing the expectations of market participants is essential, since these have direct implications on their current and future economic decisions, and on the effectiveness of policy itself (e.g., Woodford, 2005). Public communication becomes even more important in an economy where coordination motives among individuals are non-negligible. In an influential paper, Morris and Shin (2002) introduce a framework to analyze the role of public information in such a setting. In their model, public information is more valuable to agents than its information content warrants because agents have strong incentives to coordinate. As a result, aggregate welfare is not monotone in the precision of available public information, and may decrease with more precise disclosure. This insight has sparked a large literature on the social value of public information and optimal level of transparency for policymakers.[2]

However, an important limitation of the analysis in the existing literature is that it has

[1] Alan Greenspan, former Chairman of the Board of Governors of the Federal Reserve, in a 1987 speech, as quoted by the New York Times article "A Fed Focused on the Value of Clarity," by Binyamin Appelbaum, December 13, 2012.

[2] For instance, Svensson (2006) argues that in the context of the original model, reasonable parameter values imply that social welfare is increasing the precision of public information. Angeletos and Pavan (2004), Hellwig (2005) and others have shown that more public information may unambiguously increase social welfare in environments that generalize the original setting. Specifically, Angeletos and Pavan (2004) introduce complementarity at the social level by considering a model of investment complementarities, while Hellwig (2005) studies a model of monopolistic price-setting in which better public information is always welfare improving, despite sometimes increasing output volatility. The comprehensive analysis of Angeletos and Pavan (2007) characterizes conditions under which the original result continues to hold and conditions under which it is reversed.

been confined to the case where the policymaker can *commit* to its communication policy. As discussed in the extensive literature on the time-inconsistency of fiscal and monetary policy, the trade-off between commitment and discretion is a delicate issue that complicates policy making of central banks and governments (e.g., Kydland and Prescott, 1977). The policymaker's ability and willingness to commit to a course of policy actions is at the center of the discussion. However, the literature has yet to pay attention to the role of commitment in public communication, even though this is integral to effective policy implementation. While Woodford (2005) recommends that a policymaker should commit to a strategy that "can and should be more specific than a mere promise to do 'whatever best serves social welfare,'" it may be difficult, if not impossible, to fully commit to disclosing a precise amount of information in practice. The issue of public information is especially nuanced in the context of a market setting, since public communication not only reveals information, but also mediates the play of the market participants by enabling them to coordinate on publicly known events. As such, in this paper we ask: in the presence of coordination motives for individual participants, what are the implications of limited commitment on the policymaker's optimal disclosure?

Our framework builds upon several strands of the literature: strategic communication, time-inconsistency, and the value of public information. Formally, we study a variant of the Morris and Shin (2002) economy. In particular, suppose the policymaker observes a private signal but can add noise to the signal before releasing it publicly. We extend the benchmark model by incorporating two important features. First, we allow the policymaker's objective to be biased with respect to the socially desirable outcome. Recall that in Morris and Shin (2002), the policymaker's objective is to maximize welfare by minimizing the average distance between the agents' actions and the fundamental. We assume that the policymaker's objective is to minimize the average distance between the agents' actions and the fundamental, shifted by a constant bias, b, that is commonly known to all agents.[3] Our

[3] A special case of our model, in which $b = 0$, recovers the policymaker's objective in from Morris and

specification of conflict of interest is consistent, in spirit, with the models of Kydland and Prescott (1977) and Barro and Gordon (1983). The bias allows us to parsimoniously capture possible conflicts of interest between individuals and the policymaker, which may arise due to moral hazard, differences in beliefs or ideologies, preferences for robustness to model mis-specification (e.g., Ellison and Sargent, 2012), or even the possibility of corruption (e.g., Acemoglu, Egorov, and Sonin, 2013). More generally, the possibility of a bias also allows us to judge the robustness of optimal disclosure policy to small changes in the policymaker's objectives.

Second, we generalize the class of communication instruments available to the policymaker. As is standard in the literature, we allow the policymaker to control the transparency of its disclosure by optimally choosing the variance of the noise (or, equivalently, the precision of its public signal). However, we also allow the policymaker to choose the mean of the noise, conditional on its private signal. We interpret this choice of the mean as the *tone* of the public disclosure. In particular, the policymaker may strategically choose to be "optimistic" (positive mean) or "pessimistic" (negative mean) when disclosing public information about fundamentals in order to influence the behavior of other agents in the economy, especially if there is a conflict of interest. To our knowledge, this dimension of public disclosure has not been explored in these models.

These features are not only theoretically interesting, but may also be empirically important. For instance, Romer and Romer (2008) and Ellison and Sargent (2012) document that inflation and unemployment forecasts of the FOMC are generally more "pessimistic" relative to staff Greenbook forecasts. Ellison and Sargent (2012) argue this evidence is consistent with the FOMC having a preference for robustness against model mis-specification. Moreover, the tone adopted by policymakers affects market expectations, irrespective of the policy outlined. For example, using textual analysis of speeches by U.S. central bankers, Thorarinsson and Eshraghi (2013) document that the tone of the speech can influence the price of

Shin (2002).

gold bullion, and that the effect differs across the chairmen in their sample (Greeenspan vs. Bernanke).[4] While our model abstracts away from the specific source of potential conflicts of interest, it highlights the importance of such biases on the equilibrium disclosure policy. And since public communication influences market expectations, strategic policymakers are likely to pay careful attention to all aspects of their communication, including its tone.

In this context of strategic information disclosure, there is always a "babbling equilibrium" in which the public signal generated by the policymaker is completely ignored by individual agents. The question is, then, will there be other equilibria? We show that the equilibrium in which the public signal conveys useful information is very fragile. Specifically, we show that an informative equilibrium exists if and only if the policymaker is unbiased (i.e., $b = 0$), and in this case, the disclosure is fully informative. On the other hand, if the policymaker is biased, no matter how small the bias is understood to be, the optimal disclosure in equilibrium is not informative. As such, the *robust optimal disclosure policy is always uninformative*! These results are at odds with the role of public information when the government is fully committed to a disclosure rule, in which case an interior precision can be optimal. Therefore, our results call attention to the implicit assumption of commitment made by the literature in its discussion of public communication and transparency.

When the policymaker cannot commit to a disclosure policy, the agents in the economy weigh the public signal based on the anticipated precision of the signal in equilibrium. But in this case, the policymaker has the incentive to deviate and make the public signal more precise, because, doing so does not affect the weight that agents put on the public signal. As a result, the equilibrium precision for the public signal is infinite. When the policymaker is unbiased, this characterizes the equilibrium — the public disclosure is fully informative.

[4] Thorarinsson and Eshraghi (2013) measure the tone by looking at the level of different variables—including activity, certainty, optimism and realism—in each speech. The fact that rhetoric of speech and argument affects outcomes has also been noted in various other contexts. Aragones et al. (2013) define the art of rhetoric as changing other people's minds (opinions, beliefs) without providing new information. They offer models of "analogies" to capture the reasoning of boundedly rational agents.

However, when the policymaker is biased, it has an additional incentive to set the tone of the public signal strategically. For example, suppose the policymaker's bias is positive, i.e., it would like the agents' actions to be higher than the fundamental. Then, it has an incentive to increase the mean, or equivalently, choose an "optimistic" tone for the public signal to encourage agents to take a higher action. Understanding the incentives of the policymaker, individual agents will try to filter the tone out of observed public information. But then, the policymaker has an incentive to adjust its tone further, which, in turn, leads agents to filter out the tone more aggressively. In equilibrium, this leads the public signal to be completely uninformative despite being transparent, since it is dominated by the optimistic tone the policymaker wants to set — the policymaker *babbles precisely*. As such, the intuition for the fragility of informative equilibria is different from the logic of babbling equilibria in cheap talk models.

Our conclusions are robust to a number of quantitative and qualitative modifications of the benchmark model. For instance, Svensson (2006) observes that the relative accuracy of each participant's private information and the public information is important in generating the main result of Morris and Shin (2002). In the model with full commitment, the result requires that market participants must care sufficiently strongly about coordination with others relative to their concern about matching with fundamentals. The analysis of the benchmark model in the next section suggests that our results are independent of these measures. Similarly, Woodford (2005) points out that the main conclusion of Morris and Shin (2002) relies on the assumption that the social welfare function does not depend on coordination across agents. Instead, if lack of coordination is socially costly, he shows that welfare is necessarily improved by increasing the precision of the public signal. As we discuss in the Section 3, our results are robust to this modification.

Communication and real policy actions are complementary in achieving overall economic objectives. Our next goal is to study the connection between communication and policy interventions. We show that the tone of communication can play an important role in ensuring policy interventions are effective in the absence of commitment. When the policymaker can commit to a disclosure policy and also affect outcomes directly through intervention, James and Lawler (2011) argue that increasing transparency decreases social welfare regardless of parameter values, thereby strengthening the intuition from Morris and Shin (2002). In this case, the optimal disclosure is completely uninformative, but policy intervention is effective and achieves the social optimum. In Section 4, we show that in the absence of commitment (and when there are no conflicts of interest), the opposite results can emerge: the optimal disclosure is perfectly informative and the policy intervention is *completely ineffective*. Intuitively, when the public signal is more informative about the policymaker's private information, market participants can better anticipate (and undo) the policy intervention, making it less effective; without commitment, the limiting outcomes obtain.

In the presence of conflicts of interest, the same results obtain if the policymaker only affects the transparency of communication. However, if the policymaker can also affect the tone, policy interventions may be effective once again. Given the bias in objectives, the policymaker's equilibrium tone makes the public signal uninformative about its private information. As a result, market participants cannot undo the intervention, which restores its effectiveness in equilibrium. Though stylized, this result highlights the potential importance of tone in policy communication and policy implementation.

While there is no commitment in the single interaction, static model, commitment may naturally arise due to dynamic incentives when agents interact repeatedly. To explore this, we consider an infinitely repeated version of our benchmark model in the Appendix. We show that when the policymaker is sufficiently patient, a fully informative disclosure policy can be implemented using a trigger strategy equilibrium (e.g., Green and Porter, 1984; Golosov, Skreta, Tsyvinski, and Wilson, 2014). However, even in this case, fully informative disclosure is difficult to sustain in the long run — eventually, the trigger is executed and the equilibrium disclosure becomes uninformative.

The result that the robust optimal disclosure policy is uninformative may appear similar to the anti-transparency conclusions of previous studies, but the mechanism and implications are actually very different. With full commitment, limited transparency is optimal because precise public information coordinates market participants away from fundamentals. Our analysis reveals that the policymaker faces a trade-off between being informative and being manipulative, and the lack of commitment unleashes the incentives to manipulate. In reality, markets appear to respond to deliberate communication by policymakers (e.g. Bernanke and Kuttner, 2005; Savor and Wilson, 2013). Our result provides a theoretical benchmark that highlights the important role of commitment in understanding the impact of communication by policymakers, by isolating the central trade-off as starkly as possible. Specifically, in contrast to the full commitment benchmark that is widely analyzed by the literature, we provide a no-commitment benchmark. A more realistic approach, and an interesting direction for further research, would be to study a model in between these extremes, where the policymaker has partial commitment. One can also extend our analysis to a dynamic framework that incorporates reputation building and market discipline of policymakers. Finally, our analysis also adds a new dimension to the discussion of communication policy and expectations management by emphasizing how the tone of the public signal (i.e., its mean) can play a key role.

2 Benchmark Model

The setup of the benchmark model closely follows Morris and Shin (2002). There is a continuum of agents, indexed by the unit interval $[0,1]$. Agent i chooses an action $a_i \in R$, and $\mathbf{a}$ denotes the action profile of all agents. Agent i's payoff is

$$u_i(\mathbf{a},\theta) = -(1-r)(a_i-\theta)^2 - r\left(L_i - \overline{L}\right), \tag{1}$$

where $r \in (0,1)$ is a constant; θ is a random variable representing the underlying state of the economy and assumed, as in Morris and Shin (2002), to be drawn from an improper uniform distribution over the real line; and

$$L_i = \int_0^1 (a_j - a_i)^2 \, dj, \text{ and } \bar{L} = \int_0^1 L_j dj.$$

The first component in Eq. (1) represents a fundamentals-related element, while the second is the "beauty contest" element that captures agent's coordination incentives.[5] In particular, r captures the trade-off between coordination and fundamental economic activities. With full commitment, the functional form makes a qualitative difference (e.g., Woodford, 2005) for the optimal communication policy, and the weight r makes a quantitative difference (e.g., Svensson, 2006). In contrast, the results under limited commitment are robust to such changes, as we shall discuss later.

The social welfare, defined as the normalized average of individual payoffs, is

$$W(\mathbf{a}, \theta) = \frac{1}{1-r} \int_0^1 u_i(\mathbf{a}, \theta) \, di = -\int_0^1 (a_i - \theta)^2 \, di.$$

The second component in Eq. (1) is washed out in expectation. Each agent i observes the realization of an idiosyncratic, private signal

$$x_i = \theta + \varepsilon_i, \tag{2}$$

where $\varepsilon_i \sim N\left(0, \frac{1}{\beta}\right)$ is i.i.d. and independent of θ. The policymaker observes a private signal

$$y = \theta + \eta, \tag{3}$$

where $\eta \sim N\left(0, \frac{1}{\alpha}\right)$ is independent of θ. However, unlike Morris and Shin (2002), we assume

[5] As made explicit in Morris and Shin (2002) and Amato et al. (2002), the specification of this incentive structure formally coincides with that of the Lucas-Phelps Island Economy model.

that after observing the private signal y, the policymaker can choose to release a public signal of the form:

$$\widetilde{y} = y + \mu + \xi \tag{4}$$

$$= \theta + \eta + \mu + \xi, \tag{5}$$

where $\xi \sim N\left(0, \frac{1}{\gamma}\right)$, and $\mu \in [-\infty, \infty]$ and $\gamma \in [0, \infty]$ are the choice variables. We allow the precision γ to be unbounded to allow for perfectly informative disclosure i.e., when the policymaker reveals her information without adding additional noise. The assumption that μ is unbounded is made to capture the notion that a policymaker always has the room to adjust her tone relative to the market expectation. A bounded space will not be able to capture this feature.[6] We include the boundaries to ensure the domain of μ is compact, but the endpoints (i.e., $\pm\infty$) should be interpreted as extreme tone, which renders the disclosure uninformative.

The policymaker's objective is to *strategically* choose $\mu^*(y)$ and $\gamma^*(y)$ optimally to maximize the objective function $W(\mathbf{a}, \theta + b)$, where $b \in \mathbb{R}$ represents the policymaker's bias, i.e.,

$$(\mu^*(y), \gamma^*(y)) \equiv \arg\max_{(\mu,\gamma)} \mathbb{E}\left[W(\mathbf{a}, \theta + b) | y\right]. \tag{6}$$

Note that for $b = 0$, the objective function for the policymaker corresponds to the social welfare function in Morris and Shin (2002). This specification allows us to characterize the optimal disclosure policy that is robust to (small) perturbations (i.e., $b \neq 0$) in the objective function away from the social welfare benchmark.

In a hypothetical situation where it could fully dictate the actions of the agents, the policymaker would like to match the agents actions with $\theta + b$. In the absence of such

[6]The state space in Morris and Shin (2002) is unbounded, unlike the cheap-talk model of Crawford and Sobel (1982). Kartik et al. (2007) consider an unbounded state space in a cheap talk model. They argue that the assumption is suitable for modeling a financial analyst's prediction of a stock price or an adviser's evaluation of student ability.

possibilities, a strategic policymaker has an incentive to manipulate agents' beliefs: the policymaker would like agents to believe the relevant fundamental state is $\theta + b$, instead of θ. The specific function form of bias is thus consistent with the expectation management interpretation of policymaker communication (see Woodford (2005) for further discussion). When b is negative, the policymaker has a desire for the agents to take lower (and less aggressive) actions. For example, this is consistent with the objectives of a central bank that is concerned about the economy over-heating, and would therefore like to discourage excessive investment. In contrast, when b is positive, the policymaker wants to encourage higher (more aggressive) actions, as in the case of, for instance, a politician facing re-election who wishes to boost short-term employment and economic activity.

Agent i does not observe the actual choice of (μ^*, γ^*), but instead anticipates (μ^e, γ^e), and chooses her optimal action a_i after observing the public signal $\widetilde{y}$ and private signal x_i. We thus adopt the solution concept of perfect Bayesian equilibrium and we restrict attention to pure strategies of the policymaker. Moreover, following the literature, we focus on equilibria in which the actions of agents and policymakers are linear in their information.

We shall conjecture, and verify, that μ^* and γ^* will not depend on y in equilibrium. Given the specification of payoffs and the information structure, agent i's optimal behavior is characterized by the following lemma.

Lemma 1. *Given an anticipated disclosure policy (μ^e, γ^e), agent i's optimal action is given by*

$$a_i = \lambda x_i + (1-\lambda)(\tilde{y} - \mu^e), \text{ where } \lambda \equiv \frac{\beta(1-r)}{\beta(1-r) + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)}. \tag{7}$$

Proof. The details of the proof are as in Morris and Shin (2002). Here we outline the argument. Agent i's beliefs about fundamentals are given by

$$\mathbb{E}[\theta | x_i, \tilde{y}, \mu^e, \gamma^e] = \frac{\beta x_i + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)(\tilde{y} - \mu^e)}{\beta + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)}. \tag{8}$$

Conjecture a linear equilibrium in which $a_j = \kappa_x x_j + \kappa_y (\tilde{y} - \mu^e)$, and let $\bar{a} = \int_0^1 a_j dj$. Then, agent i's first order condition implies

$$\begin{aligned} a_i &= (1-r)\,\mathbb{E}_i[\theta] + r\mathbb{E}_i[\bar{a}] && (9) \\ &= (1-r)\frac{\beta x_i + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)(\tilde{y}-\mu^e)}{\beta + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)} + r\left(\kappa_x \frac{\beta x_i + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)(\tilde{y}-\mu^e)}{\beta + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)} + \kappa_y(\tilde{y}-\mu^e)\right) && (10) \\ &\equiv \kappa_x x_i + \kappa_y(\tilde{y}-\mu^e), && (11) \end{aligned}$$

and matching coefficients gives us the equilibrium strategy. ∎

Given the optimal behavior by agents, the following proposition characterizes the optimal behavior by the policymaker in equilibrium.

Proposition 1. *Suppose the policymaker chooses (μ, γ) strategically after observing y to maximize $W(\mathbf{a}, \theta + b)$. When $b = 0$, there are two possible linear equilibria: (i) one in which the optimal disclosure policy is fully informative, and (ii) one in which the optimal disclosure policy is uninformative. When $b \neq 0$, then the optimal disclosure policy is always uninformative.*

Proof. The optimal disclosure policy for the policymaker is given by

$$\begin{aligned} (\gamma^*, \mu^*) &= \arg\max_{(\mu,\gamma)} \mathbb{E}[W(\mathbf{a}, \theta+b)\,|y] && (12) \\ &= \arg\max_{(\mu,\gamma)} -\mathbb{E}\left[\int_0^1 (\lambda x_i + (1-\lambda)(\tilde{y}-\mu^e) - \theta - b)^2\, di|y\right] && (13) \\ &= \arg\max_{(\mu,\gamma)} -\mathbb{E}\left[\int_0^1 (\lambda\varepsilon_i + (1-\lambda)(\eta+\xi+\mu-\mu^e) - b)^2\, di|y\right] && (14) \\ &= \arg\max_{(\mu,\gamma)} -\left[\lambda^2\frac{1}{\beta} + (1-\lambda)^2\left(\frac{1}{\gamma}+\frac{1}{\alpha}\right) + ((1-\lambda)(\mu-\mu^e) - b)^2\right] && (15) \end{aligned}$$

since $\mathbb{E}[\varepsilon_i|y] = \mathbb{E}[\eta|y] = \mathbb{E}[\xi|y] = 0$. This implies that the optimal choice of γ does not depend on the choice of μ. Notice that in a candidate equilibrium, λ is a constant depending on the agents' expectation of the policymaker's choice, which must be correct on the equilibrium path.

When the policymaker has no bias, i.e., $b = 0$, there are two equilibria. The first is a fully informative equilibrium in which $\gamma^* = \infty$ and $\mu^* = \mu = 0$ (without loss of generality). In this case, since $\gamma^e = \gamma^*$ in equilibrium, $\lambda = \frac{\beta(1-r)}{\beta(1-r)+\alpha}$. The second is an uninformative equilibrium in which $\gamma^* = 0$, $\mu = \mu^* = 0$ (without loss of generality), in which case $\lambda = 1$.

When the policymaker has a bias, i.e., $b \neq 0$, the first order condition with respect to μ is given by:

$$2\left(\left(1-\lambda\right)\left(\mu^* - \mu^e\right) - b\right)\left(1-\lambda\right) = 0. \tag{16}$$

There are two solutions to this: either $\lambda = 1$, which requires $\gamma^* = 0$, and consequently an uninformative disclosure policy; or $\lambda < 1$, in which case,

$$\mu^* - \mu^e = \frac{b}{1-\lambda}. \tag{17}$$

But since $\mu^* = \mu^e$ in equilibrium, we need $\mu^* = \mu^e = \infty$ for $b > 0$ and $\mu^* = \mu^e = -\infty$ for $b < 0$. Again, this implies an uninformative disclosure policy — even though $\gamma^* > 0$, $\mu^* = \pm\infty$. As such, when $b \neq 0$, the disclosure policy is always uninformative. ∎

Remark 1. *Given that we allow for $\mu \in \{+\infty, -\infty\}$, the above characterizes an equilibrium with completely uninformative disclosure. If this were not the case, one could interpret the above argument as a non-existence result. However, this does not change the overall conclusions of our analysis — the robust outcome when the policymaker cannot commit to a disclosure policy is uninformative disclosure.*

The finding in Morris and Shin (2002) has promoted considerable debate on its implications in the transparency of central banking and on its quantitative and qualitative predictions. It is important to note that our results above do not depend on the parameter r, which determines the relative importance of the fundamentals vs. coordination components of payoffs, or on the relative values of α vs. β, which determine the relative precision of the agents' and policymaker's signals. Svensson (2006) highlights that welfare decreases in the precision of the public signal in the Morris and Shin (2002) model only when $r \geq 1/2$ and $\alpha < \beta/8$, which he argues may not be reasonable parameter restrictions. Our conclusions about the effect of limited commitment are not restricted to these parameter assumptions, which suggests our results are robust to quantitative modifications of the benchmark model.

3 Socially desirable coordination

In this section, we consider a generalization of the benchmark model to highlight the robustness of our main results. Woodford (2005) points out that the main conclusion of Morris and Shin (2002) relies crucially on the assumption that the social welfare function does not depend on coordination across agents, since the second component in Eq. (1) is washed out in expectation. Moreover, he shows that if instead coordination is socially beneficial, welfare is necessarily improved by increasing the precision of the public signal.

Consider a setup identical to that in the benchmark model of Section 2, except that instead of Eq. (1), agent i's payoff is given by:

$$u_i(\mathbf{a}, \theta) = -(1-r)(a_i - \theta)^2 - r(L_i - B\bar{L}), \tag{18}$$

where $B \in \mathbb{R}$. Note that when $B = 1$, we recover the payoff specified by Morris and Shin (2002), while when $B = 0$, the payoff is analogous to the one in Woodford (2005).

Social welfare is defined as the normalized average of individual payoffs:

$$W(\mathbf{a}, \theta) = \tfrac{1}{1-r} \int_0^1 u_i(\mathbf{a}, \theta) di.$$

If $B \neq 1$, coordination, the second component of (18), is relevant for social welfare as

$$\int_0^1 \left(L_i - B\bar{L}\right) di = (1 - B)\,\bar{L} \neq 0.$$

Importantly, as Woodford (2005) shows, the welfare objective corresponding to $B = 0$ is increasing in the precision of the public signal. As such, if there is no fundamentally compelling reason to assume a particular value of B, conclusions from the welfare analysis of public information would be vulnerable.

We consider again a potential conflict of interest between the policymaker and the individual agent, such that the objective function of the policymaker is given by $W(\mathbf{a}, \theta + b)$. We show that without commitment, the optimal disclosure policy robust to biases is not informative, even in this setting. The first order condition for agent i is identical to the benchmark model, and so Lemma 1 characterizes the optimal action of the agents. Given these actions, the optimal behavior of the policymaker is characterized by the following result.

Proposition 2. *Suppose the policymaker chooses (μ, γ) strategically after observing y to maximize $W(\mathbf{a}, \theta + b)$. When $b = 0$, there are two possible linear equilibria: (i) one in which the optimal disclosure policy is fully informative, and (ii) one in which the optimal disclosure policy is uninformative. When $b \neq 0$, then the optimal disclosure policy is always uninformative.*

Proof. The optimal disclosure policy for the policymaker is given by

$$(\gamma^*, \mu^*) = \arg\max_{(\mu,\gamma)} \mathbb{E}\left[W\left(\mathbf{a}, \theta + b\right)|y\right] \tag{19}$$

$$= \arg\max_{(\mu,\gamma)} \begin{array}{c} -\mathbb{E}\left[\int_0^1 \left(\lambda x_i + (1-\lambda)\left(\tilde{y} - \mu^e\right) - \theta - b\right)^2 di|y\right] \\ -\frac{r}{1-r}(1-B)\mathbb{E}\left[\bar{L}|y\right] \end{array} \tag{20}$$

$$= \arg\max_{(\mu,\gamma)} - \left[\begin{array}{c} \lambda^2 \frac{1}{\beta} + (1-\lambda)^2\left(\frac{1}{\gamma} + \frac{1}{\alpha}\right) + \left((1-\lambda)\left(\mu - \mu^e\right) - b\right)^2 \\ + \frac{r}{1-r}(1-B)\frac{\lambda^2}{\beta} \end{array}\right]. \tag{21}$$

The result then follows from comparing the above expression to the corresponding expression in equation (15) from the benchmark case. ∎

4 Policy intervention

So far, we have focused solely on communication. The value of public information is limited in this setup. In practice, communication is often followed by concrete actions. In this section, we examine the connection of the two. We allow the policymaker to affect outcomes directly through an action g, conditional on its information y. James and Lawler (2011) argue that when the policymaker can commit to an optimally designed policy rule, social welfare is decreasing in the precision of the public signal. Recall that public disclosure creates inefficiency in Morris and Shin (2002) because agents put too much weigh on public information because of its coordination role. A less precise disclosure has two effects: it mitigates this inefficiency, but creates informational inefficiency. James and Lawler (2011) show that policy intervention can undo this informational inefficiency.

We analyze equilibrium outcomes when the policymaker can strategically choose its intervention and disclosure after observing its information. We show that informative disclosure can be an equilibrium only if the policymaker's objective is perfectly aligned with that of the individual agent, but not otherwise. The informative equilibrium arises due to the expectation of the markets. If the market participants expect the public signal to be precise, their actions will be a function of the public signal with its expected precision, and therefore inefficiently under-weight their private signals. This forces the policymaker to perfectly reveal its private information, which in turn, makes the intervention ineffective, since the market perfectly anticipates (and undoes) the intervention.[7]

When there is a conflict of interest, the same results obtain if the policymaker only affects the transparency of communication. However, if the policymaker can also affect the tone, the effectiveness of policy intervention is restored. In this case, the policymaker's tone makes the public signal uninformative, and as a result, agents do not inefficiently discount their private information. Moreover, the intervention fully utilizes the policymaker's private signal, but is not undone by the agents' actions, and so is effective in equilibrium. As such, this uninformative equilibrium under limited commitment and (a tiny amount of) conflict interests recovers the outcome under full commitment and no conflict of interest as studied by James and Lawler (2011). As such, our analysis suggests that the strategic use of *tone* can play a crucial role in making policy intervention effective, when the policymaker cannot commit to a communication policy.

Specifically, we assume that the payoff to agent i is given by

$$u_i(\mathbf{a}, \theta, g) = -(1-r)(a_i - \theta - g)^2 - r\left(L_i - \overline{L}\right), \tag{22}$$

instead of by Eq. (1), and welfare is given by

$$W(\mathbf{a}, \theta, g) \quad = \quad \frac{1}{1-r}\int_0^1 u_i(\mathbf{a}, \theta, g)\, di = -\int_0^1 (a_i - \theta - g)^2\, di. \tag{23}$$

Moreover, we assume that neither the policymaker, nor any agent is able to observe the action of any other agent.

[7] James and Lawler (2011) discuss this outcome in footnote 9 of their paper.

We conjecture, and verify, that the optimal intervention $g^* = \rho_0^* + \rho^* y$ will be a linear function of y, and that, as before, μ^* and γ^* will not depend on y in equilibrium. Let $g^e = \rho^e + \rho^e y$ be the anticipated intervention in equilibrium. As before, we can verify that the optimal action by the agents is linear.

Lemma 2. *Given an anticipated disclosure policy (μ^e, γ^e) and an anticipated intervention $g^e = \rho^e + \rho^e y$, agent i's optimal action in equilibrium is given by*

$$a_i = \rho^e + \lambda x_i + (1 + \rho^e - \lambda)(\tilde{y} - \mu^e), \ \textit{where} \tag{24}$$

$$\lambda \equiv \frac{(1-r)(\delta(1+\rho^e) - \delta_\eta \rho^e)}{1 - r\delta}, \tag{25}$$

$$\delta \equiv \frac{\beta}{\beta + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)}, \ \textit{and}\ \delta_\eta \equiv \frac{\beta\gamma^e}{\alpha(\beta+\gamma^e) + \beta\gamma^e}. \tag{26}$$

Proof. Agent i's beliefs about fundamentals are given by

$$\mathbb{E}[\theta | x_i, \tilde{y}, \mu^e, \gamma^e, \rho^e] = \frac{\beta x_i + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)(\tilde{y} - \mu^e)}{\beta + \left(\frac{\alpha\gamma^e}{\alpha+\gamma^e}\right)} \equiv \delta x_i + (1-\delta)(\tilde{y} - \mu^e), \tag{27}$$

and her beliefs about the signal y is given by

$$\mathbb{E}[y | x_i, \tilde{y}, \mu^e, \gamma^e, \rho^e] = \mathbb{E}[\theta | x_i, \tilde{y}, \mu^e, \gamma^e, \rho^e] + \mathbb{E}[\eta | x_i, \tilde{y}, \mu^e, \gamma^e, \rho^e] \tag{28}$$

$$= \mathbb{E}[\theta | x_i, \tilde{y}, \mu^e, \gamma^e, \rho^e] + \frac{\frac{\beta\gamma^e}{\beta+\gamma^e}}{\alpha + \frac{\beta\gamma^e}{\beta+\gamma^e}}(\tilde{y} - \mu^e - x_i) \tag{29}$$

$$\equiv \delta x_i + (1-\delta)(\tilde{y} - \mu^e) + \delta_\eta(\tilde{y} - \mu^e - x_i). \tag{30}$$

since $\tilde{y} - \mu^e - x_i = \eta + (\mu - \mu^e) + \xi + \varepsilon_i$. Conjecture a linear equilibrium in which $a_j =$

$\kappa_0 + \kappa_x x_j + \kappa_y (\tilde{y} - \mu^e)$, and let $\bar{a} = \int_0^1 a_j dj$. Then, agent i's first order condition implies

$$a_i = (1-r)\,\mathbb{E}_i[\theta + g^e] + r\mathbb{E}_i[\bar{a}] \tag{31}$$

$$= \begin{array}{c}(1-r)\{\rho^e + (1+\rho^e)(\delta x_i + (1-\delta)(\tilde{y}-\mu^e)) + \rho^e\delta_\eta(\tilde{y}-\mu^e - x_i)\} \\ +r\{\kappa_0 + \kappa_x(\delta x_i + (1-\delta)(\tilde{y}-\mu^e)) + \kappa_y(\tilde{y}-\mu^e)\}\end{array} \tag{32}$$

$$\equiv \kappa_0 + \kappa_x x_i + \kappa_y(\tilde{y} - \mu^e), \tag{33}$$

and matching coefficients gives us the equilibrium strategy. ∎

Given the optimal behavior by agents in equilibrium, the following result characterizes the optimal disclosure and intervention by the policymaker.

Proposition 3. *Suppose the policymaker chooses (μ, γ, g) strategically after observing y to maximize $W(\mathbf{a}, \theta + b, g)$, and moreover, suppose the optimal intervention has finite first and second moments (i.e., $\mathbb{E}[g]$ and $\mathbb{E}[g^2]$ are well-defined). When $b = 0$, there are two possible linear equilibria: (i) one in which the optimal disclosure policy is fully informative, and (ii) one in which the optimal disclosure policy is uninformative. When $b \neq 0$, then the optimal disclosure policy is always uninformative.*

Proof. The optimal choice of intervention is to pick

$$g^* = \arg\max \mathbb{E}[W(\mathbf{a}, \theta + b, g)\,|y] \tag{34}$$

$$= \arg\max \mathbb{E}\left[-\int_0^1 (a_i - \theta - b - g)^2\, di|y\right] \tag{35}$$

$$= \mathbb{E}[\bar{a} - \theta - b|y]. \tag{36}$$

Given the optimal strategy $a_i = \rho_0^e + \lambda x_i + (1 + \rho^e - \lambda)(\tilde{y} - \mu^e)$, the optimal intervention is given by the first order condition:

$$g^* = \rho_0^e + \mathbb{E}\left[\lambda\theta + (1 + \rho^e - \lambda)(\theta + \eta + \xi + \mu - \mu^e)|y\right] - b \tag{37}$$

$$= \rho_0^e + (1 + \rho^e - \lambda)(\mu - \mu^e) - b + \rho^e \mathbb{E}[\theta|y] \tag{38}$$

$$\equiv \rho_0^* + \rho^* y. \tag{39}$$

Note that irrespective of the value of b, $\rho^* = \rho^e$. When $b = 0$, the intervention is ineffective since it is perfectly anticipated by the agents i.e., $\rho_0^* = \rho_0^e$ and $\rho^* = \rho^e$. When $b \neq 0$, we have

$$\rho_0^* - \rho_0^e = (1 + \rho^e - \lambda)(\mu - \mu^e) - b. \tag{40}$$

Given the optimal intervention, the optimal disclosure for the policymaker is given by

$$\begin{aligned}
\gamma^*, \mu^* &= \arg\max_{\mu,\gamma} \mathbb{E}\left[W(\mathbf{a}, \theta + b, g)|y, g = g^*\right] \\
&= \arg\max_{\mu,\gamma} -\mathbb{E}\left[\int_0^1 \left(\begin{array}{c} \rho_0^e + \lambda x_i + (1 + \rho^e - \lambda)(\tilde{y} - \mu^e) \\ -\theta - \rho_0^* - \rho^* y - b \end{array}\right)^2 di \,\middle|\, y, g = g^*\right] \\
&= \arg\max_{\mu,\gamma} -\left[\lambda^2 \tfrac{1}{\beta} + (1 - \lambda)^2 \tfrac{1}{\alpha} + (1 + \rho^e - \lambda)^2 \tfrac{1}{\gamma}\right]
\end{aligned} \tag{41}$$

Again, the optimal choice of γ does not depend on ρ_0 or μ, although the latter two choices are linked. There are two possible equilibrium values for γ: (i) $\gamma^* = 0$ and $\rho^* = 0$, in which case $\lambda = 1$, and (ii) $\gamma^* = \infty$, in which case $\lambda = \frac{\beta(1-r)}{\beta(1-r)+\alpha}$.

The first order condition for μ is given by

$$2(1 + \rho^e - \lambda)(\rho_0^e - \rho_0^* + (1 + \rho^e - \lambda)(\mu - \mu^e) - b) = 0. \tag{42}$$

As in the benchmark model, this implies that either: (i) $1 + \rho^e - \lambda = 0$, which requires $\gamma^* = 0$, and consequently an uninformative equilibrium, or (ii) $(\rho_0^e - \rho_0^* + (1 + \rho^e - \lambda)(\mu - \mu^e) - b) =$

0, which coincides with the optimality condition for ρ^* in Eq. (40). Since we impose that g has finite first and second moments, we must have that ρ_0^* is finite, and since $\rho_0^* = \rho_0^e$ in equilibrium, we have:

$$\mu - \mu^e = \frac{b}{1 + \rho^e - \lambda}. \tag{43}$$

As in the benchmark model, this implies an uninformative disclosure policy i.e., $\mu^* = \mu^e = \infty$ for $b > 0$ and $\mu^* = \mu^e = -\infty$ for $b < 0$. Since the signal $\tilde{y}$ is uninformative, the policy intervention cannot be anticipated, and so remains effective in this case. ∎

5 Conclusions

This paper considers the strategic information disclosure and the role of limited commitment in the context of Morris and Shin (2002). We show that when a policymaker cannot commit to a disclosure policy and has a biased objective, relative to social welfare, the optimal disclosure in equilibrium is completely uninformative. The analysis also establishes the importance of the *tone* (i.e., mean) of the public signal, in addition to its transparency (i.e., precision). Moreover, our results appear to be robust to a number of quantitative and qualitative modifications to the benchmark model.

We want to draw parallels between our analysis to that of time-inconsistency of a policymaker, an influential literature started from Kydland and Prescott (1977). The literature has noticed that, in the context of government taxation or central bank interest rate policy, a biased policymaker who lacks commitment power, necessarily obtains an inefficient outcome relative to the commitment benchmark. That insight has spurred a great deal of study and discussion. Similarly, we view our analysis as a no-commitment benchmark that highlights the critical role played by commitment in the context of disclosure policy. Our analysis suggests that, in addition to considering the optimal degree of transparency by the policymaker (as has been studied in the existing literature), one must also consider the credibility of the policymaker's communication. Indeed, an interesting channel to explore would be the role of transparency in building credibility. A formal investigation of credibility formation and optimal transparency necessitates an analysis of repeated interactions. We expect that a partially informative disclosure policy can be supported in a reputation equilibrium, as in Barro and Gordon (1983). In the appendix, we consider an i.i.d. repeated version of our benchmark model and show that while dynamic incentives can generate implicit commitment for the policymaker, informative disclosure is difficult to sustain in the long run. A natural avenue for future work would be to explore whether persistence in the underlying state generates stronger incentives for informative disclosure, as in Golosov, Skreta, Tsyvinski, and Wilson (2014), although the presence of coordination motives makes the analysis less tractable.

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Appendix

In this appendix, we consider an infinitely repeated version of the benchmark model. Time is indexed by $t = 0, 1, ...$ Let the discount factor across periods be $\delta \in (0, 1)$, which is the same for all players (this can be relaxed without affecting the general insights obtained from the game). The state-noise vector at date t, $(\theta_t, \varepsilon_t, \eta_t)$, is drawn i.i.d. from the same distribution as in the static model. The bias b is constant over time. At the end of each period t the average action $\bar{a}_t = \int_0^1 a_{j,t} dj$ is publicly observable and individual actions and signals remain private information.

From Lemma 1, given an anticipated disclosure policy (μ_t^e, γ_t^e) in period t, agent i's optimal action in equilibrium is given by

$$a_{i,t} = \lambda_t x_{i,t} + (1 - \lambda_t)(\tilde{y}_t - \mu_t^e), \text{ where } \lambda_t \equiv \frac{\beta(1-r)}{\beta(1-r) + \left(\frac{\alpha\gamma_t^e}{\alpha + \gamma_t^e}\right)}.$$

Then

$$\bar{a}_t = \int_0^1 a_{j,t} dj = \lambda_t \theta_t + (1 - \lambda_t)(\tilde{y}_t - \mu_t^e)$$

Therefore, observing $\bar{a}_t$ and $\tilde{y}_t$ will allow the agent to identify the true state:

$$\theta_t = \frac{\bar{a}_t - (1 - \lambda_t)(\tilde{y}_t - \mu_t^e)}{\lambda_t}.$$

As such, agents can the see how far $\tilde{y}_t$ is different from θ_t to evaluate to what extent the policymaker has deviated from (μ_t^e, γ_t^e). We construct an trigger strategy equilibrium based on this observation.

Proposition 4. *Suppose $r < \frac{\alpha+\beta}{2\beta}$. For large enough δ, there exists a trigger strategy equilibrium. On the equilibrium path, $\mu_t^* = 0$ and $\gamma_t^* = \infty$. The play stays on the equilibrium path if and only if $|\tilde{y}_t - \theta_t| \leq K$ for some constant $K \geq 0$. If $|\tilde{y}_t - \theta_t| > K$, the uninformative equilibrium is played thereafter.*

Proof. On the equilibrium path, $\mu_t^* = 0$ and $\gamma_t^* = \infty$. Then $\lambda_t^* = \lambda^* \equiv \frac{\beta(1-r)}{\beta(1-r)+\alpha}$ and

$$\theta_t = \frac{\bar{a}_t - (1 - \lambda^*)\tilde{y}_t}{\lambda^*}. \tag{44}$$

Agents' equilibrium incentive condition is easily satisfied (for they are playing static best responses). Let us consider the policymaker's incentive. The public signal follows a distribution

$$\tilde{y}_t = \theta_t + \eta_t + \mu_t + \xi_t \tag{45}$$

By assumption, $(\eta_t + \xi_t) \sim N\left(0, \frac{1}{\alpha} + \frac{1}{\gamma}\right)$. Then

$$\Pr\left(|\tilde{y}_t - \theta_t| < K\right) = \Phi\left(\frac{K-\mu}{\sqrt{\frac{1}{\alpha}+\frac{1}{\gamma}}}\right) - \Phi\left(\frac{-K-\mu}{\sqrt{\frac{1}{\alpha}+\frac{1}{\gamma}}}\right) \equiv P(\mu, \gamma, K), \tag{46}$$

where Φ is the CDF of the standard normal distribution. Note that this implies for a fixed K, P is maximized at $\mu = \frac{1}{\gamma} = 0$.

The policymaker's period-t payoff if the policymaker's choice is (μ, γ) and agents anticipate $(\mu_t^* = 0, \gamma_t^* = \infty)$ is

$$\mathbb{E}\left[W\left(\mathbf{a}_t, \theta_t + b\right)|y_t\right] \tag{47}$$

$$= -\mathbb{E}\left[\int_0^1 \left(\lambda^* x_{i,t} + (1-\lambda^*)\,\tilde{y}_t - \theta_t - b\right)^2 di|y_t\right] \tag{48}$$

$$= -\mathbb{E}\left[\int_0^1 \left(\lambda^* \varepsilon_{i,t} + (1-\lambda^*)\left(\eta_t + \xi_t + \mu\right) - b\right)^2 di|y_t\right] \tag{49}$$

$$= -\left[(\lambda^*)^2\,\tfrac{1}{\beta} + (1-\lambda^*)^2\left(\tfrac{1}{\gamma} + \tfrac{1}{\alpha}\right) + \left((1-\lambda^*)\,\mu - b\right)^2\right] \equiv u(\mu, \gamma) \tag{50}$$

In a completely uninformative equilibrium, the policymaker's period-t payoff is

$$-\left(\tfrac{1}{\beta} + b^2\right)$$

and her period-t payoff from choosing the anticipated disclosure is

$$u(0, \infty) = -\left[(\lambda^*)^2\tfrac{1}{\beta} + (1-\lambda^*)^2\tfrac{1}{\alpha} + b^2\right] \tag{51}$$

The value of staying on the equilibrium path is given by:

$$V(0, \infty) = u(0, \infty) + \delta\left(P(0, \infty, K)V(0, \infty) - (1 - P(0, \infty, K))\tfrac{1}{1-\delta}\left(\tfrac{1}{\beta} + b^2\right)\right) \tag{52}$$

while the value from deviating in the current period to (μ, γ) and then returning to the equilibrium path is

$$V(\mu, \gamma) = u(\mu, \gamma) + \delta\left(P(\mu, \gamma, K)V(0, \infty) - (1 - P(\mu, \gamma, K))\tfrac{1}{1-\delta}\left(\tfrac{1}{\beta} + b^2\right)\right) \tag{53}$$

Note that

$$V(\mu, \gamma) - V(0, \infty) = \begin{array}{c} -\left[(1-\lambda^*)^2\frac{1}{\gamma} + ((1-\lambda^*)\mu - b)^2 - b^2\right] \\ +\delta\left(V(0, \infty) + \frac{1}{1-\delta}\left(\frac{1}{\beta} + b^2\right)\right)\left(P(\mu, \gamma, K) - P(0, \infty, K)\right) \end{array} \tag{54}$$

and we want to show that the above is non-positive as $\delta \to 1$. Note that $P(\mu, \gamma, K) -$

$P(0, \infty, K) < 0$,

$$V(0,\infty) + \tfrac{1}{1-\delta}(\tfrac{1}{\beta} + b^2) = \frac{-u_0 - \frac{\delta}{1-\delta}(1-P_0)\left(\frac{1}{\beta}+b^2\right)}{1-\delta P_0} + \tfrac{1}{1-\delta}\left(\tfrac{1}{\beta} + b^2\right) \quad (55)$$

$$= -\tfrac{u_0}{1-\delta P_0} + \tfrac{1}{1-\delta}\left(\tfrac{1}{\beta} + b^2\right)\underbrace{\left(1 - \tfrac{\delta(1-P_0)}{1-\delta P_0}\right)}_{\geq 0}, \quad (56)$$

where $u_0 = u(0, \infty)$ and $P_0 = P(0, \infty, K)$. This implies that

$$\lim_{\delta \to 1} V(\mu, \gamma) - V(0, \infty) = \lim_{\delta \to 1} \tfrac{\delta}{1-\delta}\left(\tfrac{1}{\beta} + b^2\right)\left(1 - \tfrac{\delta(1-P_0)}{1-\delta P_0}\right)(P(\mu, \gamma, K) - P(0, \infty, K)) < 0, \quad (57)$$

and so for a sufficiently large δ, the policymaker optimally chooses $\mu = \frac{1}{\gamma} = 0$.

For a fixed, sufficiently large δ, we need to maximize the equilibrium welfare $W(K)$ to determine optimal K:

$$W(K) = \frac{-w_0 - \frac{\delta}{1-\delta}(1 - P(0, \infty, K))/\beta}{1 - \delta P(0, \infty, K)}, \text{ where } \quad w_0 = (\lambda^*)^2 \tfrac{1}{\beta} + (1-\lambda^*)^2 \tfrac{1}{\alpha} \quad (58)$$

$$\Rightarrow \frac{\partial}{\partial K} W = \frac{\delta(1 - \beta w_0)}{\beta(1-\delta P)^2} P_K(0, \infty, K) \quad (59)$$

Since $P_K(0, \infty, K) > 0$, optimal K depends on whether $1 - \beta w_0 > 0$ or not. Since $r < \frac{\alpha+\beta}{2\beta}$ and $\lambda^* = \frac{\beta(1-r)}{\beta(1-r)+\alpha}$, we have $1 - \beta w_0 > 0$, and so $W_K > 0$. However, note that for a fixed δ,

$$\lim_{K \to \infty} P(\mu, \gamma, K) - P(0, \infty, K) = 0,$$

and so $V(\mu, \gamma) - V(0, \infty)$ can become positive for appropriately chosen (μ, γ). Hence, for a given (sufficiently large) δ, the optimal K is the largest K such that $V(\mu, \gamma) - V(0, \infty) < 0$. ∎

The above result highlights that a fully informative disclosure can be supported using trigger strategies when the policymaker is sufficiently patient. However, note that eventually the trigger is executed and the equilibrium disclosure is uninformative. As such, the result highlights the challenge of sustaining informative communication when the policymaker is unable to commit to a disclosure policy.