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Shifts in the Inflation Target and Communication of Central Bank Forecasts

by

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Abstract

In a model with forward-looking expectations, the paper examines communication of central bank forecasts when the inflation target is subject to unobserved changes. It characterizes the effect of disclosure of forecasts on inflation and output stabilization and the choice of an active versus passive monetary policy. The paper shows that these choices depend on the slope of the Phillips curve, the central bank's preference weight on inflation relative to output and the ratio of the variability of the inflation target relative to the cost-push disturbance. The paper briefly discusses how disclosure of forecasts may be beneficial for a society that is more concerned about inflation stabilization than the central bank.

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Keywords: Forward-looking expectations, inflation target, central bank forecasts, disclosure policy

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1 Introduction

In many central banks, including the major ones, monetary policy decisions are promptly announced to the public and markets. Thus, in setting their inflation forecasts, markets have full information regarding the current stance of policy. What the markets do not know for sure, at least with respect to some central banks, is the target level of inflation or the target level of the output gap. For instance, writing on Fed's changing inflation targets, Ireland [2005] says "... the Federal Reserve has never explicitly revealed the setting for its inflation target," and then argues that "... nothing dictates that the central bank's inflation target must remain constant over time...." (p.1). He further argues that movements of the size and persistence in inflation could not have been taken place without ongoing shifts in the Federal Reserve's inflation target. The significance of an unobserved target for inflation also surfaces in other issues relevant to policy making. Among others, Erceg and Levin [2003] link the issue of gradual disinflation to private sector learning about the central banks's inflation target and Smets and Wouters [2004] introduce a time-varying inflation target when comparing business cycles in the Euro area and the U.S.

In general, occasional shifts in central banks preferences may occur for different reasons. In a seminal paper, Cukierman and Meltzer [1986] motivate time-varying shifts in the employment target of the central bank as resulting from political pressures or changes in the composition of the decision making committee of the central bank. Faust and Svensson [2001] and Jensen [2002] also adopt such an interpretation.[1] Other motivations for target shifts can also be given, especially in the case of inflation targets. A time-varying inflation target could be attributed to changing notions about the optimal rate of inflation. Of course, shifting inflation targets are not necessarily related to credibility problems. There could be genuine reasons for changing the long run inflation target at some point, as a result of "new research on measurement bias in the CPI or on the rate of "true" inflation that best promotes

[1]See chapter 13 of Cukierman [1992] for a detailed discussion of shifting objectives in monetary policy.

long run economic growth and stability."(Bernanke et al. [1999, p.322]).

This paper deals with the consequences of disclosing central bank economic forecasts for stabilization policy, when the inflation target is subject to occasional random shifts that are not observed by the public. The paper characterizes the optimal degree of disclosure of forecasts and the effect of factors such as the central bank's concern for inflation stabilization relative to output stabilization, the slope of the Phillips curve,[2] and the degree of uncertainty surrounding the inflation target relative to the aggregate cost-push disturbance. An important determinant of the resulting outcomes is the nature of expectation formation about inflation. To understand the role of forward-looking inflation expectations, we analyze the choice of disclosure of forecasts using a New Keynesian Phillips curve.

The main point of the paper can be summarized as follows. Given that a central bank is transparent about its policy decisions but not about changes in the target level of inflation, there is no incentive for the central bank to disclose its forecasts (in this case, forecasts of the cost-push shocks). The reason is that, the release of forecasts improves the stability of inflation but leads to higher instability of the output gap. For the central bank, the cost outweighs the benefits so that it has little incentive to release its forecasts. This observation holds irrespective of whether or not the central bank suffers from an inflation bias. However, the existence of a tradeoff implies that, if the central bank is populist enough, in the sense that it cares more less about inflation stabilization than the public, then society can benefit from increased disclosure of central bank forecasts.

The framework of the paper in terms of information asymmetry is closely related to (Geraats [2001]), which analyzes unobserved inflation targets with a Barro-Gordon type Phillips curve. However, our emphasis on forward-looking expectations follows Jensen [2002] and Eijffinger and Tesfaselassie [2007], which examine the case of an unobserved output target in a New

[2]The slope of the Phillips curve measures the sensitivity of inflation to changes in the output gap

Keynesian model.[3]

Section 2 introduces the model setup and information structure. Then Section 3 solves the private sector's signaling extraction problem and the central bank's choice of optimal stabilization policy. In Section 4 we take up the issue of optimal disclosure policy and associated policy rules. In Section 5, we capture the average effects of disclosure policy by allowing the output target to differ from the natural rate. In Section 6, we briefly discuss the cases of full information vis-a-vis full transparency as well as the issue of a conservative/populist central bank and the choice of an optimal disclosure regime. Section 7 gives concluding remarks.

2 The policy problem

The model economy has two periods: period 1 is interpreted to be the short run while period 2 represents the long run (this follows closely Jensen [2002]). Inflation dynamics is represented by a New Keynesian model[4]

$$\begin{aligned} \pi_1 &= E_1^p \pi_2 + \lambda x_1 + \epsilon_1 \\ \pi_2 &= E_2^p \pi_3 + \lambda x_2 \end{aligned} \tag{1}$$

where π is the rate of inflation, x is the output gap, measured relative to its natural rate, which is normalized to zero. For convenience, x is assumed here to be perfectly controlled by the central bank,[5] and ϵ is a zero-mean

[3] There is an important difference in the transmission mechanism between a New Keynesian and a Barro-Gordon type model. The latter model has static expectations so that current policy actions affect inflation expectations and actual inflation in the next period, while in the New Keynesian framework, current policy actions affect currently held inflation expectations about next period's inflation, and in turn current inflation. Thus the same information structure can lead to different conclusions based on the model at hand.

[4] The model is purely forward-looking. It may be more realistic to allow for inertia in inflation. Apart from complicating the analysis, introducing inflation inertia does not change the main message of our exercise. As long as there is some role for forward-looking behavior, information about the future state of market conditions can be important to the determination of current outcomes.

[5] This assumption simplifies the algebra without changing the basic results of the paper.

random cost-push shock to inflation. Following the literature, we assume that the shock is normally distributed, that is $\epsilon \sim N(0, \sigma_\epsilon^2)$. The parameter $\lambda > 0$ measures the sensitivity of inflation to aggregate demand.[6] We let $\epsilon_2 = 0$ since in period 2, the economy is assumed to be in a full information (long run) steady state.[7] The term $E_t^p \pi_{t+1}$, $t = 1, 2$, stands for private sector expectations of inflation in $t + 1$ conditional on all available information in period t ($E_t^p \pi_{t+1} = E(\pi_{t+1}|\Omega_t^p)$ where Ω_t^p is the information set of the private sector in period t).

Thus, inflation depends on forward-looking private sector expectations, the current output gap and the cost-push shock. Prices are sticky because of the assumption that not all firms can reset their prices in every period. When a firm has a chance to reset its price, it takes into account its forecasts of future developments in prices (and therefore inflation). The link between current inflation and expectations of future inflation differentiates the New Keynesian Phillips curve from the Barro-Gordon type Phillips curve, where past expectations of current inflation are important.

The central bank's loss function is defined over two periods,[8] and is given by $E(\sum_{t=1}^{2} L_t)$ where $L_t = \frac{1}{2}(\pi_t - \pi_t^*)^2 + \frac{\alpha}{2}(x_t - x^*)^2$. In period 1 there is a random preference shock, θ, to a known inflation target $\pi^* = 0$. That is, $\pi_1^* = \pi^* + \theta$, where θ is normally distributed, $\theta \sim N(0, \sigma_\theta^2)$, and is uncorrelated with ϵ_1. The values that x^* can take is not relevant for the key results of the paper regarding the optimal disclosure regime, so we set $x^* = 0$. For completeness, however, we discuss the case of $x^* > 0$ in section 5.

The preference shock to the inflation target is assumed to be persistent. To capture this in a simple way, we suppose that $\pi_2^* = \pi_1^*$. When preference

The analysis would not change if one adds the dynamics of output demand governed by the so called intertemporal IS equation.

[6]The standard New Keynesian model usually attaches a coefficient to the expected inflation. Here we set the coefficient equal to 1 for brevity.

[7]In terms of our notation, Jensen [2000] assumes ϵ_1 to be private information of the central bank while (implicitly) ϵ_2 is unknown to either party as of period 1; period 2 is interpreted to be the long run, while period 1 is the short run and is crucial for the choice of disclosure regime and stabilization policy.

[8]For expositional simplicity, we ignore discounting.

shocks are persistent and inflation is forward-looking, disclosure policy serves as a signaling device of future inflation target, and therefore actual inflation. The private sector aims at forecasting the systematic component of policy, which reflects changes in the preference shock to the inflation target. Although the public observes policy actions, it has imperfect information about whether changes in policy action are in response to the temporary cost-push shock or the persistent shock to the inflation target. As it turns out, inflation expectations respond strongly to policy actions if the central bank releases its forecasts, enabling the public to better infer about the preference shock and thus future inflation.

To model the choice of the optimal disclosure regime, we suppose that in period 1 the central bank has private information about the cost-push shock ϵ_1. At the beginning of period 1, the central bank announces the disclosure regime. If the full-disclosure regime is announced, the private sector will have full information about ϵ_1 as does the central bank. Otherwise, the central bank decides to keep its private information. The sequence of events and actions is as follows.

Period 1

stage 1: central bank chooses the disclosure regime.[9]

stage 2: ϵ_1 and θ realize and central bank chooses x_1.

stage 3: private sector observes x_1 and sets $E_1^p \pi_2$.

stage 4: π_1 is determined.

Period 2

stage 1: central bank chooses x_2.

stage 2: private sector observes x_2 and sets $E_2^p \pi_3$.

stage 3: π_2 is determined.

[9] Following the literature, disclosure is assumed to be truthful. The paper abstracts from strategic misrepresentation of information. Moreover, for easier exposition and without loss of generality, the central bank is assumed to have perfect knowledge of the cost-push shocks.

The timing of events is such that the central bank chooses its policy before private sector inflation expectations are set. The public observes monetary policy decisions that respond in part to the central bank's private information. This implies that the private sector can infer in part the inflation target from observed central bank actions.

Before solving the policy problem, an intuitive explanation of the mechanisms involved can be given. Consider period 1 and assume that the private sector does not observe the preference shock, θ, but knows that the central bank responds to its private information. Thus, x_1 is useful as a signal of θ, although the signal is noisy due to the presence of the cost-push shock, ϵ_1. Since the private sector observes x_1, it solves a signal extraction problem and sets $E_1^p \pi_2$ rationally, which directly affects π_1 via the Phillips curve. The upshot is that, $E_1^p \pi_2$ responds more strongly to x_1 when the central bank releases more information about ϵ_1, which in turn induces the central bank to stabilize inflation more aggressively, given the preference weight, α, at the cost of a more unstable output gap.

3 Signaling via stabilization policy

Monetary policy is set with discretion, taking into account the formation of inflation expectations.[10] The model is solved by backward induction, starting from the last period (period 2). However, since the model horizon is finite and inflation is forward-looking, we need a terminal condition for inflation expectations, which is consistent with the steady state nature of period 2 (see also Jensen [2002] in this regard).

The economy is in a full information steady state from period 2 onwards, implying that $\pi_2 = \pi_3$ and $E_2^p \pi_3 = \pi_3$. Consistent with this, we conjecture that $E_2^p \pi_3 = \pi_2^* = \theta$. This forecasting rule can be derived from an infinite horizon version of the model with full information about the loss function

[10] In the parlance of game theory, the central bank is a *Stackelberg leader* while the private sector is a *Stackelberg follower*.

of the central bank (see Appendix). The intuition is that, in steady state there is no conflict between inflation stability and output gap stability, and inflation expectations (based on fundamentals) are anchored by the inflation target, π_2^*. However, as pointed out by Jensen [2002], the exact expression for the terminal condition is not crucial for the choice of the disclosure regime in period 1. What is important is that the public anticipates that the persistent shift in the target will affect future inflation.

3.1 Period 2: Full information steady state

The central bank minimizes period 2 loss

$$\frac{1}{2}[(E_2^p\pi_3 + \lambda x_2 - \pi_2^*)^2 + \alpha x_2^2]$$

with respect to x_2, subject to $E_2^p\pi_3 = \pi_2^* = \theta$. This leads to the following steady state solution for x_2 and π_2:

$$\begin{aligned} x_2 &= 0 \\ \pi_2 &= \pi_2^* = \theta \end{aligned} \tag{2}$$

Note that the conjecture for $E_2^p\pi_3$ is consistent with the equilibrium level of inflation in eqn. (2). Moreover, the steady state value of the output gap is equal to its natural rate.[11]

Because expectations are forward-looking, eqn. (2) has implications for outcomes in period 1. As the steady state inflation rate depends on θ, the public's period 1 forecast of the steady state inflation in period 2, $E_1^p\pi_2$, is a function of any signal available on θ. Since period 1 inflation depends on $E_1^p\pi_2$, information disclosure has indirect affects on the conduct of stabilization policy in period 1. In the next two sections, we solve the model for period 1 outcomes of output gap and inflation based on alternative assumptions regarding the information structure about θ.

[11] Since $x^* = 0$, the rate of inflation is also at the target (no inflation bias).

3.2 Period 1: The case of observed inflation target

Consider first the case of full information, whereby θ is observed by the public (i.e., $\theta \in \Omega_1^p$, where Ω_1^p is the information set of the private sector in period 1). Then eqn. (2) implies $E_1^p \pi_2 = \theta$ independently of x_1 (the central bank's action).[12] Of course this is an ideal scenario for the central bank since inflation expectations are anchored at the new inflation target. The optimal values of x_1 and π_1 are now a function of ϵ_1:

$$\begin{aligned} x_1 &= -\frac{\lambda}{\alpha + \lambda^2}\epsilon_1 \\ \pi_1 &= \theta + \frac{\alpha}{\alpha + \lambda^2}\epsilon_1 \end{aligned} \tag{3}$$

Thus, when there is full information, inflation expectations are independent of policy actions and the central bank achieves optimal stabilization of inflation and output in response to the cost-push disturbance.

3.3 Period 1: The case of unobserved inflation target

Assume more realistically that the preference shock, θ, and the aggregate cost-push shock, ϵ_1, may not be observed by the private sector. Equation (2) then implies $E_1^p \pi_2 = E_1^p \pi_2^*$. In this case, the private sector has to solve a signal extraction problem.

3.3.1 Communication of central bank forecasts

Based on its disclosure policy, the central bank sends information to the public on the realization of the cost-push shock, the precision of which measures the degree of disclosure or transparency. Formally, the cost-push shock ϵ_1 is decomposed into two components. Let ϵ_k be the shock component that is released to the public and ϵ_u the component that remains unknown to the public. By construction, $\epsilon_1 = \epsilon_k + \epsilon_u$. The two components are assumed to

[12] In other words, x_1 is redundant as a signal of θ.

be uncorrelated, implying that $\sigma_\epsilon^2 = \sigma_{\epsilon,k}^2 + \sigma_{\epsilon,u}^2$, where $\sigma_{\epsilon,k}^2$ is the variance of ϵ_k and $\sigma_{\epsilon,u}^2$ is the variance of ϵ_u. We can rewrite this in a form that clarifies the choice of disclosure by the central bank: $\sigma_{\epsilon,k}^2 = \tau\sigma_\epsilon^2$ and $\sigma_{\epsilon,u}^2 = (1-\tau)\sigma_\epsilon^2$. The degree of transparency with respect to the central bank's forecasts is measured by the parameter $0 \leq \tau \leq 1$, with the extremes of full transparency and no transparency represented by $\tau \to 1$ and $\tau \to 0$, respectively. Under asymmetric information, the central bank's and the private sector's information sets are, respectively, $\Omega_1^c = \{\epsilon_k, \epsilon_u, \theta\}$ and $\Omega_1^p = \{\epsilon_k, x_1\}$. Next, we derive optimal forecasts of the private sector conditional on the disclosure regime announced by the central bank.

3.3.2 Private sector inflation expectations

Consider stage 3 of period 1, where the private sector sets inflation expectations. Under rational expectations, the private sector correctly conjectures that the central bank's equilibrium reaction function takes the form[13]

$$x_1 = h_k\epsilon_k + h_u\epsilon_u + h_\theta\theta \tag{4}$$

where three coefficients in eqn. (4) remain to be determined. According to eqn. (4), the public believes that the central bank is responding to three pieces of information—the shock to the inflation target, the cost-push shock known to the central bank and the public, and the cost-push shock known only to the central bank. Since the private sector observes x_1 (policy decisions are announced) and ϵ_k (due to the central bank's communication policy), it can infer from eqn. (4) that

$$s_1 = h_u\epsilon_u + h_\theta\theta \tag{5}$$

[13]In equilibrium, the public's conjectured reaction function must coincide with the actual rule followed by the central bank. Since it anticipates the private sector's conjecture about its action, when optimizing, the central bank takes into account the dependence of $E_1^p\pi_2$ on x_1. Thus, even though monetary policy is discretionary, it does take into account the formation of inflation expectations.

where $s_1 \equiv x_1 - h_k\epsilon_k$ is the private sector's signal based on which it constructs an optimal forecast of θ. Using the method of optimal signal extraction, the private sector's conditional forecast of θ is given by $E_1^p\theta = S_\theta s_1$, where $S_\theta \equiv h_\theta\sigma_\theta^2/(h_\theta^2\sigma_\theta^2 + h_u^2\sigma_{\epsilon,u}^2) > 0$ is the optimal weight on the signal that reflects the signal-to-noise ratio.[14] Inflation expectations are then given by

$$E_1^p\pi_2 = S_\theta s_1 \tag{6}$$

Optimal stabilization policy will depend on the central bank's anticipation of the forecasting rule (6), as is shown below.

3.3.3 Optimal stabilization policy

Consider stage 2 of period 1. The minimization problem facing the central bank in period 1, which anticipates the private sector's signal extraction process leading to eqn. (6), is:

$$\min_{x_1} E_1^c\Big[\Big(S_\theta s_1 + \lambda x_1 + \epsilon_1 - \theta\Big)^2 + \alpha x_1^2\Big] \tag{7}$$

Differentiating (7) with respect to x_1, and keeping in mind that s_1 depends on x_1, leads to the following first order condition:[15]

$$\Big(S_\theta E_1^c s_1 + \lambda x_1 + \epsilon_k + \epsilon_u - \theta\Big)(\lambda + S_\theta) + \alpha x_1 = 0 \tag{8}$$

where eqn. (5) implies $E_1^c s_1 = h_u\epsilon_u + h_\theta\theta$. The optimality condition (8) can now be solved for x_1 and expressed as a (reaction) function of the three state variables, θ, ϵ_k and ϵ_u. To get the rational expectations solution, we match each coefficient in the first order condition with that conjectured in eqn. (4); this leads to the following system of equations:

$$h_\theta = \frac{\lambda + S_\theta}{\alpha + (\lambda + S_\theta)^2} \equiv F(h_\theta, h_u) > 0 \tag{9}$$

[14] In the limiting case where $\tau \to 1$ ($\sigma_{\epsilon,u}^2 \to 0$), the signal reveals the central bank's inflation target perfectly.

[15] Note that θ and ϵ_u enter symmetrically in the loss function. In the final solution, their coefficients have to be equal in absolute value in the reaction function for x_1.

$$h_u = -\frac{\lambda + S_\theta}{\alpha + (\lambda + S_\theta)^2} \equiv -F(h_\theta, h_u) < 0 \tag{10}$$

$$h_k = -\frac{\lambda + S_\theta}{\alpha + \lambda^2 + \lambda S_\theta} < 0 \tag{11}$$

Equations (9) and (10) are solved for h_θ and h_u simultaneously.[16] The solution for h_k then follows from eqn. (11). There are two potential solutions.

The first rational expectations solution is characterized by $\bar{h}_\eta = -\bar{h}_1^u \to 0$ and from eqn. (11), $h_1^k = -\frac{1}{\lambda}$. We call this "passive policy" because the central bank does not respond to its private information (θ and ϵ_u). Using this result in the Phillips curve, we get period 1's equilibrium output gap and inflation, expressed in terms of deviations from their respective targets (note that $x_1 - x^* = x_1$, as $x^* = 0$)

$$\begin{aligned} \bar{x}_1 - x^* &= -\frac{1}{\lambda}\epsilon_k \\ \bar{\pi}_1 - \theta &= -(1 - H)(\theta - \epsilon_u) \end{aligned} \tag{12}$$

where $H \equiv \sigma_\theta^2 / (\sigma_\theta^2 + \sigma_{\epsilon,u}^2)$.

The second solution is characterized by an "active policy" rule,

$$\begin{aligned} \bar{h}_\theta &= \frac{\lambda(1 - 2H) + \sqrt{4\alpha H(1 - H) + \lambda^2}}{2(\alpha + \lambda^2)} > 0 \\ \bar{h}_u &= -\bar{h}_\theta < 0 \\ \bar{h}_k &= -\frac{\lambda \bar{h}_\theta + H}{(\alpha + \lambda^2)\bar{h}_\theta + \lambda H} < 0 \end{aligned} \tag{13}$$

In this case, period 1 equilibrium deviations of the output gap and inflation from their respective targets are

$$\bar{x}_1 - x^* = \bar{h}_k \epsilon_k + \bar{h}_\theta(\theta - \epsilon_u)$$

[16] Due to the sign restrictions in these two equations, we look for solutions where $h_\theta > 0$ and $h_u < 0$.

$$\bar{\pi}_1 - \theta \;=\; (1 + \lambda \bar{h}_k)\epsilon_k + (\lambda \bar{h}_\theta + H - 1)(\theta - \epsilon_u) \tag{14}$$

Since both solutions have $h_u = -h_\theta$, it follows that

$$E_1^p \pi_2 = S_\theta s_1 = \frac{1}{h_\theta} H(-h_\theta \epsilon_u + h_\theta \theta) = H(\theta - \epsilon_u) \tag{15}$$

As inflation expectations are invariant to the particular rational expectations solution, which of the two equilibria prevails depends on the optimal policy rule (see below).

Since θ and ϵ_u are assumed to be uncorrelated, eqn. (15) implies that the variance of $E_1^p \pi_2$ is (after simplifying) equal to $H\sigma_\theta^2$. As $\partial H/\partial \tau > 0$, the variability of inflation expectations increases with the degree of disclosure. Furthermore, from eqn. (15) we see that inflation expectations behave in a way that reflect the state of the economy. For instance, a positive shock to the inflation target ($\theta > 0$) will be accompanied by an increase in inflation expectations, and a positive realization of the unobserved component of the cost-push shock will be associated with lower inflation expectations. Thus, inflation expectations have a stabilizing role. This outcome is interesting, especially in light of the solution with a passive rule where the central bank abstains from responding to its private information.

4 Optimal disclosure regime and policy rules

In stage 1 of period 1, the central bank announces the disclosure regime (that is, it chooses whether or not to disclose its forecasts) and makes a decision to follow either the active policy rule (14) or the passive policy rule (12) so as to minimizes the expected loss.

From the equilibrium dynamics of inflation and the output gap derived under the active and passive policy rules, we can see that $E(\bar{\pi}_1 - \theta)^2$ is decreasing in τ while $E(\bar{x}_1^2)$ is increasing in τ. Thus, the choice of a disclosure regime introduces a tradeoff between output gap stability and inflation stability.

We now consider the central bank's choice between two alternative regimes, namely, full-disclosure ($\tau = 1$) and no-disclosure ($\tau = 0$).[17] In this case, we compare the expected loss to the central bank under both regimes.

When a full-disclosure regime is announced, the public has perfect knowledge about the cost-push shock and can infer the inflation target indirectly ($\tau \to 1$ implying that $\sigma^2_{\epsilon,u} \to 0$ and $H = 1$). From eqn. (13), $\bar{h}_\theta, \bar{h}_u \to 0$ and $\bar{h}_k = -1/\lambda$. In that case, the equilibrium levels of the output gap and inflation in the two equilibria coincide and are given by

$$\begin{aligned} \bar{x}_1|_{\tau\to 1} &= -\frac{1}{\lambda}\epsilon_1 \\ \bar{\pi}_1|_{\tau\to 1} &= \theta \end{aligned} \tag{16}$$

The fact that the private sector precisely knows the realization of ϵ_1 and can, therefore, infer indirectly the value of θ has stark implications for stabilization policy. The equilibrium given by eqn. (16) reveals that, even if the central bank cares about output gap stabilization ($\alpha > 0$), inflation and inflation expectations are anchored at the central bank's new target inflation because the cost-push shock is completely absorbed by the output gap. The expected loss in period 1 when announcing $\tau \to 1$ is given by

$$E(L_1)|_{\tau\to 1} = \frac{\alpha}{\lambda^2}\sigma^2_\epsilon \tag{17}$$

4.1 No-disclosure regime

Under a no-disclosure regime, the public has imperfect knowledge about the cost-push shock and its signal is a very noisy indicator of the preference shock. Formally, we have $\tau \to 0$ implying that $\sigma^2_{\epsilon,u} \to \sigma^2_\epsilon$ in the definition of H. Here, the private sector faces maximum uncertainty about ϵ_1.[18] When announcing a no-disclosure regime, the expected loss under the passive policy rule differs

[17] For a similar approach see e.g., Cukierman [2001] and Geraats [2001].

[18] Note, however, that the public's conditional and unconditional forecasts of θ are not equal, since $E^p_1\theta = \frac{\sigma^2_\theta}{\sigma^2_\theta+\sigma^2_\epsilon}(\theta - \epsilon_1) \neq 0$ as long as σ^2_ϵ is bounded.

from the expected loss under the active policy rule. More specific, when $\tau \to 0$, the expected loss under the passive policy rule, denoted by $E(L_1^P)$, is

$$E(L_1^P)|_{\tau\to 0} = \frac{\sigma_\epsilon^2}{\sigma_\theta^2 + \sigma_\epsilon^2}\sigma_\epsilon^2 \tag{18}$$

while the corresponding expected loss under the active policy rule, $E(L_1^A)$, is

$$E(L_1^A)|_{\tau\to 0} = \frac{\alpha}{\alpha+\lambda^2}\sigma_\epsilon^2 + \frac{\lambda\Big(\lambda(\sigma_\theta^2+\sigma_\epsilon^2) - \sqrt{4\alpha\sigma_\theta^2\sigma_\epsilon^2 + \lambda^2(\sigma_\theta^2+\sigma_\epsilon^2)^2}\Big)}{2(\alpha+\lambda^2)} \tag{19}$$

When it comes to the choice of a disclosure regime, one needs to check if the expected loss (18) or (19) is lower than the expected loss (17). It is not difficult to see that, as long as $\alpha, \sigma_\epsilon^2 > 0$, the expected loss (19) is lower than the expected loss (17). Thus, the full-disclosure regime is dominated by the no-disclosure regime with an active policy rule.

Given that a no-disclosure regime is optimal, the question is whether the central bank is better off following the active policy rule rather than the passive policy rule. The answer, however, is not clear and depends on the parameters of the model. In this regard, the active policy rule dominates the passive policy rule (i.e., $E(L_1^A)|_{\tau\to 0} < E(L_1^P)|_{\tau\to 0}$) if the slope of the Phillips curve, λ, is large enough, and the relative weight on output stabilization, α, and the signal-to-noise ratio, $\sigma_\theta^2/\sigma_\epsilon^2$, are small enough. The reason is that the central bank actively responds to the inflation target and the cost-push shock if

(1) λ is large enough, so that the output cost of reducing inflation variability is very small,

(2) α is small enough, since this means that the overriding priority for monetary policy is stable inflation,

(3) σ_θ^2 is small enough and/or σ_ϵ^2 is large enough, as these conditions imply that the signal (policy action) becomes less informative and, in turn, inflation expectations respond little to policy actions, allowing the central bank to respond to shifts in the inflation target and the cost-push shock.

5 Average effects of disclosure policy

The analysis thus far has been done under the assumption that there is no inflation bias, $x^* = 0$. In this section we discuss the effects of allowing $x^* > 0$.

5.1 Period 2: Full information steady state

In period 2, the policy problem is to minimize $\frac{1}{2}[(E_2^p\pi_3 + \lambda x_2 - \theta)^2 + \alpha(x_2 - x^*)^2]$ with respect to x_2, subject to $E_2^p\pi_3 = \theta + \frac{\alpha}{\lambda}x^*$ (see Appendix). The reduced form solution is

$$\begin{aligned} \bar{x}_2 &= 0 \\ \bar{\pi}_2 &= \theta + \frac{\alpha}{\lambda}x^* \end{aligned} \quad (20)$$

which is a standard result in the time-inconsistency literature—the steady state output gap is equal to its natural rate while the average rate of inflation is higher than its target. That is, the economy suffers from an inflation bias without any gains in output.

5.2 Period 1: The case of observed inflation target

Equation (2) implies $E_1^p\pi_2 = \theta + \alpha x^*/\lambda$, independently of the realization of x_1. The problem is thus similar to that in period 2, except for the presence of a non-zero shock ϵ_1. In equilibrium

$$\begin{aligned} \bar{x}_1 &= -\frac{\lambda}{\alpha + \lambda^2}\epsilon_1 \\ \bar{\pi}_1 &= \theta + \frac{\alpha}{\lambda}x^* + \frac{\alpha}{\alpha + \lambda^2}\epsilon_1 \end{aligned} \quad (21)$$

As in period 2, there is an average inflation bias in period 1 under full information (π_1 depends positively on x^*) but since private sector inflation expectations are independent of policy actions, the central bank achieves optimal stabilization of inflation and output in response to ϵ_1.

5.3 Period 1: The case of unobserved inflation target

From period 2's equilibrium inflation, $E_1^p \pi_2 = E_1^p \theta + \alpha x^*/\lambda = S_\theta s_1 + \alpha x^*/\lambda$. Thus the signal extraction problem of the public is identical to the main text, as x^* is common knowledge. The only difference is that now the conjectured rule (4) includes a constant term, h_0, due to the presence of x^*. In period 1, the central bank minimizes

$$\min_{x_1} E_1^c \Big[(E_1^p \pi_2 + \lambda x_1 + \epsilon_1 - \theta)^2 + \alpha (x_1 - x^*)^2 \Big] \tag{22}$$

subject to $E_1^p \pi_2 = S_\theta s_1 + \frac{\alpha}{\lambda} x^*$. The solution for x_1 and the matching of the coefficients in the solution with those conjectured is similar to the case with $x^* = 0$, although we now have a system with four equations: (9), (10), (11) and

$$h_0 = -\frac{\alpha x^* S_\theta}{\lambda(\alpha + \lambda^2 + \lambda S_\theta)} < 0 \tag{23}$$

where $-\frac{\alpha}{\lambda^2} x^* < h_0 < 0$ depending on $0 < S_\theta < \infty$. The system is again solved recursively starting with eqn. (9) and eqn. (10). The solution for h_0 when following an active policy rule is $\bar{h}_0 = -\frac{\alpha x^* H}{\lambda \bar{h}_\theta (\alpha + \lambda^2) + \lambda^2 H}$. The passive policy rule will have $\bar{h}_\theta \to 0$, irrespective of the degree of transparency, so that $\bar{h}_0 = -\frac{\alpha}{\lambda^2} x^*$.

The active policy rule leads to the following reduced form

$$\begin{aligned} \bar{x}_1 - x^* &= \bar{h}_0 - x^* + \bar{h}_k \epsilon_k + \bar{h}_\theta (\theta - \epsilon_u) \\ \bar{\pi}_1 - \theta &= \frac{\alpha x^*}{\lambda} + \lambda \bar{h}_0 + (\lambda \bar{h}_\theta + H - 1)(\theta - \epsilon_u) \end{aligned} \tag{24}$$

while under the passive policy, we have

$$\bar{x}_1 - x^* = -\frac{\alpha}{\lambda^2} x^* - x^* + \bar{h}_k \epsilon_k + \bar{h}_\theta (\theta - \epsilon_u)$$

$$\bar{\pi}_1 - \theta \quad = \quad (1 + \bar{h}_k)\epsilon_k + (\lambda\bar{h}_\theta + H - 1)(\theta - \epsilon_u) \tag{25}$$

Remember that under full information, the magnitude of the inflation bias is equal to $\frac{\alpha}{\lambda}x^*$. When there is asymmetric information and the central bank adopts the active policy rule, the inflation bias becomes smaller, as can be seen from the constant term in the reduced form for inflation in eqn. (24), $\frac{\alpha x^*}{\lambda} + \lambda\bar{h}_0 < \frac{\alpha x^*}{\lambda}$. In fact, under the passive policy the inflation bias disappears although at the same time the average level of the output gap deviates further from its target.

From eqn. (24), increased communication by the central bank reduces the average level of inflation but leads to too low output gap. Thus, disclosure policy affects not only the variability tradeoff between inflation and output but also leads to a tradeoff in their average values. An increase in the precision of the signal about the cost-push shock is bad for the average level and volatility of the output gap but good for the average level and variability of inflation. Overall, the costs dominate the benefits.

6 Further issues

6.1 Full information vs. full transparency

We briefly discuss the issue of full information (defined to mean direct disclosure of the inflation target). We have seen that, in the framework above, full-disclosure of (full transparency about) forecasts is never optimal. Now suppose it were possible to disclose the shifts in the central bank's inflation target directly. Can this strategy improve outcomes? Below is a comparison of the expected losses arising under full-disclosure and full information. This comparison is interesting since the two regimes lead to different incentives for setting optimal monetary policy.[19]

[19] Among others, Faust and Svensson [2001] and Jensen [2002] analyze the welfare implications of disclosing the central bank's employment/output target directly and compare the resulting outcome with the case of full transparency about control errors in monetary

Based on the reduced form (3), the expected loss under full information (where "FI" stands for full information) is

$$E(L_1^{FI}) = \frac{\alpha}{\alpha + \lambda^2}\sigma_\epsilon^2 \tag{26}$$

The expected loss (26) is smaller than expected loss (17). If it was possible for the central bank to reveal changes in its preference (in our case, shifts in the inflation target) directly, that would be preferred to a regime where the central bank's inflation target is indirectly inferred from disclosing its forecasts for the cost-push shocks.[20] The reason is that full transparency leads to suboptimal policy responses to the cost-push shocks, in particular, the output gap becomes excessively volatile. In fact, full-disclosure leads to the worst outcome of all regimes.

6.2 Conservative society and disclosure policy

We have shown that disclosure of forecasts leads to a variability tradeoff, as it leads to lower inflation variability at the cost of higher output gap variability. Although we do not pursue it here, we remark that there is a sense in which full transparency may be beneficial from societal point of view if one allows for differences in preferences between the central bank and the society. Specifically, if society has appointed a populist central banker, in the sense that the central bank places less weight on inflation stabilization, then society maybe better off under a full-disclosure regime, as this improves inflation performance (which is society's main concern).

policy. In Faust and Svensson [2001], full information leads to the worst outcome in terms of the expected loss. In contrast, Jensen [2002] finds that the full information regime dominates the full transparency regime when the central bank has high credibility (i.e., suffers from small inflation bias) and there is a need for stabilization in response to cost-push disturbances (e.g. due to large variance in these shocks).

[20] This result is consistent with the classic signaling models, where the equilibrium with private information (and associated signal extraction) leads to worse outcomes than the corresponding equilibrium under symmetric information.

7 Concluding remarks

The paper has examined the consequences of disclosing central bank economic forecasts for stabilization policy, when the inflation target is unobserved by the public. An important determinant of the resulting outcomes will be the nature of inflation expectations. In that regard, the public is assumed to be forward-looking. The paper has characterized the optimal degree of disclosure of forecasts and how it is determined by factors such as the central bank's preferences regarding inflation stabilization versus output stabilization, the sensitivity of inflation to changes in the output gap, and the degree of uncertainty the public faces about the inflation target relative to the aggregate cost-push disturbance.

The main point of the paper is that, if a central bank is transparent about its policy decisions but not about changes to its target level of inflation, then there is little incentive for the central bank to disclose its forecasts regarding the state of the economy. This observation holds irrespective of whether or not the central bank suffers from an inflation bias. Moreover, if the central bank can communicate changes in its inflation target directly, it would improve overall performance compared to a regime where the central bank lets the public infer the inflation target by releasing its forecasts of cost-push shocks.

Finally, we point out that there is a sense in which full-disclosure may be beneficial for society. If, for instance, society has appointed a populist central banker, in the sense that the central bank places less weight on inflation stabilization, then society maybe better off under a transparent regime, as this improves inflation performance.

Appendix

For an infinite horizon, full information model (see for e.g. Clarida et al. [1999]), the goal of the central bank is to minimize[21]

$$E_1 \sum_{t=1}^{\infty} L_t \tag{A.1}$$

subject to $\pi_t = E_t \pi_{t+1} + \lambda x_t + \epsilon_t$, where $L_t = \frac{1}{2}(\pi_t - \theta)^2 + \frac{\alpha}{2}(x_t - x^*)^2$.

Under discretion, the optimality condition is given by $x_t - x^* = -\frac{\lambda}{\alpha}(\pi_t - \theta)$. Substituting the optimality condition into the Phillips curve and solving for rational expectations, the equilibrium dynamics of the system is given by

$E_t \pi_{t+1} = \theta + \frac{\alpha}{\lambda} x^*$

$x_t = -\frac{\lambda}{\alpha+\lambda}\epsilon_t$ and

$\pi_t = \theta + \frac{\alpha}{\lambda} x^* + \frac{\alpha}{\alpha+\lambda}\epsilon_t$.

In a steady state, there are no disturbances to the system ($\epsilon_t = 0$ for all t) and all variables are equal to their expected value: $\pi = E\pi = \theta + \frac{\alpha}{\lambda} x^*$ and $x = 0$. This is the basis for the steady state, full information solutions for the long run (period 2 in the main text).

[21] Since the central bank and private sector have identical information, we have $E_1^c = E_1^p = E_1$.

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