Publishing Central Bank Forecasts

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Abstract

In this paper, a simple model of information asymmetry is used to study central bank forecast publication. Central banks are assumed to choose between not publishing a forecast, publishing a forecast that conditions on current policy, publishing an unconditional forecast, or publishing both. There is no incentive for the central bank to publish forecasts unless it faces conflicting output and inflation objectives, and also possesses an information advantage over agents. A conservative central bank that does not have a large information advantage over agents may prefer not to publish forecasts at all, while a central bank that enjoys a large information advantage will prefer to publish unconditional forecasts.

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1. Introduction

In recent years, a growing number of central banks have started publishing their forecasts, starting with Norges Bank (1979), followed by the Bank of England (1993), the Reserve Bank of New Zealand (1996), Sveriges Riksbank (1997), the Bank of Finland (1999), and the Bank of Thailand (2000). In this paper, the publication of central bank forecasts is analyzed. A theoretical model of central bank forecasting is developed, based on information asymmetries between agents and the central bank. The information sets of each type of agents may be thought of as comprising two parts: (i) information pertaining to the size and propagation of shocks in the economy; and (ii) information related to the target of the central bank. The publication of forecasts may be used by the central bank to confer information on agents that is outside their information set. While the central bank will not necessarily have an information advantage about the size and propagation of shocks, it will by definition have an information advantage about its target.

Central banks will be modeled as deciding whether to publish their forecasts or not based on the properties of the information sets of both the central bank and economic agents. In particular, they will select one of (i) not publishing forecasts; (ii) publishing "conditional" forecasts (as at the Bank of England does, for example) that condition on an information set that is known by economic agents and do not incorporate expected future policy decisions, and therefore primarily communicate information about the expected size and propagation of shocks, rather than information about the policy target of the central bank; (iii) publishing "unconditional" forecasts (as at the Reserve Bank of New Zealand since mid-1997, for example) that incorporate expected future policy decisions, thereby communicating information about both shocks and the policy target of the central bank; and (iv) publishing both conditional and unconditional forecasts.

At the heart of the decision to publish forecasts is a trade-off between output and inflation variability. To the extent that the central bank has an information advantage over agents, it can achieve an optimal division between output and inflation variability each period. On the other hand, to the extent that the central bank forgoes its information advantage by divulging it to agents, it is less able to partition this variability optimally between output and inflation (a cost), but also reduces the variability of the inflation expectations of agents, and therefore inflation (a benefit). Which one of these dominates depends on the size and nature of the information advantage, and also the relative importance of output variability versus inflation variability in the central bank's loss function.

The decision to publish conditional or unconditional forecasts introduces one further complication. A conditional forecast is modeled as providing agents with complete knowledge of the central bank's estimates of the size and propagation of shocks. In contrast, an unconditional forecast contains information about both shocks and the policy target. Agents observing unconditional forecasts therefore face a signal-extraction problem as they seek to learn about both expected inflation shocks and the policy target simultaneously. One possible remedy to the signal-extraction problem that is considered is for the central bank to publish both conditional and unconditional forecasts.

In the following section, related literature is outlined. A simple model, incorporating uncertainty about inflation shocks, is developed in section 3, with a discussion of the optimal forecasting decision based on the characteristics of agents' information sets.[1] Section 4 concludes.

2. Related Literature

Forecasts play a prominent role in the conduct of monetary policy. For example, Svensson (1997) outlines their importance for monetary policy when there is an explicit policy target. He advocates a strategy for conducting monetary policy with an inflation target of "inflation forecast targeting," or adjusting the monetary policy instrument such that the central bank's expectation (or forecast) of the target variable should be equal to the target at an appropriate horizon. As a result, deviations between the target and the actual outcome can be viewed as a forecast error by the central bank, and should be orthogonal to the central bank's information set. As Rowe and Yetman (2002) demonstrate, this orthogonality condition can be used to identify the target of the central bank.

Faust and Svensson (2001) use a linear-quadratic framework similar to the one employed here in which central bank transparency (of which publishing forecasts may be considered a part) is linked to the ability of economic agents to deduce the intentions of the central bank from observables. They simulate the learning process of agents seeking to estimate a time-varying employment target, and find that low credibility results in a more inflationary policy, but one that is less expansionary in the sense that inflation will be lower than expectations. They find that increased transparency of the central bank's intentions is generally desirable, although it makes the bank's reputation and credibility more sensitive to its actions.

[1] Appendix I considers the case of uncertainty about demand shocks.

In recent years, many central banks have replaced obfuscation with greater transparency while seeking to gain credibility for a new policy regime characterized by explicit inflation targeting. Geraats (2001a) offers an explanation for this, using a two-period optimal-control model, where agents rationally try to determine the inflation target, and monetary policy responds optimally to this. She argues that strong (conservative) central banks benefit from transparency (in the form of publishing forecasts) by (i) establishing a reputation more quickly, and (ii) being able to respond to negative output shocks at less cost to their reputation. In contrast, weak (that is, less conservative) central banks are likely to prefer opaqueness. Similarly, Yetman (2001) considers the credibility formation process of an inflation targeting central bank in an infinite-horizon model, and illustrates the gains to credibility formation if the central were to publish its forecasts of the variables that are inputs into the policy process, and on which agents and the central bank have differing views.

In any case, publishing forecasts may be beneficial if there is an informational asymmetry between agents and the central bank, and it does not necessarily require that the central bank have the information advantage. For example, Tarkka and Mayes (1999) consider the case where the central bank measures inflation expectations with error, and the purpose of publishing forecasts is to communicate to agents the inflation expectations on which policy is based. In their model, forecast publication is always desirable.[2]

Clearly any central bank that does not enjoy perfect credibility for its policy target enjoys at least one information advantage over agents in the form of knowing its own policy target. There is some empirical evidence that other information advantages also

[2] This result does not extend to the current framework; see Appendix II for more details.

exist. For example, Joutz and Stekler (2000) demonstrate that the Federal Reserve produces more accurate forecasts than commercial forecasters for a variety of variables and data sets. Romer and Romer (2000) argue that this advantage is so great that, if they had the choice, commercial forecasters would be best off discarding their own forecasts and adopting those of the Federal Reserve. They suggest that this information advantage is because the Federal Reserve commits more resources to forecasting than any single commercial forecaster. Others have argued that, because of their institutional nature, central banks should produce more accurate forecasts. Not only do they face less uncertainty as to their own future policy actions, but, as Peek, Rosengren, and Tootell (1999) have shown, they typically have access to confidential bank supervisory data that contains information that is useful for forecasting.

3. A Simple Analytical Model with Uncertain Inflation Shocks

A simple linear-quadratic model is now developed that will be used to investigate central bank forecast publication. Inflation is determined by a Phillips curve of the form

$$\pi = \pi^e + \beta y + \epsilon, \tag{1}$$

where π and y are inflation and the output gap respectively, π^e is agents expectations of inflation, and ϵ is an inflation shock term. The central bank is assumed to have complete control over the output gap (y) (an extension that relaxes this assumption is considered in Appendix I), and sets policy to minimize a loss function given by

$$L = (\pi - \pi^*)^2 + \omega y^2, \tag{2}$$

where π^* is the inflation target, which may not be known by the public. A loss function characterized by $\omega = 0$ represents a central bank that cares only about inflation deviations from target, while for $\omega \to \infty$, the central bank cares only about the output gap.

The central bank is assumed to operate under discretion, so that optimal monetary policy entails minimizing the loss function (2), resulting in a reaction function given by

$$y^r = \frac{-\beta}{\beta^2 + \omega}(\pi^e - \pi^* + \epsilon^c) \tag{3}$$

where ϵ^c is the central bank's expectation of the inflation shock term.

Both agents and the central bank are assumed to have unbiased expectations of the inflation shock term, and agents are assumed to have an unbiased prior estimate of the inflation target (the "perceived" target, π^p) that jointly satisfy

$$\begin{pmatrix} \epsilon^a \\ \epsilon^c \\ \pi^p \end{pmatrix} \sim \left(\begin{pmatrix} \epsilon \\ \epsilon \\ \pi^* \end{pmatrix}, \begin{pmatrix} \sigma_a^2 & \sigma_{ac} & 0 \\ \sigma_{ac} & \sigma_c^2 & 0 \\ 0 & 0 & V(\pi^p) \end{pmatrix} \right), \tag{4}$$

where ϵ^a represents agents' expected inflation shock. The perceived target is assumed to be independent of expected inflation shocks, while expectation errors and the perceived target are independent of the level of the inflation shock ($E[(\pi^p - \pi^*)\epsilon] = E[(\epsilon^a - \epsilon)\epsilon] = E[(\epsilon^c - \epsilon)\epsilon] = 0$), where $\epsilon \sim (0, \sigma^2)$.

The central bank decides whether to publish its forecast before observing a signal about the inflation shock term, based on the distributional assumptions in (4). A published forecast may take one of two forms: conditional, or unconditional. An unconditional forecast will take the form of

$$\pi^{un} = E(\pi |\ \epsilon^c, y^r), \tag{5}$$

where y^r represents the optimal policy response by the monetary authority conditional on its information set, while a conditional forecast will take the form

$$\pi^{co} = E(\pi |\ \epsilon^c, \bar{y}), \tag{6}$$

where $\bar{y}$ is the current level of output and is known by both the central bank and agents. Note that agents are assumed to know the form that forecasts take, so that forecasts that condition on any level of output that is known to both agents and the central bank communicate exactly the same information to agents.

No Forecast Publication

Suppose that the central bank chooses not to publish its forecast. Because ϵ^c and ϵ^a are both unbiased estimates of ϵ, agents' best estimate of ϵ^c is ϵ^a. Then inflation expectations are given by

$$\pi^e = \pi^p + \frac{\omega}{\beta^2}\epsilon^a. \tag{7}$$

Substituting this into the reaction function and the Phillips curve, we may obtain

$$y = \frac{-\beta}{\beta^2+\omega}(\pi^p - \pi^*) - \frac{\omega}{\beta(\beta^2+\omega)}(\epsilon^a - \epsilon) - \frac{\beta}{\beta^2+\omega}(\epsilon^c - \epsilon) - \frac{1}{\beta}\epsilon, \tag{8}$$

$$(\pi - \pi^*) = \frac{\omega}{\beta^2+\omega}(\pi^p - \pi^*) + \frac{\omega^2}{\beta^2(\beta^2+\omega)}(\epsilon^a - \epsilon) - \frac{\beta^2}{\beta^2+\omega}(\epsilon^c - \epsilon) + \frac{\omega}{\beta^2}\epsilon, \tag{9}$$

so that the central bank faces an expected loss of

$$EL^{no} = \frac{\omega}{\beta^2+\omega}V(\pi^p) + \frac{\omega^3}{\beta^4(\beta^2+\omega)}\sigma_a^2 + \frac{\beta^2}{\beta^2+\omega}\sigma_c^2 + \frac{\omega(\beta^2+\omega)}{\beta^4}\sigma^2. \tag{10}$$

Conditional Forecast Publication

Suppose, instead, that the central bank publishes an inflation forecast that is conditional on the current value of output (and does not take account of the optimal discretionary policy), while policy continues to be set according to (3). The conditional forecast may be modeled as the inflation expectation of the central bank, excluding the impact of policy- that is,

$$\pi^{co} = \pi^e + \beta\bar{y} + \epsilon^c, \tag{11}$$

where $\bar{y}$ is the current (known) value of y. Since $\bar{y}$ and π^e are known by agents, a conditional forecast communicates ϵ^c to agents. Agents then use this to efficiently update their knowledge of the shock as

$$\begin{aligned} \hat{\epsilon}^a &= [(\sigma_a^2 - \sigma_{ac})\epsilon^c + (\sigma_c^2 - \sigma_{ac})\epsilon^a]F^{-1} \\ &= \epsilon^a - (\sigma_a^2 - \sigma_{ac})(\epsilon^a - \epsilon^c)F^{-1}, \end{aligned} \tag{12}$$

where $F = \sigma_a^2 + \sigma_c^2 - 2\sigma_{ac} > 0$, and

$$V(\hat{\epsilon}^a) = C(\hat{\epsilon}^a, \epsilon^c) = [\sigma_a^2\sigma_c^2 - (\sigma_{ac})^2]F^{-1}. \tag{13}$$

This implies inflation expectations on the part of agents (which condition on π^p rather than the unknown π^*) of

$$\pi^e = \pi^p + \frac{\omega}{\beta^2}\hat{\epsilon}^a + (\hat{\epsilon}^a - \epsilon^c), \tag{14}$$

output and inflation of

$$y = \frac{-\beta}{\beta^2 + \omega}(\pi^p - \pi^*) - \frac{1}{\beta}(\hat{\epsilon}^a - \epsilon) - \frac{1}{\beta}\epsilon, \tag{15}$$

$$(\pi - \pi^*) = \frac{\omega}{\beta^2 + \omega}(\pi^p - \pi^*) + \frac{\omega}{\beta^2}(\hat{\epsilon}^a - \epsilon) - (\epsilon^c - \epsilon) + \frac{\omega}{\beta^2}\epsilon, \tag{16}$$

and an expected loss to the central bank of

$$\begin{aligned} EL^{co} &= \frac{\omega}{\beta^2 + \omega}V(\pi^p) + \frac{\omega(\omega - \beta^2)}{\beta^4}[\sigma_a^2\sigma_c^2 - (\sigma_{ac})^2]F^{-1} + \sigma_c^2 + \frac{\omega(\beta^2 + \omega)}{\beta^4}\sigma^2 \\ &= EL^{no} + \frac{\omega}{\beta^4(\beta^2 + \omega)}F^{-1}[\beta^4(\sigma_c^2 - \sigma_{ac})^2 - \omega^2(\sigma_a^2 - \sigma_{ac})^2]. \end{aligned} \tag{17}$$

Because a conditional forecast does not communicate how the central bank plans to respond to shocks, it also does not communicate the target of the central bank. However, it communicates the central bank's expectation of the size and propagation of shocks precisely.

Unconditional Forecast Publication

In contrast to a conditional forecast, an unconditional forecast incorporates the optimal policy response of the central bank, and therefore information on the target, π^*. Taking expectations of the Phillip's curve (1), this forecast takes the form

$$\pi^{un} = \frac{\omega}{\beta^2 + \omega}(\pi^e + \epsilon^c) + \frac{\beta^2}{\beta^2 + \omega}\pi^*. \tag{18}$$

Agents do not know the true target (π^*) or the central bank's information on expected shocks (ϵ^c), but instead use the forecast to update their prior estimates. Agents' expected inflation satisfies

$$\pi^e = \frac{\omega}{\beta^2 + \omega}(\pi^e + \epsilon^a) + \frac{\beta^2}{\beta^2 + \omega}\pi^p, \tag{19}$$

so that the information content contained in the unconditional inflation forecast is proportional to the difference between (18) and (19), or

$$[\beta^2(\pi^p - \pi^*) + \omega(\epsilon^a - \epsilon^c)]. \tag{20}$$

Assuming the distributional assumptions in (4), and in particular that agents' priors on the target and the shock are independent, the forecast may be used to efficiently update π^p, ϵ^a, and agents' expectation of ϵ^c in a manner equivalent to least squares learning, or Bayesian updating. The updated estimates, $\hat{\hat{\pi}}^p$, $\hat{\hat{\epsilon}}^a$, and $\hat{\hat{\epsilon}}^c$ may be written as

$$\hat{\hat{\pi}}^p = \pi^p - \beta^2 V(\pi^p)[\beta^2(\pi^p - \pi^*) + \omega(\epsilon^a - \epsilon^c)]G^{-1}, \tag{21}$$

$$\hat{\hat{\epsilon}}^a = \epsilon^a - \omega(\sigma_a^2 - \sigma_{ac})[\beta^2(\pi^p - \pi^*) + \omega(\epsilon^a - \epsilon^c)]G^{-1}, \tag{22}$$

$$\hat{\hat{\epsilon}}^c = \epsilon^a - \omega F[\beta^2(\pi^p - \pi^*) + \omega(\epsilon^a - \epsilon^c)]G^{-1}, \tag{23}$$

where

$$G = \beta^4 V(\pi^p) + \omega^2 F, \tag{24}$$

$$V(\hat{\hat{\pi}}^p) = V(\pi^p) - \beta^4 V(\pi^p)^2 G^{-1}, \tag{25}$$

$$V(\hat{\hat{\epsilon}}^a) = C(\hat{\hat{\epsilon}}^a, \hat{\hat{\epsilon}}^c) = \sigma_a^2 - \omega^2(\sigma_a^2 - \sigma_{ac})^2 G^{-1}, \tag{26}$$

$$V(\hat{\hat{\epsilon}}^c) = \sigma_a^2 - \omega^2(\sigma_a^2 - \sigma_c^2) F G^{-1}, \tag{27}$$

$$C(\hat{\hat{\pi}}^p, \hat{\hat{\epsilon}}^a) = C(\hat{\hat{\pi}}^p, \hat{\hat{\epsilon}}^c) = -\omega\beta^2 V(\pi^p)(\sigma_a^2 - \sigma_{ac}) G^{-1}, \tag{28}$$

$$C(\hat{\hat{\pi}}^p, \epsilon^c) = -\omega\beta^2 V(\pi^p)(\sigma_{ac} - \sigma_c^2) G^{-1}, \tag{29}$$

$$C(\hat{\hat{\epsilon}}^a, \epsilon^c) = \sigma_{ac} - \omega^2(\sigma_a^2 - \sigma_{ac})(\sigma_{ac} - \sigma_c^2) G^{-1}, \tag{30}$$

$$C(\hat{\hat{\epsilon}}^c, \epsilon^c) = \sigma_{ac} - \omega^2(\sigma_{ac} - \sigma_c^2) F G^{-1}. \tag{31}$$

Inflation expectations are therefore given by

$$\pi^e = \hat{\hat{\pi}}^p + \frac{\beta^2 + \omega}{\beta^2} \hat{\hat{\epsilon}}^a - \hat{\hat{\epsilon}}^c, \tag{32}$$

and output and inflation by

$$y = \frac{-\beta}{\beta^2 + \omega}(\hat{\hat{\pi}}^p - \pi^*) - \frac{1}{\beta}(\hat{\hat{\epsilon}}^a - \epsilon) + \frac{\beta}{\beta^2 + \omega}(\hat{\hat{\epsilon}}^c - \epsilon) - \frac{\beta}{\beta^2 + \omega}(\epsilon^c - \epsilon) - \frac{1}{\beta}\epsilon, \tag{33}$$

$$(\pi - \pi^*) = \frac{\omega}{\beta^2 + \omega}(\hat{\hat{\pi}}^p - \pi^*) + \frac{\omega}{\beta^2}(\hat{\hat{\epsilon}}^a - \epsilon) - \frac{\omega}{\beta^2 + \omega}(\hat{\hat{\epsilon}}^c - \epsilon) - \frac{\beta^2}{\beta^2 + \omega}(\epsilon^c - \epsilon) + \frac{\omega}{\beta^2}\epsilon. \tag{34}$$

Combining these, the central bank's expected loss function may be expressed variously as

$$\begin{aligned}
EL^{un} &= \frac{\omega}{\beta^2 + \omega} V(\hat{\hat{\pi}}^p) + \frac{\omega(\beta^2 + \omega)}{\beta^4} V(\hat{\hat{\epsilon}}^a) + \frac{\omega}{\beta^2 + \omega} V(\hat{\hat{\epsilon}}^c) + \frac{2\omega}{\beta^2} C(\hat{\hat{\pi}}^p, \hat{\hat{\epsilon}}^a) - \frac{2\omega}{\beta^2 + \omega} C(\hat{\hat{\pi}}^p, \hat{\hat{\epsilon}}^c) \\
&\quad - \frac{2\omega}{\beta^2} C(\hat{\hat{\epsilon}}^a, \hat{\hat{\epsilon}}^c) + \frac{\beta^2}{\beta^2 + \omega}\sigma_c^2 + \frac{\omega(\beta^2 + \omega)}{\beta^4}\sigma^2 \\
&= \frac{\omega}{\beta^2 + \omega} V(\pi^p) - \frac{\omega}{\beta^2 + \omega}\beta^4 V(\pi^p)^2 G^{-1} + \frac{\omega(\omega - \beta^2)}{\beta^4}[\sigma_a^2 - \omega^2(\sigma_a^2 - \sigma_{ac})^2 G^{-1}] \\
&\quad + \frac{\omega}{\beta^2 + \omega}[\sigma_a^2 - \omega^2(\sigma_a^2 - \sigma_c^2) F G^{-1}] - \frac{2\omega^3}{\beta^2 + \omega} V(\pi^p)(\sigma_a^2 - \sigma_{ac}) G^{-1} + \frac{\beta^2}{\beta^2 + \omega}\sigma_c^2 \\
&\quad + \frac{\omega(\beta^2 + \omega)}{\beta^4}\sigma^2 \\
&= EL^{co} - \frac{\omega}{\beta^2 + \omega} V(\pi^p) G^{-1} F^{-1}[FG + (\beta^4 - \omega^2)(\sigma_{ac} - \sigma_c^2)^2] \\
&= EL^{no} - \frac{\omega}{\beta^4(\beta^2 + \omega)} G^{-1}\Big([\beta^4 V(\pi^p) + \omega^2(\sigma_a^2 - \sigma_{ac})]^2 - \omega^2\beta^4(\sigma_{ac} - \sigma_c^2)^2\Big).
\end{aligned} \tag{35}$$

Unconditional and Conditional Forecast Publication

Note that it would be possible for the central bank to publish both types of forecasts, and therefore communicate both the shock and the target exactly. However, this is not observed in practice. One possible explanation for this is that processing central bank forecasts is costly for agents, introducing bounded rationality into the learning process. Then publishing too much information may actually be costly to the central bank. Another possibility is that it is not optimal for central banks to publish both types of forecasts. We consider this possibility here. From (10), (17) and (35), a central bank that publishes both types of forecasts faces an expected loss of

$$
\begin{aligned}
EL^{bo} &= \frac{\omega(\omega-\beta^2)}{\beta^4}[\sigma_a^2\sigma_c^2-(\sigma_{ac})^2]F^{-1}+\sigma_c^2+\frac{\omega(\beta^2+\omega)}{\beta^4}\sigma^2 \\
&= EL^{un}+\omega(\beta^2-\omega)V(\pi^p)G^{-1}F^{-1}(\sigma_{ac}-\sigma_c^2)^2 \\
&= EL^{co}-\frac{\omega}{\beta^2+\omega}V(\pi^p) \\
&= EL^{no}+\frac{\omega}{\beta^4(\beta^2+\omega)}F^{-1}\Big(\beta^4(\sigma_c^2-\sigma_{ac})^2-\omega^2(\sigma_a^2-\sigma_{ac})^2]\Big) \\
&\quad -\frac{\omega}{\beta^2+\omega}V(\pi^p). \qquad (36)
\end{aligned}
$$

Comparison

The optimal forecasting decision of the central bank may be determined by examining equations (17), (35) and (36). A number of special cases are examined, to provide insights into the working of the model.

First note that if the central bank enjoys perfect credibility and both agents and the central bank have the same information set, or if the central bank cares only about inflation or output ($\omega \in \{0, \infty\}$), the forecasting decision of the central bank is of no consequence. The loss of the central bank is independent of its forecasting decision. The presence of both conflicting output and inflation objectives, and informational asymmetries, are necessary for the central bank to have any motivation to publish forecasts.

Similarly, if the central bank enjoys perfect credibility (so that $V(\pi^p) = 0$), whether the central bank publishes conditional, unconditional, or both types of forecasts is of no consequence, since agents know the reaction function of the central bank, and can therefore determine the central bank's unconditional expectation of inflation from its conditional forecast. It is straight forward to show that a central bank that enjoys perfect credibility will benefit from forecast publication if

$$\omega(\sigma_a^2 - \sigma_{ac}) > \beta^2(\sigma_c^2 - \sigma_{ac}), \tag{37}$$

that is, if it places a sufficiently small weight on inflation variability (ω large), and has a sufficiently large information advantage over agents (σ_a^2 large relative to σ_c^2). There are two effects at work here. First, the cost of publishing a forecast is that the central bank forgoes the ability to use its information advantage to optimally apportion the shock between output and inflation variability; the smaller is ω, the more fully the forecast will be reflected in inflation expectations, and therefore inflation, and so this cost will be larger. Note that this is the reverse of Geraats (2001a), as here more conservative central banks are less inclined to publish forecasts than less conservative ones. The reason for this difference is that in Geraats (2001a), publishing a forecast does not influence inflation expectations, but instead is only used by agents trying to learn about the inflation target for use in forming inflation expectations in future periods. Therefore publishing forecasts does not have any impact on the ability of the central bank to conduct policy optimally. In contrast, if publishing a forecast also communicates the central bank's expected inflation shocks, it may impede the central bank's optimal conduct of monetary policy, particularly with a conservative central banker. Cukierman (2000) distinguishes between publishing forecasts before agents have formed expectations ("full transparency") and after agents have formed expectations ("limited transparency"), and argues that in general, limited transparency is optimal.[3]

There is a second effect at work as well. The benefit from publishing a forecast results from reduced inflation volatility due to reduced volatility of inflation expectations. The larger is the information advantage of the central bank (the smaller is σ_c^2 relative to σ_a^2), the larger this effect is.

If agents and the central bank share the same information sets about the inflation shock ($\sigma_c^2 = \sigma_a^2 = \sigma_{ac}$), and the central bank does not enjoy perfect credibility, outcomes are identical whether the central bank fails to publish a forecast, or publishes a conditional forecast. However, there remains a difference between publishing conditional and unconditional forecasts. From (35) and (36),

$$EL^{bo} = EL^{un} = EL^{no} - \frac{\omega}{\beta^2 + \omega} V(\pi^p), \tag{38}$$

so that publishing an unconditional forecast is equivalent to publishing both types of forecast and is always optimal, since it gains credibility for the central bank at no cost in terms of the ability of the central bank to allocate shocks between output and inflation variability optimally.

Now consider the case where the central bank does not possess an information advantage over agents with regard to the inflation shock so that $\sigma_c^2 > \sigma_a^2$ and $\sigma_a^2 = \sigma_{ac}$. Then agents do not adjust their expectations of the inflation shock after observing the

[3] A similar effect is also at work in Gersbach (2001); see Geraats (2001b, pg 13) for a discussion.

central bank's forecast ($\hat{\hat{\epsilon}}^a = \hat{\epsilon}^a = \epsilon^a$). A forecast then communicates the information on which monetary policy is based, which is inferior to the information held by agents. From (14) and (17), publishing a conditional forecast is never optimal, since inflation expectations are more volatile when they incorporate the (relatively noisy) expectations of the central bank than when they condition only on the agents' more precise expectations. However, it can be shown that

$$EL^{un} = EL^{no} - \frac{\omega}{\beta^2 + \omega}[\beta^4 V(\pi^p)^2 + \omega^2(\sigma_a^2 - \sigma_c^2)^2]G^{-1}, \tag{39}$$

so publishing an unconditional forecast is preferable to no forecast if the central bank suffers from low credibility relative to the size of the information advantage of agents, or places a high weight on inflation stability. Note also that publishing both types of forecasts will dominate an unconditional forecast if $\omega > \beta^2$ (the central bank cares sufficiently about inflation that the benefits of perfect credibility more than offset the cost of increased inflation expectations variability), and will dominate no forecast publication if

$$V(\pi^p) > (\sigma_c^2 - \sigma_a^2), \tag{40}$$

that is, credibility is sufficiently low relative to the size of the information advantage of agents. Tarkka and Mayes (1999) found that publishing forecasts is desirable even if the source of information asymmetry is mis-measurement of inflation expectations so that the central bank effectively possesses inferior information to agents. This result does not extend to the current framework. A necessary condition for the central bank to benefit from publishing forecasts is that the central bank has an information advantage over agents (see Appendix II for more details).

As a final example, consider the case suggested by the results in Romer and Romer

(2000) and Joutz and Stekler (2000) where the central bank has an information advantage over agents. In the limiting case where the central bank's information set dominates agents (so that agents would be best off simply adopting central bank forecasts if they were able), $\sigma_a^2 > \sigma_c^2$ and $\sigma_c^2 = \sigma_{ac}$. From (17), a conditional forecast is always preferred to no forecast, since the benefits of reduced inflation expectations volatility always dominate the reduced control in apportioning the shock optimally between output and inflation volatility. However,

$$EL^{bo} = EL^{un} = EL^{co} - \frac{\omega}{\beta^2 + \omega} V(\pi^p), \tag{41}$$

so an unconditional forecast will dominate, and is equivalent to publishing both types of forecast. That is because, in this case, inflation expectations are given by

$$\pi^e = \pi^p + \epsilon^a - \frac{1}{\beta^2}[\beta^2(\pi^p - \pi^*) + \omega(\epsilon^a - \epsilon^c)]. \tag{42}$$

If agents over-estimate π^*, they correspondingly underestimate ϵ, and the effect of over-estimating π^* and underestimating ϵ exactly cancel out in inflation expectations, and therefore in the central bank's loss function. Therefore a central bank that has a large enough information advantage over agents can do no better than publishing unconditional forecasts.

4. Conclusions

In this paper, a simple model of information asymmetry is used to study central bank forecast publication. Inflation expectations are assumed to respond to published, central bank forecasts, and the central bank is assumed to measure inflation expectations with precision when optimally setting discretionary monetary policy. Central banks choose between not publishing a forecast, publishing a conditional forecast (that communicates only information about the expected size and propagation of shocks through the economy), publishing an unconditional forecast (that communicates information about both shocks and the policy target), and publishing both types of forecasts. It is shown that there is no incentive for the central bank to publish forecasts unless it faces conflicting output and inflation objectives, and also possesses an information advantage over agents.

A conservative central bank that does not have an information advantage over agents may prefer not to publish forecasts. At the heart of this result is a fundamental asymmetry between the behavior of output and inflation. In the simple linear-quadratic environment employed here, inflation expectations drive inflation, while output is not influenced by output expectations. Sharing information with agents via the publication of forecasts may help or hinder the conduct of monetary policy depending on the impact of that information on inflation expectations, and the relative weight of inflation in the central bank's loss function. Therefore a conservative central banker, who focuses primarily on inflation stability, may find that the publication of central bank forecasts makes her job more difficult by driving inflation away from the target via expectations.

If central bank expectations have an information advantage over agents, as suggested by the empirical results of Romer and Romer (2000) and Joutz and Stekler (2000), then central banks should publish forecasts. If publishing a single forecast, such central banks would benefit most from publishing unconditional forecasts; in the limiting case where the central bank's information set dominates that of agents, this is equivalent to publishing both conditional and unconditional forecasts.

Appendix I. A Simple Analytical Model With Uncertain Demand Shocks

Suppose that the main source of uncertainty in the economy is the presence of demand shocks, rather than inflation shocks as modeled above. Then inflation is determined by a Phillips curve of the form

$$\pi = \pi^e + \beta y, \tag{1'},$$

and the central bank no longer has complete control over the output gap. Suppose instead that

$$y = y^r + \epsilon \tag{2'}$$

where y^r is the policy variable and ϵ is the demand shock. The optimal discretionary policy to minimize the loss function (2) will take the form

$$y^r = \frac{-\beta}{\beta^2 + \omega}(\pi^e - \pi^*) - \epsilon^c \tag{3'}$$

where ϵ^c is the central bank's expectation of the demand shock term.

Assuming distributional assumptions on the perceived target and the demand shock term as in (4), we can now address the optimal forecasting decision by the central bank.

No Forecast Publication

Suppose that the central bank chooses not to publish its forecast. Because ϵ^c and ϵ^a are both centered on ϵ, from agents' point of view, $E(\epsilon^c) = \epsilon^a$. Therefore inflation expectations are given by

$$\pi^e = \pi^p. \tag{7'}$$

Substituting this into the reaction function and the Phillips curve, we may obtain

$$y = \frac{-\beta}{\beta^2 + \omega}(\pi^p - \pi^*) - (\epsilon^c - \epsilon), \tag{8'}$$

$$(\pi - \pi^*) = \frac{\omega}{\beta^2 + \omega}(\pi^p - \pi^*) - \beta(\epsilon^c - \epsilon), \tag{9'}$$

so that the central bank faces an expected loss of

$$EL^{no} = \frac{\omega}{\beta^2 + \omega} V(\pi^p) + (\beta^2 + \omega)(\sigma_c^2 + \sigma^2). \tag{10$'$}$$

Conditional Forecast Publication

Suppose, instead, that the central bank publishes an inflation forecast that is conditional on the current value of output, while policy continues to be set according to (3′). The conditional forecast may be modeled as the

$$\pi^{co} = \pi^e + \beta\bar{y}, \tag{11$'$}$$

where $\bar{y}$ is the current (known) value of y. Note that since π^e and $\bar{y}$ are both known by agents, a conditional forecast fails to communicate anything of value of agents. Therefore

$$EL^{co} = EL^{no}. \tag{17$'$}$$

Unconditional Forecast Publication

Suppose, instead, that the central bank publishes an unconditional forecast of inflation that incorporates the optimal policy response. Taking expectations of the Phillip's curve (1′), this forecast will take the form

$$\pi^{un} = \pi^* + \frac{\omega}{\beta^2 + \omega}(\pi^e - \pi^*). \tag{18$'$}$$

Agents' expected inflation satisfies

$$\pi^e = \pi^p, \tag{19$'$}$$

so that the information content contained in the unconditional inflation forecast is proportional to

$$[\pi^p - \pi^*], \tag{20$'$}$$

and an unconditional forecast communicates the inflation target exactly, but not ϵ^c. Therefore inflation expectations are given by

$$\pi^e = \pi^*, \tag{32'}$$

and output and inflation by

$$y = -(\epsilon^c - \epsilon), \tag{33'}$$

$$\pi = \pi^* - \beta(\epsilon^c - \epsilon), \tag{34'}$$

and the central bank's expected loss function is

$$EL^{un} = (\beta^2 + \omega)(\sigma_c^2 + \sigma^2). \tag{35'}$$

Unconditional and Conditional Forecast Publication

Clearly if the central bank publishes both types of forecast,

$$EL^{bo} = EL^{un}. \tag{36'}$$

Comparison

From (10′), (17′), (35′) and (36′),

$$EL^{bo} = EL^{un} < EL^{co} = EL^{no}.$$

If the main source of uncertainty in the economy is demand shocks, then there is a role for unconditional forecasts that communicate the inflation target of the central bank, but because optimal monetary policy will always reverse any information the central bank has on the demand shock, an inflation forecast will not communicate the expected shock to agents.

Appendix II. Measuring Inflation Expectations with Error

We now consider the case in Tarkka and Mayes (1999). Suppose that the central bank's measure of inflation expectations is given by

$$E_c(\pi^e) = \pi^e + \eta, \quad \eta \sim (0, \sigma_\eta^2) \tag{1''}$$

so that inflation expectations are measured with error. To identify the impact of inflation expectation mis-measurement on the forecasting decision in isolation, suppose that all other shocks are equal to zero, and the central bank enjoys perfect credibility. Then

$$y^r = \frac{-\beta}{\beta^2 + \omega}(E_c(\pi^e) - \pi^*). \tag{3''}$$

No Forecast Publication

If a central bank does not publish a forecast, agents do not know η. Therefore

$$\pi^e = \pi^*, \tag{7''}$$

$$y = \frac{-\beta}{\beta^2 + \omega}\eta, \tag{8''}$$

$$(\pi - \pi^*) = \frac{-\beta^2}{\beta^2 + \omega}\eta, \tag{9''}$$

so that the central bank faces an expected loss of

$$EL^{no} = \frac{\beta^2}{\beta^2 + \omega}\sigma_\eta^2. \tag{10''}$$

Forecast Publication

A central bank that publishes an inflation forecast communicates η. Taking expectations,

$$\pi^e = \pi^* - \eta, \tag{14''}$$

$$y = 0, \tag{15''}$$

$$(\pi - \pi^*) = \eta, \tag{16''}$$

so that the central bank faces an expected loss of

$$EL^{fo} = \sigma_\eta^2. \tag{17''}$$

Comparison

Clearly $EL^{fo} > EL^{no}$, so forecast publication is not optimal. When the central bank reveals the error with which expectations are measured, rational agents respond by adjusting inflation expectations, so that the full measurement error is reflected in inflation. This is never optimal for the central bank.

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