Optimal Degrees of Transparency in Monetary Policymaking: The case of imperfect information about the cost-push shock*

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November 2000

Abstract

This note complements my results in Jensen (2000) wherein transparency is synonymous with release of information about shocks hitting after policy is set (i.e., "control errors"). Here, I examine the case where transparency is synomymous with release of information about shocks realized before policy is set. It is shown that the distortions induced by transparency in terms of stabilization performance also apply in this case.

Keywords: Transparency; monetary policy; central bank institutions.

JEL: E42, E52, F58.

*I thank EPRU for financial support (the activities of EPRU are financed by a grant from The Danish National Research Foundation).

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1. Introduction

This note complements my results obtained in Jensen (2000) (henceforth, HJ) wherein transparency, following Faust and Svensson (2000), is synonymous with the release of information about shocks hitting the economy after policy is set (so-called "control errors"). This scenario corresponds to what Geraats (2000) labels "operational transparency," i.e., transparency about what may or may not have caused planned outcomes of policy to be pertubed *after* policy implementation. Within the same model of HJ, I examine here the case where transparency is synonymous with release of information about shocks realized before policy is set (so-called "cost-push" shocks). This scenario is labelled "economic transparency" by Geraats (2000) and corresponds to release about information about the known state of the economy *before* policy is implemented.

While one can always quarrel about the appropriateness of different labels (shocks occurring after policy implementation are, e.g., also "economic"), the scenarios clearly differ. It is therefore of interest to examine whether the implications of transparency for policy conduct also differ in a model emphasizing forward-looking behavior as HJ. This note shows that they do not. The distortions induced by transparency in terms of poorer macroeconomic stabilization performance, highlighted and explained in HJ, hold also under the scenario considered here.

This note is technical and telegraphic in language, and is therefore only meant for readers who are already familiar with HJ. In consequence, expressions and notation will only be explained whenever new appear.

2. The model

The forward-looking inflation equations for periods 1 and 2 are:

$$\pi_1 = \mathrm{E}\left[\pi_2 | I_1^P\right] + \kappa x_1 + \varepsilon, \quad \kappa > 0, \tag{1}$$

$$\pi_2 = \mathrm{E}\left[\pi_3 | I_2^P\right] + \kappa x_2, \tag{2}$$

where $\varepsilon \sim \mathrm{N}(0, \sigma_\varepsilon^2)$ is the "cost-push" shock, over which — in absence of transparency — the central bank has an informational advantage.[1] In this version of the model, there are

[1]Immediately, one may question the realism of this assumption, as underlying (1) is price-setting behavior of firms who are probably relatively better capable of knowing their costs. However, (1) is an aggregate expression, so even though each single firm knows its own cost, it may have inferior knowledge about aggregate costs in comparison with the central bank.

Table 1: Timeline of events and actions

Period 0 :	x_0^* is drawn				
Period 1 :	ε, θ are realized	x_1 is chosen	ε^k is revealed	$\mathrm{E}\left[\pi_2 \vert I_1^P\right]$ is formed	π_1 materializes
Period 2 :	x_2 is chosen	π_2 materializes			

no control errors, so the central bank controls demand, and thus the output gap (since technology shocks are absent), perfectly.

Society has the loss function:

$$L^S = \mathrm{E}\left[\sum_{i=1}^{2}\left[\lambda\left(x_i - x^*\right)^2 + \pi_i^2\right]\right], \quad \lambda > 0, \quad x^* > 0. \tag{3}$$

The loss function of the central bank is given by

$$L^{CB} = \mathrm{E}\left[\sum_{i=1}^{2}\left[\lambda\left(x_i - x_i^*\right)^2 + \pi_i^2\right]\right], \tag{4}$$

with

$$x_1^* = x_0^* + \theta, \quad x_2^* = x_1^*, \quad x_0^* \text{ given}, \tag{5}$$

where $\theta \sim \mathrm{N}(0, \sigma_\theta^2)$ is the shock to the output gap target in period 1.

To model transparency formally, I assume that after monetary policy has been conducted in period 1, the price setters will get some information about ε. More specifically, the shock is split into two parts:

$$\varepsilon = \varepsilon^k + \varepsilon^u, \tag{6}$$

where $\varepsilon^k \sim \mathrm{N}\big(0, \sigma_{\varepsilon^k}^2\big)$ becomes known to the price setters, whereas $\varepsilon^u \sim \mathrm{N}(0, \sigma_{\varepsilon^u}^2)$ remains unknown. Transparency is then formally modelled as

$$\sigma_{\varepsilon^k}^2 = \tau\sigma_\varepsilon^2, \qquad \sigma_{\varepsilon^u}^2 = (1-\tau)\,\sigma_\varepsilon^2, \tag{7}$$

where $0 \leq \tau < 1$ is the index of transparency.

Table 1 provides a graphical presentation of the timing of events in the model. The informational asymmetries in period 1 are as follows. Both the central bank and price setters know the structural parameters of the model and the statistical properties of shocks. At the time the central bank chooses policy, it has the information set $I_1^{CB} = \{x_0^*, \varepsilon, \theta\}$. The price setters' information set is $I_1^P = \left\{x_0^*, x_1, \varepsilon^k\right\}$.

2.1. Equilibrium under full information about the central bank's preferences

This section derives the equilibrium under full information, i.e., when $\theta \in I_1^P$. The equilibrium is derived under the assumption that the central bank acts in a discretionary fashion. In period 2 the central bank solves $\min_{x_2} \left[\lambda \left(x_2 - x_1^*\right)^2 + \pi_2^2\right]$ subject to (2) and a terminal condition $\mathrm{E}\left[\pi_3 | I_2^P\right] = (\lambda/\kappa)\, x_2^*$. From the relevant first-order condition, $\lambda \left(x_2 - x_1^*\right) + \kappa \left[(\lambda/\kappa)\, x_1^* + \kappa x_2\right] = 0$, equilibrium output gap and inflation in period 2 follow as

$$x_2 = 0, \quad \pi_2 = (\lambda/\kappa)\, x_1^*. \tag{8}$$

In period 1 the central bank solves $\min_{x_1} \mathrm{E}\left[\lambda \left(x_1 - x_1^*\right)^2 + \pi_1^2 | I_1^{CB}\right]$ subject to (1), and subject to the fact that by (8), $\mathrm{E}\left[\pi_2 | I_1^P\right] = (\lambda/\kappa)\, x_1^*$ when $\theta \in I_1^P$. From the relevant first-order condition, $\mathrm{E}\left[\lambda \left(x_1 - x_1^*\right) + \kappa \left[(\lambda/\kappa)\, x_1^* + \kappa x_1 + \varepsilon\right] | I_1^{CB}\right] = 0$, the equilibrium output gap and inflation in period 1 follow as

$$x_1 = -\frac{\kappa}{\lambda + \kappa^2}\varepsilon, \qquad \pi_1 = (\lambda/\kappa)\left(x_0^* + \theta\right) + \frac{\lambda}{\lambda + \kappa^2}\varepsilon. \tag{9}$$

Note that the inflation shock, due to the central bank's dislike of inflation variability, is optimally "spread out" onto the output gap and inflation, and that the optimal discretionary monetary policy is attained at $x_0^* = 0$.

2.2. Equilibrium under asymmetric information: the role of transparency

Now the model is solved for the case of asymmetric information, and again, the model is solved by backwards induction. It is straightforward that in period 2, the decision by the central bank is the same as in the case of full information. Hence, (8) applies under asymmetric information as well. The crucial matter in determining the solution for period 1 is the identification of $\mathrm{E}\left[\pi_2 | I_1^P\right]$, as this is a determinant of period 1 inflation. Since $\pi_2 = (\lambda/\kappa)\, x_1^* = (\lambda/\kappa)\left(x_0^* + \theta\right)$ this boils down to finding $\mathrm{E}\left[\theta | I_1^P\right]$.

For this purpose, conjecture that the central bank's period 1 equilibrium policy can be expressed as

$$x_1 = h - h_\varepsilon^k \varepsilon^k - h_\varepsilon^u \varepsilon^u + h_\theta \theta, \tag{10}$$

where h, h_ε^k, $h_\varepsilon^u > 0$ and $h_\theta > 0$ are coefficients to be determined. It will be shown that if price setters believe that (10) applies, then the central bank's optimal policy will indeed be of this form. Price setters can construct a "signal" variable, s_1, at the expectations formation stage:

$$s_1 = x_1 + h_\varepsilon^k \varepsilon^k - h. \tag{11}$$

It then follows by (6) that s_1 can be condensed as

$$s_1 = h_\theta \theta - h_\varepsilon^u \varepsilon^u. \tag{12}$$

In determining $\mathrm{E}\left[\theta | I_1^P\right]$, price setters then solve a standard signal-extraction problem. Because θ and ε^u are independently normally distributed, the conditional expectation of θ becomes

$$\mathrm{E}\left[\theta | I_1^P\right] = \mathrm{E}\left[\theta | s_1\right] = \mathcal{S}\left(h_\theta, h_\varepsilon^u\right) s_1, \quad \mathcal{S}\left(h_\theta, h_\varepsilon^u\right) \equiv \frac{h_\theta \sigma_\theta^2}{h_\theta^2 \sigma_\theta^2 + h_\varepsilon^{u2} \sigma_{\varepsilon^u}^2} > 0, \tag{13}$$

where $\mathcal{S}\left(h_\theta, h_\varepsilon^u\right)$ can be interpreted as the degree of informativeness of s_1 in terms of predicting θ. For high values of $\sigma_{\varepsilon^u}^2$, s_1 provides noisy information about θ, whereas in the limit of $\sigma_{\varepsilon^u}^2 \rightarrow 0$, the signal reveals the value of θ precisely. The price setters' rational expectation of period 2 inflation follows as

$$\mathrm{E}\left[\pi_2 | I_1^P\right] = (\lambda/\kappa) \left[x_0^* + \mathcal{S}\left(h_\theta, h_\varepsilon^u\right) s_1\right]. \tag{14}$$

The central bank's optimal behavior in period 1 is characterized by the solution to

$$\min_{x_1} \mathrm{E}\left[\lambda \left(x_1 - x_0^* - \theta\right)^2 + \pi_1^2 | I_1^{CB}\right],$$

subject to (1) and (14). The first-order condition is

$$\begin{aligned} & \mathrm{E}\left[\lambda \left(x_1 - x_0^* - \theta\right) | I_1^{CB}\right] \\ & + \mathrm{E}\left[\left((\lambda/\kappa)\left[x_0^* + \mathcal{S}\left(h_\theta, h_\varepsilon^u\right) s_1\right] + \kappa x_1 + \varepsilon\right) \left(\kappa + (\lambda/\kappa) \mathcal{S}\left(h_\theta, h_\varepsilon^u\right) \frac{\partial s_1}{\partial x_1^I}\right) \Bigg| I_1^{CB}\right] \\ = & \ 0. \end{aligned} \tag{15}$$

From (11), it follows that $\partial s_1 / \partial x_1 = 1$. Also, note by (12) that $\mathrm{E}\left[s_1 | I_1^{CB}\right] = h_\theta \theta - h_\varepsilon^u \varepsilon^u$. Using these insights, (15) reduces to

$$\lambda \left(x_1 - x_0^* - \theta\right) + \left((\lambda/\kappa)\left[x_0^* + \mathcal{S}\left(h_\theta, h_\varepsilon^u\right)\left(h_\theta \theta - h_\varepsilon^u \varepsilon^u\right)\right] + \kappa x_1 + \varepsilon\right)\left(\kappa + (\lambda/\kappa) \mathcal{S}\left(h_\theta, h_\varepsilon^u\right)\right) = 0. \tag{16}$$

From (16), the optimal period 1 policy emerges as

$$
\begin{aligned}
x_1 &= -\frac{(\lambda/\kappa)^2 x_0^* \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} - \frac{\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \varepsilon \\
&\quad + \frac{\lambda \mathcal{S}(h_\theta, h_\varepsilon^u) h_\varepsilon^u (1 + (\lambda/\kappa^2) \mathcal{S}(h_\theta, h_\varepsilon^u))}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \varepsilon^u \\
&\quad + \frac{\lambda [1 - \mathcal{S}(h_\theta, h_\varepsilon^u) h_\theta (1 + (\lambda/\kappa^2) \mathcal{S}(h_\theta, h_\varepsilon^u))]}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \theta,
\end{aligned}
$$

and thus

$$
\begin{aligned}
x_1 &= -\frac{(\lambda/\kappa)^2 x_0^* \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} - \frac{\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \varepsilon^k \\
&\quad + \frac{\lambda [1 - \mathcal{S}(h_\theta, h_\varepsilon^u) h_\theta (1 + (\lambda/\kappa^2) \mathcal{S}(h_\theta, h_\varepsilon^u))]}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \theta \\
&\quad + \frac{\lambda \mathcal{S}(h_\theta, h_\varepsilon^u) h_\varepsilon^u (1 + (\lambda/\kappa^2) \mathcal{S}(h_\theta, h_\varepsilon^u)) - [\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u)]}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \varepsilon^u, \qquad (17)
\end{aligned}
$$

which verifies the form of the conjecture (10). The unknown coefficients must satisfy (where the solutions for h_ε^k and h can be read off (17) immediately, and where the solutions for h_θ and h_ε^u are derived through minor algebraic manipulations):

$$
\begin{aligned}
h_\theta &= \frac{\lambda}{\lambda + (\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u))^2} \equiv \mathcal{F}(h_\theta, h_\varepsilon^u) > 0, && (18) \\
h_\varepsilon^k &= \frac{\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} > 0, && (19) \\
h_\varepsilon^u &= \frac{\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + (\kappa + (\lambda/\kappa) \mathcal{S}(h_\theta, h_\varepsilon^u))^2} \equiv \mathcal{G}(h_\theta, h_\varepsilon^u) > 0, && (20) \\
h &= -\frac{(\lambda/\kappa)^2 x_0^* \mathcal{S}(h_\theta, h_\varepsilon^u)}{\lambda + \kappa^2 + \lambda \mathcal{S}(h_\theta, h_\varepsilon^u)} \lesseqgtr 0. && (21)
\end{aligned}
$$

Consider now the limiting case of full transparency, $\tau \to 1$. In this case, everything about the cost-push shock is revealed, and therefore, by (7), $\sigma_{\varepsilon^u}^2 = (1 - \tau) \sigma_\varepsilon^2 \to 0$. In consequence, $\mathcal{S}(h_\theta, h_\varepsilon^u) \to 1/h_\theta$, cf. (13). It then follows from (18) that $h_\theta \to 0$, and, thus, $\mathcal{S}(h_\theta, h_\varepsilon^u) \to \infty$. Examining (19), (20) and (21) then reveals that $h_\varepsilon^k \to 1/\kappa$, $h_\varepsilon^u \to 0$ and $h \to -(\lambda/\kappa^2) x_0^*$. Collecting this information, then provides the equilibrium solution for the output gap and inflation in period 1 as

$$
x_1|_{\tau \to 1} = -\left(\lambda/\kappa^2\right) x_0^* - (1/\kappa) \varepsilon, \qquad \pi_1|_{\tau \to 1} = (\lambda/\kappa) \theta. \qquad (22)
$$

Approaching full transparency, inflation expectations are extremely sensitive to the actions of the central bank, who is therefore induced to give inflation stabilization highest priority in policymaking and thus act in isolation of political pressures for a particular output target. As a result output becomes excessively unstable, and inflation excessively stable in comparison with the optimal balance, which is given in (9).

3. Concluding comments

This note shows that with forward-looking elements in inflation determination, the "excess sensitivity" of expectations with respect to policy actions — induced by transparency — *distorts* shock stabilization. The setting is one where transparency is about shocks known to the policymaker before policy actions are taken. The results parallel those of HJ, where transparency concerns shocks hitting the economy after policy decisions are made. Hence, whether transparency is "economic" or "operational," in the terminology of Geraats (2000), is inessential. Transparency of either form is a policy-distorting "straitjacket."

This is advantageous if the policymaker lacks low-inflation credibility and needs the "discipline of the market" in order not to pursue unduly expansive policies. It is, however, undesirable, if the policymaker *has* such credibility, and therefore does not need to be "disciplined," but instead needs to perform efficient macroeconomic stabilization without the restraints imposed by transparency.

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