News Management in Monetary Policy: When Central Banks Should Talk to the Government

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Abstract

Central banks are often considered to be better informed about the present or future state of the economy than the government. A conservative central bank has an incentive to exploit this asymmetry by strategically managing its information policy. Strategic news management will keep the government uncertain about the state of the economy and increase the central bank's leeway for conducting a conservative monetary policy. We show that withholding information from the government is an equilibrium. However, there are also well defined limits to strategic information policy as the central bank has to distort monetary policy to be in line with its news management. A simple extension of our findings is that, if the government on occasion learns about the bank's true information, it will then overrule the central bank's decision on monetary policy.

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1 Introduction*

While the issue of central bank independence has received a lot of attention in recent years, the interaction between governments and central banks has been less well explored. Most theoretical and empirical research focuses on the setup of an independent authority and its relation with the wage setting public.[1] An exception to the rule is Lohmann (1992), who develops a model of monetary policy with potential overruling by the government. The government and the central bank learn about the state of the economy at the same time. The bank then sets monetary policy and the government decides whether to overrule the central bank's decision. Overruling, however, will never emerge as the central bank can anticipate the government's reaction perfectly and can accommodate its wishes if necessary.

The standard result of 'no overruling in equilibrium' is at odds with the vast amount of evidence on conflicts, both small and large, between central banks and governments.[2] In what follows, we will show that, while the traditional informational assumptions are useful for explaining the creation of an independent monetary authority, they severely and unrealistically limit the policy space of the central bank. Changing the informational assumptions and permitting the bank to carry out a strategic information policy alters the outcome of the interaction. In particular, we show that the central bank may strategically withhold information from the government. A simple extension of our findings is that, if on occasion the government learns about the central bank's true information, it actually does overrule the central bank's decision on monetary policy in equilibrium.

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1 For the time-inconsistency problem see Kydland and Prescott (1977). For the argument in favor of an independent and conservative central bank see Barro and Gordon (1983) and Rogoff (1985). Walsh (1995) and Svensson (1997) make suggestions that may secure low inflation without introducing the bias towards higher output variation predicted by these models. Empirically the trade-off between central bank independence and output stabilization has yet to be pinned down [Eijffinger and De Haan (1996)].

2 An example for a small but visible conflict would be public criticism of monetary policy by the government. Havrilesky (1995) shows for the U.S. that such publicly expressed discontent is frequent and that the Fed tends to accommodate this criticism. Another type of visible but limited conflict are fiscal/monetary policy inconsistency. Frey and Schneider (1981) argue that the Bundesbank often accommodates the government's revealed preferences if this type of inconsistency occurs. See Cukierman (1992) and Maxfield (1997) for evidence on more strenuous conflicts that include overruling of the central bank, for instance, replacing the governor by the government.

Central banks are often considered to be better informed about the present or future state of the economy than the government.[3] As a matter of fact, one commonly quoted argument for an independent central bank is that legislators want a "highly informed third party (the central bank)" to help them monitor the government's economic policy [Maxfield (1997, p. 12)]. One reason for the central banks' superior information might be that they themselves produce many of the statistics relevant for the assessment of the economy or of the effectiveness of monetary policy. In Germany, for instance, the Bundesbank is the only source of current information about the activities of the important commercial banking sector [Bundesbank (1995)]. Moreover, central banks often have access to confidential information from bank supervisors [Peek, Rosengren, and Tootell (1998)]. There is also some co-operation between different central banks that may further enhance this informational advantage. In addition, central banks usually have both the incentives and the means to develop superior forecasting capacities. Their "staff is simply better at processing and interpreting information" [Romer and Romer (1996, p. 12)].[4] Again, this will render private or government sector forecasts of the economy inferior to those of the central bank.[5] Finally, even central bank independence, as such, can lead to asymmetric information in favor of the monetary authority. A government that wants to delegate monetary policy to an independent central bank, but at the same time sets out to monitor the central bank's information set perfectly, would certainly create a credibility problem for its intended policy. In fact, perfect accountability is generally regarded as a telltale sign of a lack of central bank autonomy [Eijffinger and De Haan (1996)]. Therefore, a certain amount of asymmetric information might be intrinsic to central bank independence.

This is not to claim that, in every instance, the central bank is better informed than the government, but rather that there will often be informational asymmetries that require a

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3 See, for instance, Canzoneri (1985), Goodfriend (1986), Cukierman (1992), and Romer and Romer (1997). More recent applications of the idea of private central bank information include Garfinkel and Oh (1995) and Schaling (1995). For a survey, see Prast (1996).

4 Another source of asymmetric information could be preferences of the central bank board which are only imperfectly observable due to new appointments. See Waller and Walsh (1996), Lohmann (1997), Berger and Woitek (1997), and Eijffinger, Hoeberichts, and Schaling (1998).

5 Romer and Romer (1996), Orphanides (1997), and Peek, Rosengren, and Tootell (1998) show empirically that the US Fed has significantly more information about future inflation than other forecasters.

central bank's decision either to forward this information to the government or to keep it private. Sometimes the very nature of the bank's information makes it private. The Bank of England, for instance, which aims at being as transparent as possible in its policy decisions, collects valuable information through a network or regional agents that "cannot be published not least because the Bank would not then be given much of the information to start with." [Vickers (1998, p. 7)]. But even if it were unconstrained in forwarding its information to the government, a conservative central bank might have an incentive to use its information advantage strategically. Consider the example of a central bank that holds exclusive information about an upcoming recession. It might pay for the central bank to withhold this information from the government. Withholding information keeps the government uncertain about the future state of the economy. We show that this uncertainty makes the government less willing to intervene in monetary policy, even when it suspects strategic news management by the central bank. Strategic news management is particularly important in information-sensitive institutional arrangements such as the inflation targeting procedures in Canada, New Zealand, Sweden, or the UK [cf. Svensson (1998)], but it will also have an impact in standard set-ups where independent monetary policy is combined with potential overruling.[6]

The result that a central bank can exploit its informational advantages to carry out a conservative monetary policy without facing government intervention is intuitively appealing. However, we also show that there are well defined limits to the central bank's strategic information policy. Withholding information from the government comes at a cost. The central bank has to conduct a monetary policy that is in line with its information policy. That is, it cannot conduct a policy that counteracts an upcoming economic shock and at the same time claim uncertainty about the future state of the economy. Hence the central bank has to weigh the benefits of increased room of maneuver against the costs of mimicking an uninformed player. We show that the costs of pretending to be uninformed decrease with the

6 Private information may also influence the relationship between the monetary authority and wage setters. As Cukierman and Meltzer (1986) show, information asymmetries may lead a central bank to choose a less efficient money control procedure when the public cannot discriminate between persistent preference shifts and transitory control errors. The reason is that withholding information creates additional leeway for surprise inflation when deemed necessary.

size of the expected shock. Another result is that the central bank is more likely to withhold information when the government is less conservative.

In what follows, we will set up a simple model that combines the relevant ingredients for a game of monetary policy with possible overruling by the government (Section 2). Section 3 and 4 will discuss the emerging equilibria under full information and under symmetric uncertainty. Monetary policy and news management under asymmetric information are discussed in Section 5. Section 6 extends the model to allow for overruling.

2 The Model

Consider an economy where output y is a function of the wages w (predetermined by the labor market), of the level of inflation π (to be generated by monetary policy), and nature choosing the state of the world s. For simplicity, we limit our attention to two possible states of the world. There are 'normal times' and recessions. A recession ($s = R$) occurs with probability p of reducing the economy's output by $z > 0$, while the economy is at its normal output level ($s = N$) with probability $1 - p$:

$$y = \begin{cases} \pi - w & \text{for } s = N \\ \pi - w - z & \text{for } s = R \end{cases} \tag{1}$$

We normalize the natural equilibrium level of output in normal times to zero.[7] The principal problem of the two players, the government g and the independent central bank cb, is the choice of π subject to (1) and to their institutional and informational constraints. The central bank sets the inflation rate by minimizing its loss function

$$L_{cb} = (y - y_o)^2 + \chi \cdot \pi^2 \ , \tag{2}$$

where $y_o > 0$ is its output bliss point and χ is the (predetermined) relative weight the bank puts on deviations of inflation from its target level set to 0. The government's loss function is

$$L_g = (y - y_o)^2 + \eta \cdot \pi^2 + \delta \cdot c \ . \tag{3}$$

[7] We include the influence of the labor market (w) and the normalization of output in normal times to zero to facilitate the comparison with the existing literature.

The government shares the central bank's targets for output and inflation but puts less weight on welfare losses generated by positive inflation rates ($0 < \eta < \chi < \infty$), i.e., the government is less inflation averse than the central bank. The welfare losses the government has to suffer depend on its choice of two alternative regimes which rule its relation with the central bank, the cases of overruling ($\delta = 1$) and no-overruling ($\delta = 0$). As long as the government refrains from intervening in monetary policy, the dummy variable δ is 0. Here the government passively suffers the losses incurred by the central bank's choice of π. Alternatively, in a case of overruling, that is, when the government intervenes in order to determine the inflation rate itself, δ becomes 1 and the government has to pay overruling costs c, with $0 < c < \infty$. The costs c could be the legislative and political effort necessary to overrule an independent central bank. For instance, the intervention costs will rise with the number of political agents involved in the legal changes necessary for overruling a (legally) independent central bank [Moser (1994)].[8] Thus the government's decision to overrule or tolerate the central bank's monetary policy depends on a trade off between the advantages of being able to set inflation according to its own preferences and the costs of such a conflict. However, it will also depend on the information the government has about the size of shock z.[9]

For the interaction of government and central bank we assume the time structure summarized in Figure 1. In stage 1, nature decides whether a recession will occur. The kind of information held by each player varies between a set of scenarios we will discuss below. Depending on the scenario, both players, neither of the players, or only one of them may receive information on the true state of the world before it becomes public knowledge at the payoff stage of the game. Subject to this information structure, the central bank chooses

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8 An alternative interpretation points to the popular backing for an institution like the Bundesbank which politicians would have to overcome in cases of conflict [Berger (1997)]. Here, the government would only have an indirect influence on the choice of intervention costs. For a similar view on the 1997 "Goldwar" between the Bundesbank and the German government see the *Economist* (1997, p. 15).

9 Our setup can be viewed as the reduced form of a model in which the government chooses both the central bank's preferences and its intervention costs in an initial stage of the game; see Lohmann (1992) for a model with symmetric information. However, because the government's basic motivation for delegating monetary authority remains unchanged by the introduction of private information for the central bank, we do not have to explicitly model this stage here. Since our focus is on the analysis of strategic information sharing within a given institutional setting rather than on its determination, this is a valid simplification. In a similar vein, we assumed that wages are set before the game starts.

inflation π in stage 2. In addition, since in some cases the central bank alone holds information about *z*, it also decides on sharing this information with the government. Then, at stage 3 of the game, the government decides whether to accept the central bank policy or to overrule the central bank and implement its own preferred monetary policy. Finally, at stage 4, *z* is revealed and payoffs are realized.

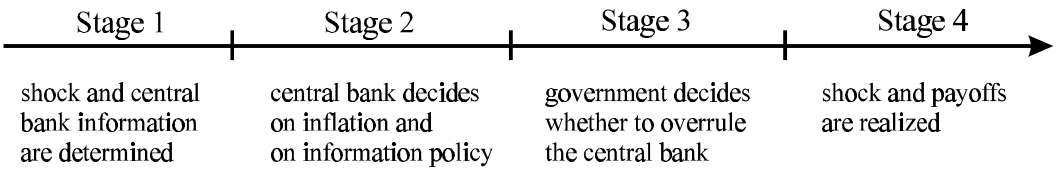

Figure 1

The interaction between the central bank and the government very much depends on the information each side has. We will first consider the *full information case*, where both the government and the central bank are completely informed about the state of the world (Section 3). A second scenario, the *no information case*, goes to the other extreme and assumes that neither player receives any information about the state of the world. All decisions in stages 2 and 3 of the game will be solely based on prior beliefs (Section 4). Third, building on the results derived under the previous two information scenarios, we introduce asymmetric information to allow for *strategic news management* (Section 5). With probability *q*, the central bank receives information about the state of the world (*N*, *R*), while the government remains uninformed about the true state of the world. If the central bank receives information it can decide whether to share this information with the government at stage 2 of the game. We assume that the central bank cannot lie about the kind of information it has received. The bank can retain its information, but it cannot claim that it has received a signal (even though it has not) or report misleading information (when it has). A justification for this assumption is that, in both cases, the central bank may be punished for misinforming the government when the state of the world becomes public knowledge at stage 4 and contradicts the central bank's message to the government.[10] As an extension, Section 6 will

[10] This verification process is similar to the one presented in Shin (1994). There is an inherent asymmetry as it is never possible to prove that another agent had information about some exogenous event. However, if someone

sketch the case of strategic information with information spillovers. This extension suffices to allow for government overruling in equilibrium.

3 The Full Information Case

In a first step we analyze the interaction of government and independent central bank in a perfect information set up. We assume that both government and central bank are perfectly informed about the true state of the world *s* when they make their decisions. Alternatively, we could presume that the central bank receives a signal about the true state of the world and always discloses this information honestly to the government.

Stage 3: The Government's Decision

If the government overrules the central bank ($\delta = 1$), it will set the inflation rate that minimizes its own loss function (3) taking into account (1):

$$\min_{\pi} L_g = (\pi - x_s)^2 + \eta \cdot \pi^2 + c \quad \text{with} \quad x_s = \begin{cases} x_N \equiv w + y_o & \text{for } s = N \\ x_R \equiv w + y_o + z & \text{for } s = R \end{cases}.$$

The optimal inflation rate is then given by

$$\frac{\partial L_g}{\partial \pi} = 0 \quad \Leftrightarrow \quad \pi_g = \frac{x_s}{1+\eta}.$$

However, intervening in monetary policy may or may not be optimal for the government. In the decision whether to overrule the monetary authority, the government compares the losses with and without intervention [$L_g(\delta = 1, \pi_g)$ and $L_g(\delta = 0, \pi_{cb})$, respectively]. Thus the government will not overrule the central bank iff

$$L_g(\delta = 0, \pi_{cb}) \le L_g(\delta = 1, \pi_g) \quad \Leftrightarrow \quad \pi_{cb} \ge \frac{x_s}{1+\eta} - \sqrt{\frac{c}{1+\eta}} \equiv \overline{\pi}_F. \tag{4}$$

The subscript *F* denotes the full information case. From (4) it is clear that there is a critical inflation value $\overline{\pi}_F$ below which the government will overrule the central bank because the

falsely claims to have information he may be proven wrong when the outcome contradicts his claims. This requires that information is precise and random errors are excluded.

central bank's tight monetary policy keeps output too low. The critical value depends negatively on the government's preferences for price stability (η), positively on the occurrence and extent of a recession (z which enters positively into x_S), and negatively on overruling costs (c). For inflation rates lower than $\overline{\pi}_F$, the government will always overrule the central bank and implement its preferred policy. Only for inflation rates above $\overline{\pi}_F$ will the government refrain from intervening in the central bank's monetary policy decisions. However, since there are positive costs of overruling the monetary authority ($c > 0$), the critical value is always below the government's own optimal inflation rate: $\overline{\pi}_F < \pi_g = x_S/(1+\eta)$.

Stage 2: Central Bank Policy

Without potential intervention from the government, the central bank would minimize its loss function

$$\min_{\pi} L_{cb} = (\pi - x_S)^2 + \chi \cdot \pi^2 .$$

Therefore, the first best inflation rate for the central bank is given by

$$\frac{\partial L_{cb}}{\partial \pi} = 0 \quad \Leftrightarrow \qquad \pi_{cb,F} = \frac{x_S}{1+\chi} .$$

However, if the optimal inflation rates for the government and the central bank differ significantly, i.e. if $\pi_{cb,F} < \overline{\pi}_F$, the government will overrule the central bank and impose a higher inflation rate. From equations (2) and (4), it is easy to see that the central bank is always better off avoiding the intervention instead of getting into conflict with the government. Because of the intervention costs, the central bank can choose an inflation rate that is lower than the government's first best policy by $\sqrt{c/(1+\eta)}$ in order to make the government indifferent between its two options. In other words, the central bank has to accommodate to the government's preference for higher inflation to some extent in order to avoid intervention. Hence, the central bank's best policy is

$$\pi^*_{cb,F} = \begin{cases} \pi_{cb,F} & \text{for } \pi_{cb,F} \geq \overline{\pi}_F \\ \overline{\pi}_F & \text{for } \pi_{cb,F} < \overline{\pi}_F \end{cases} . \qquad (5)$$

For economic downturns ($s = R$ and $z > 0$), this implies that the central bank can choose its preferred policy, if

$$\pi_{cb,F} \geq \overline{\pi}_F \qquad \Leftrightarrow \qquad z \leq \frac{1+\chi}{\chi-\eta} \cdot \sqrt{(1+\eta)\cdot c} - w - y_o \equiv \overline{z}_F \ . \tag{6}$$

For large shocks ($z > \overline{z}_F$), the central bank has to give way to the government's pressure and chooses $\overline{\pi}_F$. We assume that $\overline{z}_F > 0$. This implies that in normal times, that is, for $s = N$ and for minor recessions z, the central bank is not threatened by government intervention and can choose its first best policy. Proposition 1 summarizes the results.

Proposition 1 (Full Information). *Under full information, there is no overruling of the central bank in equilibrium. If threatened by government intervention, the central bank partially accommodates the government's policy preferences (Lohmann 1992).*

Figure 2 illustrates the proposition. The central bank's choice of inflation rates (the bold gray line) is shown as a function of the shock z. For all positive shocks, the central bank's optimal inflation rate is strictly below the government's preferred inflation rate (π_g).

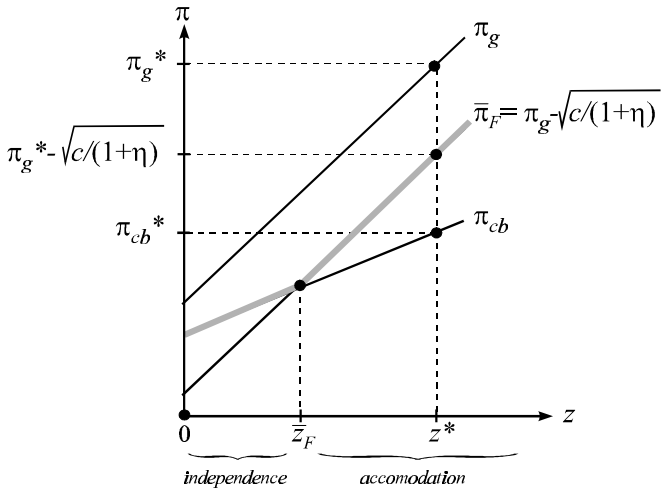

Figure 2

For small shocks $z \in [0, \overline{z}_F]$, however, intervention costs are too high to make it worthwhile for the government to intervene in monetary policy; the bank can realize its ideal inflation rate. For shocks above this threshold, the gap between the two inflationary target levels becomes large enough to make government intervention credible: the central bank will accommodate to an inflationary policy of $\overline{\pi}_F$. The reason is simply that for a shock like z^*

($z^* > \bar{z}_F$) the increase in inflation over the central bank's optimal (but unfeasible) response (π^*_{cb}) enforced by an overruling government (π^*_g) would be higher than the one under accommodation ($\pi^*_g - \sqrt{c/(1+\eta)}$). As a result, the government will never overrule the central bank in the full information equilibrium.

4 The No Information Case

In a second step, we analyze the opposite information structure of the model, in which both players, central bank and government, are uninformed about the true state of the world. In this case the players will minimize their expected losses based on their prior beliefs about the likelihood of each state of nature. We assume that they use the probabilities p and $1-p$, with $0 < p < 1$, for the occurrence of recessions and normal times, respectively.

The results under no information are a straightforward extension of the findings in the full information case (see Appendix 1). The government's threshold for overruling the central bank now becomes

$$\bar{\pi}_0 \equiv \frac{p \cdot x_R + (1-p) \cdot x_N}{1+\eta} - \sqrt{\frac{c}{1+\eta}} \ ,$$

where the subscript 0 marks variables that refer to the no (or zero) information scenario. As a consequence, the central bank will shift from a regime of independence to one of accommodation, if the size of the possible shock exceeds

$$\bar{z}_0 \equiv \frac{\bar{z}_F}{p} \ .$$

Proposition 2 compares the thresholds triggering accommodation under full information and uncertainty.

Proposition 2 (Uncertainty). *Under uncertainty the central bank's leeway in setting its ideal inflation rate increases compared to the full information case ($\bar{z}_0 > \bar{z}_F$).*

As the lack of information can be to the advantage of the monetary authority, the question of whether the central bank can exploit uncertainty strategically arises.

5 The Strategic Information Case

Having studied the two basic information variants, we now allow for strategic information policy. In this scenario, the government remains uninformed as in Section 4 but, with probability *q*, the central bank may receive an unbiased signal about the true state of the world. However, the central bank does not receive the signal for sure: $0 < q < 1$. With probability $(1-q)$, the central bank remains uninformed. The government cannot observe whether the central bank actually receives the signal or not. Therefore, the central bank can keep the information to itself and imitate an uninformed player.

This strategic information policy may be advantageous to a conservative central bank if such a policy allows an inflation lower than with an informed government. Obviously, such a benefit only accrues in situations where the central bank would otherwise have to yield to the pressure from a well informed government. In normal times ($s = N$), retaining information cannot be a beneficial strategy for the central bank as it can realize its first best monetary policy anyhow. Therefore, the strategic withholding of information only comes into play if the central bank's information signals an economic downturn ($s = R$).[11]

Whether the strategic withholding of information occurs in equilibrium does not only depend on the model's parameters, i.e. the magnitude of shock *z*, preferences η and χ, cost of overruling *c*, and probabilities *p* and *q*, it also depends on the government's expectation about the behavior of the central bank. Hence, there can be two fulfilled expectations equilibria in pure strategies.[12] First, the government expects the central bank to reveal all signals honestly, and the central bank is better off revealing all information than imitating an uninformed player. Second, the government expects the central bank to carry out a strategic information policy, and the central bank's payoffs are higher when the good signals ($s = N$) are revealed and bad signals ($s = R$) are kept secret. In the latter case, the central bank acts as if it has not received any signal. We will analyze the two potential equilibria in turn. Depending on the parameters of the model, both the honest revelation and the strategic information policy can

[11] If no signal is obtained by the central bank, no information can be transmitted to the government. There is also no strategy for credibly announcing that no signal was received.

[12] To simplify matters, we restrict ourselves to pure strategies.

be unique equilibria. However, there is also range of parameters where multiple equilibria are feasible.

5.1 Information Is Revealed

What is the government's rule for intervention if it expects the central bank to reveal information honestly? And what conditions have to be met for the central bank to actually choose a truthful information strategy given this expectation?

Stage 3: The Government's Decision

If the central bank announces a signal $s = R$, both players are perfectly informed. Remember that, in this section, we analyze the case where the government believes that the bank reveals all available information. Furthermore, all central bank signals are perfectly verifiable for the government. Consequently, the government's preferred policy would generate the inflation rate $\pi_g = x_R/(1+\eta)$ and the critical level for avoiding overruling is $\pi_{cb} \geq \overline{\pi}_F$ (see Section 3). If the central bank, however, claims that there is no signal, we are back to the no information case (Section 4). The government would like to see the inflation rate at the level $\pi_g = [p \cdot x_R + (1-p) \cdot x_N]/[1+\eta]$ but will not overrule the central bank as long as $\pi_{cb} \geq \overline{\pi}_0$.

Stage 2: Central Bank Policy

Given the government's expectations, the central bank can honestly reveal the information and play

$$\pi^*_{cb,F} = \begin{cases} \pi_{cb,F} & \text{for } z \leq \bar{z}_F \\ \overline{\pi}_F & \text{for } z > \bar{z}_F \end{cases}$$

[see conditions (5) and (6)] or it can mimic an uninformed player

$$\pi^*_{cb,0} = \begin{cases} \pi_{cb,0} & \text{for } z \leq \bar{z}_0 \\ \overline{\pi}_0 & \text{for } z > \bar{z}_0 \end{cases}$$

[see (A1.2) and (A1.3)]. Note that the announcement 'no information' also implies that the central bank has to adjust its monetary policy accordingly ($\pi_{cb,0}$ instead of $\pi_{cb,F}$). Even though the government cannot observe whether the central bank has received a signal, the monetary policy itself is observable. Therefore, the public announcement and the monetary policy have to correspond.

For truthful revelation of all information to be an equilibrium, the central bank must have no incentive to deviate from the forwarding strategy $\pi^*_{cb,F}$, i.e. $L_{cb}(\pi^*_{cb,F}) \leq L_{cb}(\pi^*_{cb,0})$. Whether this condition holds depends on the thresholds for government intervention under full or no information and the size of the expected shock. The basic question is whether a forwarding equilibrium can arise even though the central bank has an incentive to withhold information to lessen government pressure for a more expansionary policy. Three scenarios can arise.

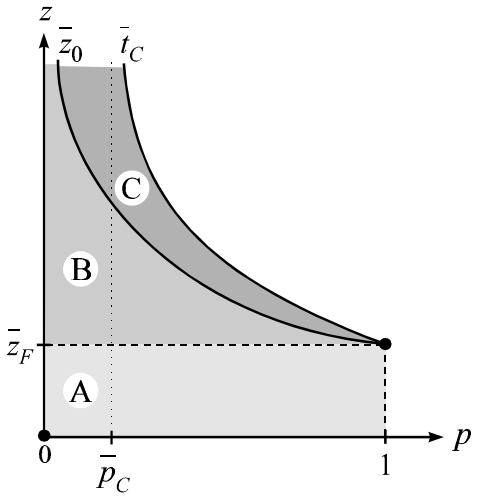

Figure 3

(A) $z \in [0, \bar{z}_F]$

If the shock is small enough ($z \in [0, \bar{z}_F]$), the central bank can carry out its ideal policy no matter whether it forwards or withholds its information. Under both strategies, the central bank is not constrained by a potential overruling by the government. Even with a truthful revelation of the signal *s* = *R*, the central bank can choose its preferred level of inflation. Hence, there is no reason to withhold any information and $L_{cb}(\pi_{c,F}) \leq L_c(\pi_{cb,0})$ holds for

sure. The outcome is illustrated in Figure 3. The probability *p* of an economic downturn is measured on the horizontal axis, and the magnitude of the shock is denoted on the vertical axis. Since the central bank's decision to reveal its information is independent of the probability of a recession, *p*, forwarding will be an equilibrium in the entire area A.

(B) $z \in (\bar{z}_F, \bar{z}_0]$

For intermediate shocks ($z \in (\bar{z}_F, \bar{z}_0]$), the central bank has to accommodate the government's wishes only if it decides to forward its information. In this case, it will have to adjust inflation to $\bar{\pi}_F$, which is above its first best policy. It can avoid accommodation by not forwarding its information about the upcoming recession to the government. In that case, however, it will also have to lower inflation to a rate that is consistent with its no-information announcement, i.e. $\pi_{cb,0}$, but lower than its first best choice. We show in Appendix 2 that, if the central bank is only *moderately conservative* in the sense that $2 \cdot (1+\eta) > (1+\chi)$, i.e. the two players do not differ too much with respect to their inflation aversion, the central bank is always better off forwarding information:

$$L_{cb}(\bar{\pi}_F) \leq L_{cb}(\pi_{cb,0}) \text{ for } z \in (\bar{z}_F, \bar{z}_0]. \quad (7)$$

Therefore, forwarding will always be an equilibrium in this range of shocks. Proposition 3 sums up this result.

Proposition 3 (Costs of Mimicking). *Suppose the government expects truthful revelation and the shock is in the intermediate range* $z \in (\bar{z}_F, \bar{z}_0]$. *Then a moderate central bank is better off by forwarding its information to the government and increasing the inflation rate accordingly, even though it would remain unconstrained when withholding information.*

The result seems somewhat counterintuitive. Why should the central bank ever be better off by forwarding its private information, if this leads to a restriction of its policy space? Both strategies – forwarding and withholding – are associated with costs for the central bank. On the one hand, forwarding information forces the bank to accommodate the government by choosing a higher rate of inflation. On the other, claiming that there is no private information (withholding strategy), requires the central bank to mimic an uninformed player and, thus, it has to pick an inflation rate in accordance with the expected, and not the actual, value of the

shock. Since $p < 1$, this policy will always require inflation to be set too low even from the perspective of a conservative central bank. In other words, the central bank faces a second best choice: it will have to decide between an inflation rate which is too low given the size of the recession and an inflation rate too high given its conservative preferences. As Proposition 3 shows, a moderate central bank will always decide in favor of revealing its information and accepting an inflation too high from its perspective as long as the size of the recession is not too large. Again we can illustrate the equilibrium outcome in Figure 3. Condition (7) is always fulfilled in the entire area B, which is above $\bar{z}_F$ and below the $\bar{z}_0$ line.

(C) $z \in (\bar{z}_0, \infty)$

Finally, for very large shocks ($z \in (\bar{z}_0, \infty)$) the central bank has no choice but to adjust to the government's pressure independent of its information policy. So we have to check whether truthful revelation can also be an equilibrium for large shocks. While the bank's basic decision is still to weigh the costs of forwarding information against the costs of mimicking an uninformed player, the latter are now less severe. For smaller z ($z < \bar{z}_0$), withholding meant that the central bank, when not forwarding, had to pick inflation unrestricted and thus in accordance with its no-information reaction function. Being trapped by its own conservatism, it preferred to forward information rather than withhold it. With larger z [$z \in (\bar{z}_0, \infty)$] the central bank will actually be constrained by government pressure when withholding information. This may be to the advantage of the central bank because yielding to the government allows the bank to choose a rate of inflation that is higher than the rate implied by its reaction function and, therefore, closer to its first best in terms of the upcoming recession. Therefore, forwarding may no longer be an equilibrium depending on the size of the shock.

To derive the relevant critical threshold for the existence of the forwarding equilibrium, remember that with truthful revelation of signal $s = R$, the central bank targets the government's full information threshold level of

$$\bar{\pi}_F = \frac{x_R}{1+\eta} - \sqrt{\frac{c}{1+\eta}}\,.$$

Under the alternative strategy of information withholding, the central bank has to play

$$\bar{\pi}_0 = \frac{p \cdot x_R + (1-p) \cdot x_N}{1+\eta} - \sqrt{\frac{c}{1+\eta}}.$$

It is easy to see that $\bar{\pi}_F \geq \bar{\pi}_0$. This illustrates once more the incentives the central bank has to deviate from the full information strategy as the alternative strategy allows lower inflation rates. For the full information strategy to be an equilibrium, the condition

$$L_{cb}(\bar{\pi}_F) \leq L_{cb}(\bar{\pi}_0)$$

has to hold. Substituting for x_R and x_N, making use of $\bar{z}_F$ and rearranging the term results in

$$z \cdot \left[\tfrac{1}{2} \cdot (1+p) \cdot (1+\chi) - (1+\eta)\right] \cdot \frac{1}{\chi - \eta} \leq \bar{z}_F. \tag{8}$$

The condition for a full information equilibrium depends on the sign of the term in brackets. By defining a new threshold variable

$$\bar{t}_C(p) \equiv \frac{2 \cdot \bar{z}_F \cdot (\chi - \eta)}{p \cdot (1+\chi) - [(2 \cdot (1+\eta) - (1+\chi)]}, \tag{9}$$

we can rewrite the equilibrium condition as

$$L_{cb}(\bar{p}_F) \leq L_{cb}(\bar{p}_0) \quad \Leftrightarrow \quad \begin{cases} z > 0 & \text{for } p \leq \bar{p}_C \\ z \leq \bar{t}_C(p) & \text{for } p > \bar{p}_C \end{cases} \tag{10}$$

where $\bar{p}_C \equiv \frac{2 \cdot (1+\eta) - (1+\chi)}{1+\chi}$.

The term in brackets in (8) is negative for all $p < \bar{p}_C$ and the equilibrium condition holds for all z.[13] In Figure 3, this case is illustrated in the area to the left of $\bar{p}_C$. For $p > \bar{p}_C$, the term in brackets is positive, and the incentive to deviate from the full information strategy depends on the magnitude of the shock. For shocks that are not too large [$z \leq \bar{t}_C(p)$], the central bank has an incentive to stick to the full information equilibrium (below $\bar{t}_C$) even though forwarding the recession forecast will force it to accommodate the government's preferences for higher inflation.[14] The reason is the same as before: the costs of mimicking an

[13] Recall that $\bar{t}_C$ becomes negative for $p < \bar{p}_C$.

[14] As we are analyzing shocks in the range of $\bar{z}_0 < z$, the above condition can only be relevant if $t_C(p) \geq \bar{z}_0$. This requirement is always met when the central bank is moderately conservative, i.e. if $2 \cdot (1+\eta) > (1+\chi)$ holds.

uninformed player are still higher than the costs associated with revealing the signal. Area C marks the equilibrium condition in Figure 3.

We can now summarize the forwarding equilibrium in the strategic information case across all three ranges of shocks.

Proposition 4 (Forwarding). *Suppose the government expects truthful revelation and the expected shock is not too large i.e.* $z \leq t_C(p)$ *for* $p > \overline{p}_C$ *or* $z > 0$ *for* $p \leq \overline{p}_C$. *Then a moderately conservative central bank is always better off forwarding its information to the government.*

In Figure 3, these conditions are fulfilled in areas A, B, and C.

5.2 Information Is Withheld to Create Uncertainty

Knowing the conditions for the forwarding equilibrium, where all information is truthfully revealed to the government, we can now turn to the withholding equilibrium. Here, the government expects the central bank to withhold information strategically. And the central bank's best strategy is indeed to announce that no signal was received when a recession is known to be ahead. Recall that we consider just two states of the world, *N* and *R*, and that the occurrence of a recession is perfectly verifiable in the last stage of the game.

Stage 3: The Government's Decision

When the central bank claims that it has not received any signal, the government cannot distinguish whether this claim is true or whether there is a signal indicating a recession. Given the central bank's announcement, the government will form *a posteriori* beliefs about the state of the economy. The central bank is fully informed with probability *q*, and the probability of a recession is *p*. The two events are assumed to be stochastically independent. If the central bank claims to have no information, the government calculates the following *a posteriori* beliefs:

$$\text{Prob}(\text{recession}\,|\,\text{'no info'}) = \frac{(1-q)\cdot p + q\cdot p}{(1-q)+q\cdot p} = \frac{p}{(1-q)+q\cdot p} \equiv \hat{p}$$

and

$$\text{Prob}(\text{normal}\,|\,\text{'no info'}) = \frac{(1-q)\cdot(1-p)}{(1-q)+q\cdot p}$$

With probability *p*, there is a recession; the government, however, cannot distinguish whether the central bank is informed (1-*q*) or uninformed (*q*). With probability (1-*p*), the economy is on its normal growth path but the central bank may indeed receive no signal - this happens with probability (1-*q*).[15] The denominator in the above expressions is simply the probability that the central bank claims to have no information: this will occur if either the central bank has not received a signal itself [(1-*q*)·1] or (by assumption) if it has received a signal indicating a recession [*q*·*p*].

Before we move on to show how the government will make use of these probabilities to calculate its overruling strategy in the case of information withholding, let us briefly consider the implications of the assumption that the central bank's information on the state of the economy is uncertain ($q < 1$). Assume for a moment that the private information of the central bank is certain ($q = 1$). In this case, a straightforward application of the full-disclosure or unraveling theorem [Grossman (1981), Milgrom (1981)] suggests that the information asymmetry is eliminated by the actual interaction of the monetary and the fiscal authorities. The central bank's news management is limited to forwarding or withholding its information. Clearly then, incentives for the bank are to withhold any "bad" news and forward information only in the case of "good" news. Knowing that the central bank's own information is certain, however, the government will correctly translate any failure to disclose information on the side of the bank into "bad" news. As a consequence, the central bank's private information is fully revealed in equilibrium. To see this, simply set $q = 1$ in the *a posteriori* beliefs above. This implies that $\hat{p}$, the conditional probability of a recession in the case of no information forwarding by the central bank, is 1. Thus, when the central bank reports "no information", but the government is sure that its opponent has received information in the first place, the government correctly concludes that there will be a recession. However, even the most

[15] As in the previous section, we consider pure strategies only. Hence, the central bank cannot randomize between keeping or forwarding information.

sophisticated central bank's information on the state of the economy will contain some residual uncertainty. If the information obtained by the central bank falls short of being certain, the full-disclosure result breaks down.[16]

What is the government's overruling policy when it assumes that the central bank is withholding information? Based on its *a posteriori* beliefs, the government can calculate its expected loss function with and without intervention. If the government overrules the central bank, it will set the inflation rate that minimizes its own expected loss function given the new probabilities

$$\min_{\pi} \; EL_g = \hat{p} \cdot \left[(\pi - x_R)^2 + \eta \cdot \pi^2 \right] + (1 - \hat{p}) \cdot \left[(\pi - x_N)^2 + \eta \cdot \pi^2 \right] + c.$$

Therefore, the optimal inflation rate is given by

$$\frac{\partial EL_g}{\partial \pi} = 0 \qquad \Leftrightarrow \qquad \pi_g = \frac{\hat{p} \cdot x_R + (1 - \hat{p}) \cdot x_N}{1 + \eta}$$

Comparing the expected losses with and without intervention, we can calculate a critical level for the central bank's monetary policy. Like in the no information case, the government will not overrule the central bank iff

$$EL_g(\delta = 0, \pi_c) \leq EL_g(\delta = 1, \pi_g) \;\Leftrightarrow\; \pi_c \geq \frac{\hat{p} \cdot x_R + (1 - \hat{p}) \cdot x_N}{1 + \eta} - \sqrt{\frac{c}{1 + \eta}} \equiv \hat{\pi}_{SI}$$

We use the ^-sign and the subscript *SI* to mark variables that refer to the strategic information (or information withholding) scenario.

Stage 2: Central Bank Policy

In order to determine when a strategic information policy will be an equilibrium, we have to compare the central bank's payoffs under this strategy with the payoffs from a full information policy. Withholding of information is an equilibrium if the government anticipates this behavior and the central bank still has no incentive to deviate to a full

16 As already argued by Okuno-Fujiwara, Postlewaite and Suzumura, (1990) and pointed out by Shin (1994, p. 59), "the unraveling result is extremely sensitive to any uncertainty concerning what the informed party actually knows." For an earlier argument in the same vein see Milgrom and Roberts (1986). Bolton and Dewatripont (1997) provide a survey of the literature.

information policy. For a full information policy, the central bank's optimal inflation rates are the same as in Sections 3 and 5.1:

$$\pi^{*}_{cb,F} = \begin{cases} \pi_{cb,F} & \text{for } z \le \bar{z}_F \\ \bar{\pi}_F & \text{for } z > \bar{z}_F \end{cases}$$

If the central bank, however, mimics an uninformed player, it has to take into account the fact that the government anticipates the strategic behavior and puts a probability $\hat{p}$ on the occurrence of a recession. Mimicking an uninformed player, the central bank has to set an inflation rate of $\pi_{cb,0} = [p \cdot x_R + (1-p) \cdot x_N] / [1+\chi]$ but can now only do so as long as $\pi_{cb,0} \ge \hat{\pi}_{SI}$. As before, we reformulate this condition in terms of the magnitude of the shock *z*:

$$z \le \frac{\bar{z}_F \cdot (\chi - \eta)}{(1+\chi) \cdot \hat{p} - (1+\eta) \cdot p} \equiv \hat{z}_{SI} .$$

Below the critical value $\hat{z}_{SI}$, the central bank imitates an uninformed player by targeting an inflation rate of $\pi_{cb,0}$. For larger shocks, the central bank adjusts to the government's wish for higher inflation, which takes into account the *posteriori* beliefs, and will choose $\hat{\pi}_{SI}$. Hence, for mimicking an uninformed player, the central bank has to carry out a monetary policy according to

$$\pi^{*}_{cb,SI} = \begin{cases} \pi_{cb,0} & \text{for } z \le \hat{z}_{SI} \\ \hat{\pi}_{SI} & \text{for } z > \hat{z}_{SI} \end{cases} .$$

Strategic information policy is an equilibrium if the central bank's losses are less than (or the same as) with a full information policy, i.e. if $L_{cb}(\pi^{*}_{cb,SI}) \le L_{cb}(\pi^{*}_{cb,F})$. Whether the withholding strategy is an equilibrium depends on the constraints faced by the central bank under each of the two strategies. In Appendix 3, we show that withholding can never be an equilibrium if the central bank is moderately conservative and the shock is below the adjustment threshold $\hat{z}_{SI}$.[17] This result essentially extends Proposition 3 in the previous section. There we argued that, when the government expects truthful revelation, withholding is unattractive for the central bank as long as mimicking an uninformed player involves having to choose an inflation rate in accordance with the bank's no-information reaction

[17] The properties of the critical value $\hat{z}_{SI}$ are discussed in Appendix 4.

function. For a withholding equilibrium to exist, the expected shock will have to be sufficiently large to reduce the central bank's choice to one between adjusting to government pressure under one or the other information strategy. Appendix 3 shows that this result also carries over to the case where the government suspects strategic withholding of information.

Now we turn to the case of larger shocks [$z > \hat{z}_{SI}$] where the central bank is restricted under both information strategies, that is where it has to adjust to government pressure regardless of its news management. For a withholding equilibrium to exist we need

$$L_{cb}(\hat{\pi}_{SI}) \le L_{cb}(\bar{\pi}_F) \quad \Leftrightarrow \quad (1+\chi)\cdot\left[\bar{\pi}_F^2 - \hat{\pi}_{SI}^2\right] - 2\cdot x_R \cdot \left[\bar{\pi}_F - \hat{\pi}_{SI}\right] \ge 0$$

for some $z > \hat{z}_{SI}$. It is easy to see that $\bar{\pi}_F > \hat{\pi}_{SI}$ holds. Dividing by $(\bar{\pi}_F - \hat{\pi}_{SI})$ and rearranging the expression yields

$$z \cdot \frac{\hat{p}\cdot(1+\chi) - [2\cdot(1+\eta) - (1+\chi)]}{2\cdot(\chi-\eta)} \ge \bar{z}_F .$$

As $2\cdot(1+\eta) > (1+\chi)$ for moderate central banks, this condition will only be fulfilled for

$$z \ge \hat{t}_C \qquad \text{and} \qquad p > \hat{p}_C \tag{11}$$

where $\hat{t}_C = \dfrac{2\cdot\bar{z}_F\cdot(\chi-\eta)}{\hat{p}\cdot(1+\chi) - [2\cdot(1+\eta) - (1+\chi)]}$

and $\hat{p}_C = -\dfrac{[(1+\chi) - 2\cdot(1+\eta)]\cdot(1-q)}{(1+\chi) - q\cdot[2\cdot(1+\eta) - (1+\chi)]}$.

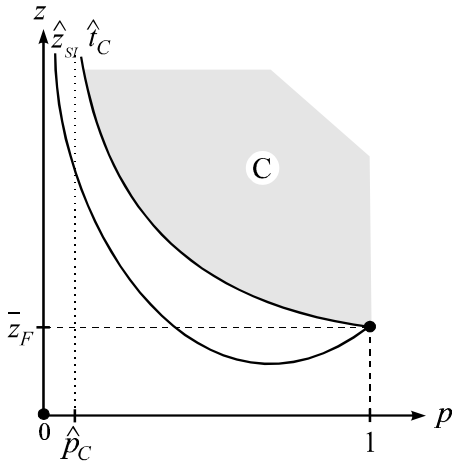

Figure 4

In Figure 4, these requirements are illustrated in area C to the right of the $\hat{t}_C$-curve. Recall that our analysis is confined to shocks larger than $\hat{z}_{SI}$. Therefore, as a last step in our analysis, we have to prove that $\hat{z}_{SI} \leq \hat{t}_C$ holds in the relevant range. Setting $\hat{z}_{SI} = \hat{t}_C$ shows that there is only one common point in the positive quadrant ($p = 1, z = \bar{z}_F$).[18] Taking the derivatives of $\hat{t}_C$ and $\hat{z}_{SI}$ with respect to *p*, it turns out that $\partial \hat{z}_{SI} / \partial p\big|_{p=1} > \partial \hat{t}_C / \partial p\big|_{p=1}$. Hence, to the left of $p = 1$, the $\hat{t}_C$-curve is strictly above the $\hat{z}_{SI}$-curve.[19] Now we can summarize the emergence of a withholding equilibrium.

Proposition 5 (Withholding). *Suppose the government expects information withholding and the expected shock is sufficiently large, i.e.* $z \geq \hat{t}_C$ *for* $p > \hat{p}_C$. *Then even a moderately conservative central bank is better of withholding its information from the government.*

In other words, if the economic shocks are sufficiently large and their occurrence is sufficiently likely, the government may expect the central bank to withhold relevant information. Then, the central bank's best response is indeed to withhold all signals that indicate a recession.

5.3 Equilibria

We can conclude our discussion of the central bank's strategic information policy by putting together the pieces from the previous analysis. The equilibrium outcomes are illustrated in Figure 5. Below the $\bar{t}_C$-curve, forwarding all information is an equilibrium. The government expects the central bank to reveal all signals honestly. And the central bank's best response to these expectations is to transmit even signals that indicate a recession. Above the $\hat{t}_C$-curve, the government believes that the central bank withholds signals about a recession and the central bank does so. The withholding equilibrium is played. Proposition 6 sums up.

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18 The other point the two curves have in common is $p = \{[(1+\chi) - 2 \cdot (1+\eta)]/[2 \cdot (1+\eta)]\} \cdot \{(1-q)/q\}$. As this value is negative for a moderately conservative central bank, it is irrelevant for the analysis.

19 For the argument, we have implicitly assumed that the central bank is always constrained when forwarding its information. However, there might be cases with $\bar{z}_F \geq \hat{z}_{SI}$, where the central bank is not constrained by choosing the full information strategy and achieves its first best inflation rate (the area below $\bar{z}_F$ and above $\hat{z}_{SI}$ in Figure 4; see Appendix 4). But this only makes the forwarding strategy more profitable. Since forwarding was advantageous even when it led to the central bank being constrained by government pressure, it surely is attractive when the central bank can chose its first best rate of inflation after forwarding.

Proposition 6 (Equilibria). *Allowing the central bank to use its information strategically can lead to two (fulfilled expectation) equilibria: forwarding and withholding of the central bank's information. There is a set of economic downturns (p, z) where both strategies can be equilibrium outcomes* $[\hat{t}_C \leq z \leq \bar{t}_C]$.[20]

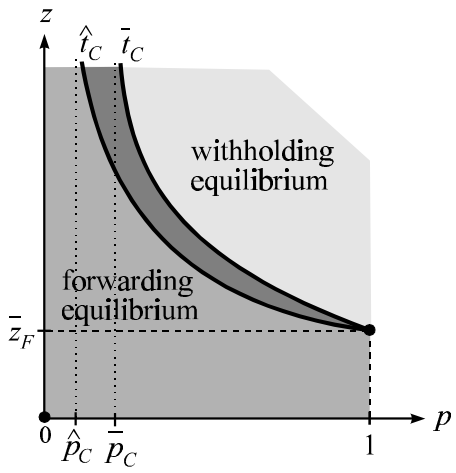

Figure 5

The intuition for the cases with multiple equilibria is straightforward. Recall that withholding information means that the central bank has to mimic an uninformed player which is costly because the central bank has to choose a too low inflation rate compared to its first best rate. Among other things, the costs of mimicking depend on the regime of government expectation. A government that expects withholding puts higher *a posteriori* probability on the occurrence of a recession if no information has been forwarded from the central bank [$\hat{p} > p$]. This raises the threshold for government intervention and, thus, brings the central bank closer to its desired inflation rate. Involuntarily, a pessimistic government expectation invites the central bank to play a game of strategic news management.

6 The Case for Overruling

A simple extension of our findings is that, if the government does on occasion learn about the true state of the economy, it actually overrules the central bank's decision on monetary policy. If the central bank acts as if it has received no information about an economic downturn and the government knows better, the government will enforce a higher inflation rate in order to

[20] $\hat{t}_C \leq \bar{t}_C$ will always be true for $p \leq 1$ and $q \geq 0$.

accommodate large economic shocks. To see this, it will not be necessary to integrate this mechanism for overruling explicitly into our model. A simple thought experiment will do the trick: keep all assumptions the same as in Section 5 but suppose the government learns about the true state of the economy with a probability ε close to zero. Then the central bank will not change its monetary policy as long as the punishment is finite. Recall that in the present model the central bank is punished by a discrete jump in the inflation rate once it is overruled.[21] There is no incentive for the central bank to deviate from its policy of strategic information. Even if the probability for the government being informed increases, the central bank will continue its strategic information policy, and from time to time it will be overruled in equilibrium by the government.

When will overruling occur? Two straightforward implications of our model are worth mentioning. First, from what we learned about the central bank's incentive to withhold information from the government, we know that overruling will be more likely when the expected size of recessions is large. This seems to be broadly in line with the discretionary way especially slow growing economies deal with their central banks [Eijffinger and de Haan (1996)]. A second implication is that withholding and overruling are less likely to occur under conservative governments. Increasing η, the government's degree of conservatism, shifts both $\bar{t}_C$ and $\hat{t}_C$ in Figure 4 to the right [cf. (9) and (11)]. This increases the range of expected shocks that is compatible with a forwarding equilibrium and reduces the likelihood of overruling. The scarce empirical evidence available seems to suggests that conflicts with central banks occur more often with non-conservative governments than with conservative ones.[22]

A fruitful extension of the model would be to endogenize the probability of information spillovers ε. Consider an investment technology that would allow the government

[21] In the given set up, the punishment is simply a constant. In a more elaborate model, overruling costs and, thus, ultimately the bank's punishment could be endogenous depending on, for instance, the change in the inflation rate associated with the overruling of the central bank.

[22] See, for instance, the time path of the continuous indices for conflicts between the Bundesbank and the German government provided by Berger and Schneider (1998) or the account of the quarrels between the social-democratic governments and the Bundesbank in the early 1980s by Marsh (1992). Havrilesky (1995) finds that pressures on US monetary policy were higher when administrations were more expansionary.

at some cost to buy into a lottery that will give access to the central bank's information with probability $\varepsilon > 0$. The government invests in the linkages with the central bank to counteract the bank's power due to superior access to information. The scenarios of Sections 3 and 5 can be seen as special cases of this endogenous information process. With information costs close to zero, the government will be as well informed as the central bank. With infinite information costs, the case of strategic information arises as the government has to rely on the central bank forwarding its information. In line with models of opportunistic government behavior, it could be conjectured that the government will be more eager to possess such information when its re-election is at stake [Downs (1957), Nordhaus (1975)]. Other things being equal, this would lead us to expect more conflicts in pre-election periods than in other periods.

7 Conclusion

The literature on central banking so far has provided explanations of why we observe independent central banks and why central banks are usually more conservative than governments. However, little is known about the interaction between the two institutions. Bridging the gap, we focus on the central bank's strategic news management with respect to the government when the government can overrule but the central bank has private information on the state of the economy. If the information held by the central bank is certain, the bank's news management is reduced to full disclosure. However, if the central bank's information status is uncertain, the full-disclosure result breaks down even when the other informational assumptions are retained. Thus, a central bank that is better informed than the government can exploit this asymmetry to carry out a low inflation policy without facing government intervention. But we also point to the limits of central bank news management. Withholding information from the government is not without costs, as the central bank has to conduct monetary policy in line with its information policy. That is, it cannot take a policy stance that counteracts an upcoming recession and simultaneously claim uncertainty about the future state of the economy. Therefore the central bank will weigh the benefits of an increased

room of maneuver against the costs of mimicking an uninformed player. We show that two equilibria in pure strategies might exist in this informational framework. First, the government expects truthful revelation of all signals received by the central bank, and the central bank indeed forwards all information to the government. Second, the government expects the central bank to withhold signals of recessions, and the central bank indeed only forwards information pointing towards a favorable development of the economy. Withholding is more likely to be an equilibrium, when the looming recession is severe or occurs with a high probability. A simple extension of our findings is that, if the government on occasion learns about the central bank's true information, it actually does overrule the central bank's decision on monetary policy. This might help to explain some real-world conflicts between central banks and governments.

Appendix 1: No Information Case

Stage 3: The Government's Decision
If the government overruled the central bank ($\delta = 1$), it would set the inflation rate so as to minimize its own expected loss function

$$\min_{\pi} EL_g = p \cdot \left[(\pi - x_R)^2 + \eta \cdot \pi^2\right] + (1-p) \cdot \left[(\pi - x_N)^2 + \eta \cdot \pi^2\right] + c \, .$$

The subscripts *R* and *N* denote the state of nature. The optimal inflation rate is given by

$$\frac{\partial EL_g}{\partial \pi} = 0 \qquad \Leftrightarrow \qquad \pi_g = \frac{p \cdot x_R + (1-p) \cdot x_N}{1+\eta} \, . \tag{A1.1}$$

The numerator in the second term of equation (A1.1) is simply the expected state of the economy. In deciding whether to overrule the central bank, the government again compares the expected losses with intervention, $EL_g(\delta = 1, \pi_g)$, with those without intervention:

$$EL_g(\delta = 0, \pi_{cb}) = p \cdot \left[(\pi_{cb} - x_R)^2 + \eta \cdot \pi_{cb}^2\right] + (1-p) \cdot \left[(\pi_{cb} - x_N)^2 + \eta \cdot \pi_{cb}^2\right] .$$

The government will not overrule the central bank iff

$$EL_g(\delta = 0, \pi_{cb}) \le EL_g(\delta = 1, \pi_g) \;\Leftrightarrow \pi_{cb} \ge \frac{p \cdot x_R + (1-p) \cdot x_N}{1+\eta} - \sqrt{\frac{c}{1+\eta}} \equiv \overline{\pi}_0$$

Stage 2: Central Bank Policy
Without overruling, the central bank would minimize its expected loss function

$$\min_{\pi} EL_{cb} = p \cdot \left[(\pi - x_R)^2 + \chi \cdot \pi^2\right] + (1-p) \cdot \left[(\pi - x_N)^2 + \chi \cdot \pi^2\right]$$

Therefore, the first best inflation rate for the central bank is given by

$$\frac{\partial EL_{cb}}{\partial \pi} = 0 \qquad \Leftrightarrow \qquad \pi_{cb,0} = \frac{p \cdot x_R + (1-p) \cdot x_N}{1+\chi}$$

As in the full information case, the government will overrule the central bank and impose a higher inflation rate if the optimal inflation rates differ significantly. To avoid this intervention, the central bank's monetary policy has to generate an inflation rate above the critical level $\overline{\pi}_0$ for overruling. Hence, the central bank's best policy is

$$\pi^*_{cb,0} = \begin{cases} \pi_{cb,0} & \text{for } \pi_{cb,0} \ge \overline{\pi}_0 \\ \overline{\pi}_0 & \text{for } \pi_{cb,0} < \overline{\pi}_0 \end{cases} . \tag{A1.2}$$

The central bank can set its ideal inflation rate, if

$$\pi_{cb,0} \ge \overline{\pi}_0 \qquad \Leftrightarrow \qquad z \le \frac{\overline{z}_F}{p} \equiv \overline{z}_0 \, . \tag{A1.3}$$

Appendix 2: Forwarding Equilibrium

For a forwarding equilibrium,

$$L_{cb}(\overline{\pi}_F) \le L_{cb}(\pi_{cb,0}) \tag{A2.1}$$

has to hold. In case (B), the central bank is constrained when forwarding information, because

$\pi_F = x_R/(1+\eta) - \sqrt{c}/(1+\eta) > \pi_{cb,F} = x_R/(1+\chi)$. Since $x_R > x_N$, we also know that $\pi_{cb,F} = x_R/(1+\chi) > \pi_{cb,0} = [p \cdot x_R + (1-p) \cdot x_N]/(1+\chi)$. Hence, $\pi_F > \pi_{cb,0}$. Therefore, condition (A2.1) can be rewritten as

$$(1+\chi) \cdot [\bar{\pi}_F + \pi_{cb,0}] - 2 \cdot x_R \leq 0. \tag{A2.2}$$

Substituting for the inflation rates and using the definition for x_R and $\bar{z}_F$ yields

$$z \cdot \left[1 - (1-p) \cdot \frac{1+\eta}{\chi - \eta}\right] \leq \bar{z}_F .$$

If the expression in brackets is negative, i.e. if $p < (2 \cdot (1+\eta) - (1+\chi))/(1+\eta) \equiv \bar{p}_B$, the equilibrium condition holds for all z as $z, \bar{z}_F > 0$. If, however, the expression is positive, the shock has to be below the threshold value

$$z \leq (\bar{z}_F \cdot (\chi - \eta))/(p \cdot (1+\eta) - [2 \cdot (1+\eta) - (1+\chi)]) \equiv \bar{t}_B(p).$$

We can summarize the equilibrium condition as

$$L_{cb}(\bar{\pi}_F) \leq L_{cb}(\pi_{cb,0}) \quad \Leftrightarrow \quad \begin{cases} z > 0 & \text{for } p \leq \bar{p}_B \\ z \leq \bar{t}_B(p) & \text{for } p > \bar{p}_B \end{cases}, \tag{A2.3}$$

$$\text{with } \bar{p}_B \equiv \frac{2 \cdot (1+\eta) - (1+\chi)}{1+\eta} \text{ and } \bar{t}_B(p) \equiv \frac{\bar{z}_F \cdot (\chi - \eta)}{p \cdot (1+\eta) - [2 \cdot (1+\eta) - (1+\chi)]}.$$

It is straightforward to show that the inequality $L_{cb}(\bar{\pi}_F) \leq L_{cb}(\pi_{cb,0})$ holds in the relevant range. First, z is positive by assumption.[23] Second, for $p > \bar{p}_B$ the inequality $z \leq \bar{t}_B(p)$ is always fulfilled, because $z \leq \bar{z}_0$ and $\bar{z}_0 < \bar{t}_B(p)$ if the central bank is moderately conservative [$2 \cdot (1+\eta) > (1+\chi)$] and $p < 1$.[24] It follows that we can rewrite the equilibrium condition (A2.3) as

$$L_{cb}(\bar{\pi}_F) \leq L_{cb}(\pi_{cb,0}) \text{ for } z \in (\bar{z}_F, \bar{z}_0],$$

which is expression (7) in the text.

Appendix 3: No Withholding Equilibria for $z < \hat{z}_{SI}$

For analytical convenience, we will derive the result in two steps, depending on whether the central bank will be constrained when forwarding information.

(A) $z \in [0, \bar{z}_F]$

Here, revealing the signal $s = R$, the central bank can choose its first best monetary policy. Hence, there is no reason to withhold information. In this range of economic shocks, $L_{cb}(\pi_{cb,SI}) > L_{cb}(\pi_{cb,F})$ will always hold and the strategic information policy can never be an equilibrium.

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[23] Note that the condition in the upper line actually reads: $z > \bar{t}_B$ for $p \leq \bar{p}_B$. However, as $\bar{t}_B$ becomes negative for $p < \bar{p}_B$ and z is positive by assumption, the condition $z > \bar{t}_B$ is always fulfilled. Therefore, we can write $z > 0$.

[24] If the central bank takes a tougher stance on inflation ($2 \cdot (1+\eta) < (1+\chi)$), $\bar{t}_B(p)$ becomes a binding constraint for the forwarding equilibrium in (B). The general outcome does not change with this assumption.

(B) $z \in (\bar{z}_F, \hat{z}_{SI}]$

For shocks in the range $z \in (\bar{z}_F, \hat{z}_{SI}]$, the central bank has to adjust its policy to $\bar{\pi}_F$ if the true information is revealed to the government. The central bank is not constrained, however, if it mimics an uninformed player ($\pi_{cb,0}$). For the strategic information policy to be an equilibrium, $L_{cb}(\pi_{cb,0}) \leq L_{cb}(\pi_F)$ has to hold. As $\pi_F > \pi_{cb,0}$ (see Appendix 2), we can rewrite this condition as

$$(1+\chi) \cdot [\bar{\pi}_F + \pi_{cb,0}] - 2 \cdot x_R \geq 0 .$$

The term on the left hand side is the same as in condition (A2.2), only the sign has changed. Hence, an equilibrium condition for the strategic information policy is given by

$$L_{cb}(\pi_{cb,0}) < L_{cb}(\bar{\pi}_F) \quad \Leftrightarrow \qquad z > \bar{t}_B(p) \text{ for } p > \bar{p}_B . \tag{A3.1}$$

For values $p \leq \bar{p}_B$, the condition $z \leq \bar{t}_B(p)$ can never be fulfilled in the relevant range of positive shocks. In the case of the moderately conservative central bank with $2 \cdot (1+\eta) > (1+\chi)$, it is easy to check that $\hat{z}_{SI} \leq t_B$ holds in the relevant range ($p > \bar{p}_B$). Recall that the condition (A3.1) was derived under the assumption of $z \leq \hat{z}_{SI}$. Hence, if the central bank is only moderately conservative, it never pays for it to hide a signal that hints at an economic downturn, i.e. there is no withholding equilibrium in this case.[25]

Appendix 4: Properties of $\hat{z}_{SI}$

(I) The expression $\hat{z}_{SI} = [\bar{z}_F \cdot (\chi - \eta)] / [(1+\chi) \cdot \hat{p} - (1+\eta) \cdot p]$ is convex in p with a minimum at $p_{\min} = -(1-q)/q + \sqrt{(1+\chi)/(1+\eta)} \cdot \sqrt{1-q}/q$. As the probability of a recession is defined on the interval $p \in (0,1)$ only, there is an interior minimum for $(1-q) < (1+\eta)/(1+\chi)$. In the drawing of Figure 5, it is assumed that this inequality holds.

(II) It is also useful to compare the two values $\hat{z}_{SI}$ and $\bar{t}_B$. For the case of the moderately conservative central bank with $2 \cdot (1+\eta) > (1+\chi)$, it is easy to check that $\hat{z}_{SI} \leq \bar{t}_B$ holds in the relevant range ($p > \bar{p}_B$). This is the case of Figure 5. For the more conservative central bank with $2 \cdot (1+\eta) < (1+\chi)$, we would get:

$$\hat{z}_{SI} \geq \bar{t}_B \text{ for } (1-q) > 2 \cdot (1+\eta)/(1+\chi) \text{ and}$$

$$\hat{z}_{SI} \gtrless \bar{t}_B \Leftrightarrow p \lessgtr \frac{[(1+\chi) - 2 \cdot (1+\eta)] \cdot (1-q)}{2 \cdot (1+\eta) \cdot q} \text{ for } (1-q) < 2 \cdot (1+\eta)/(1+\chi) .$$

(III) On the relation of $\bar{z}_F$ and $\hat{z}_{SI}$ note that $\bar{z}_F < \hat{z}_{SI}$ holds whenever the central bank is moderately conservative and its information is sufficiently uncertain to fulfil the condition $q < 1/(1+p)$.[26]

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[25] For a more conservative central bank, it pays to withhold information for the range of shocks defined by (B) as long as $p < \{[(1+\chi) - 2 \cdot (1+\eta)] \cdot (1-q)\} / [2 \cdot (1+\eta) \cdot q]$.

[26] $\bar{z}_F < \hat{z}_{SI}$ cannot be taken for granted. However, it will not be necessary to consider the reverse relationship explicitly. For $\bar{z}_F \geq \hat{z}_{SI}$, the central bank is not constrained by choosing the full information strategy and achieves its first best inflation rate. Therefore, in the case where $q>1/(1+p)$, we would simply be back to case (A) where the full information strategy always dominates.

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