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RESEARCH ARTICLE

Fiscal-monetary Interactions: The Effect of Fiscal Restraint and Public Monitoring on Central Bank Credibility

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Abstract This paper offers new insights into the interactions between private agents, the government, and a central bank, and their effect on the outcomes of monetary policy. In a simple game theoretic model we show that, unless there is public monitoring, impatient governments will be tempted to override or outmaneuver the central bank and create surprise inflation to boost output. This both undermines the government's reputation for sound fiscal policies and reduces the central bank's credibility. The result is not only higher and more volatile inflation but also sub-optimal output. More importantly, it is also shown that this is likely to occur even if the central banker is fully independent and the government is always patient. In contrast, if the public monitors sufficiently carefully, the central bank is never overridden and monetary policy can be credible even under an impatient government. We derive the general conditions under which each scenario occurs and then relate them to the developments in central banking over the past two decades, most notably to the trends towards greater independence, explicit inflation targeting, clearer communication and transparency. Interestingly, transparency is shown to reduce the variability of both inflation and output (by reducing the monitoring cost and making public monitoring more likely) which is in contrast to the usual transparency literature with a single policymaker which supposes a transparency-volatility trade-off.

Keywords Monetary-fiscal interaction · Reputation · Credibility · Overriding · Monitoring · Central bank independence · Inflation targeting · Transparency

JEL Classification E52 · E61 · C72

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1 Introduction

The recent literature has seen a growth of interest in the interactions between fiscal and monetary policies, after a long period in which each was analysed in isolation as if there were only one policymaker able to act alone and in his/her own self-interest. The idea that policies might interact is an old one, going back to Tinbergen (1954), Mundell (1962) and Cooper (1969). But those studies, as do those of the more recent vintage (for example Dixit and Lambertini (2003), Persson et al. (2006), Hughes Hallett (2005)), always treated the interactions in terms of the impacts of the policies themselves. Thus the focus has therefore been the spillover effects between policies, and their capacity to damage the achievements of other policy makers and other policy instruments.[1] This paper takes a deliberately different tack, and examines how actions or indiscipline by one policymaker can undermine the credibility and hence effectiveness of another: the impact of spillovers between reputations in other words.

Our paper starts from this earlier stream of literature, but connects it with the research on the effects of reputation initiated by Barro and Gordon (1983) and Backus and Driffill (1985a). These papers and the subsequent literature examined the evolution of *monetary policy reputation* and its effects on credibility and economic performance. The main policy recommendation from this literature has been to suggest delegating monetary policy to an independent and conservative central banker (in the spirit of Rogoff (1985)).

However, McCallum (1995) has warned that this may not solve the credibility problem since the government may still 'override' the independent central banker; that is interfere directly either by firing the central banker as in Lohmann (1992), or temporarily overruling him as in Hughes Hallett and Libich (2006a) by offsetting the conservative monetary policies with expansionary fiscal policies.

Bridging the two streams of thought we explicitly address McCallum's concerns by examining the effect of the *government's (fiscal) reputation* on monetary policy credibility and outcomes. Another novel ingredient is to give the behaviour of the public, who are allowed to 'monitor' the policymakers in this paper, a key role in the analysis. In this context, we find that McCallum's concerns were justified by showing that even if the central banker is (1) fully independent, (2) fully conservative, and (3) has a reputation that is perfect—inferior inflation and output outcomes may still occur.

Framework and intuition The basic structure of our non-cooperative game is similar to Barro and Gordon (1983) but it has three players as in Hughes Hallett and Weymark (2002). We also adopts some features from Rogoff (1985)—an optimal degree of conservatism; from Lohmann (1992)—the possibility of overriding of this delegation; and the Faust and Svensson (2001) idea that policy credibility may vary. We also include Backus and Driffill's (1985b) incomplete information about the

[1] The difference, however, is that this second generation of interaction papers contains the possibility that the policymakers may face conflicts in their ability to commit to their objectives or announced policies, potentially undermining their reputation for consistency and discipline, over and above any conflicts that may exist between the direct effects of those policies.

government types and reputations, the Feige and Pearce (1976) formulation of economically rational expectations, and Imperato's (2002) observation that public monitoring may be costly.[2]

Unlike the government that has an over-ambitions output target, the central banker is optimally conservative in the Rogoff (1985) sense. The banker has some (potentially full) independence from the government (denoted CBI). There are two types of government. The *weak* (impatient) type of government has a temptation to 'override' the central banker (i.e. temporarily suppress or interfere with) the central banker's job (degree of CBI). This may lead to an output gain through surprise inflation but it deteriorates the government's reputation (and hence future outcomes for which reason the strong/patient type is not tempted to override). The problem is that the rational public cannot observe the government's type (and its interference) in real time unless in 'monitors'—pays a fee for a signal that reveals the government's type.

Findings and policy implications Our first proposition combines the results of Rogoff (1985) and the comments of McCallum (1995). It shows that, regardless of public monitoring, CBI reduces inflation but only if it is not overridden. However, an interesting qualification is that CBI actually increases credibility even if it is overridden (Proposition 3).

The analysis then shows that, if the public does not monitor, monetary policy lacks credibility (Proposition 5) and that credibility in this case is an increasing function of the government's reputation (Proposition 6). The economy's average inflation is above the target (Proposition 2) and output is never at the potential level (Proposition 5). Furthermore, both inflation and output are now more variable (Proposition 8). All these results are a consequence of the interactions between an imperfect fiscal reputation and the *possibility* of the government overriding the central bank.

In contrast however, public monitoring is shown to discourage even the impatient type of government from interfering with the central bank's independence. Monitoring therefore leads to superior inflation and output outcomes through a reduction in the probability of the central banker being overridden (Propositions 4 and 7) and through the resulting increase in the credibility of monetary policy.

In the light of these results, we need to show under what circumstances the public will find it optimal to monitor. Policy transparency (TR) turns out to be the key determinant. This refers to *both* the transparency of government and central bank policies; *and* to both types of policy transparency: 'economic' TR (publishing models, data, forecasts) and 'goal' TR (explicitness of objectives/targets in the legislation), a distinction which is due to Geraats (2002). Since TR reduces the public's monitoring cost, it enlarges the parameter space of the public's optimal monitoring (Proposition 9) and hence produces socially superior outcomes (Propositions 10 and 11).

This implies that the two policymakers can, by encouraging monitoring and reducing its cost, and by increasing the transparency of their own decision making, increase the credibility and discipline in their policies. This improves the utility of all

[2] In which case, it may be rational for the public not to monitor at all (Demertzis and Hughes Hallett (2006)).

players involved. The rest of the paper is structured as follows. Section 2 describes the model and Section 3 presents the results. Section 4 examines a number of related extensions and robustness. Section 5 summarizes and concludes.

2 The model

Our framework assumes three players in the policy game: the public, p, the government, g, and the central bank, b. They are rational, have common information sets and know their rivals to be equally rational. The economy itself is summarized by a Lucas supply relationship

$$x_t = \omega\left(\pi_t - \pi_t^e\right) + \varepsilon_t \tag{1}$$

where $\omega > 0$, x is the output gap (the difference between actual and potential output), π is inflation, π^e is expected inflation, ε denotes a supply shock (with zero mean), and t denotes discrete time. Players' discount factors are δ_b, δ_g, and δ_p (we will refer to those with $\delta=1$ as patient and those with $\delta<1$ as impatient). Their one-period utility functions are the following

$$u_t^i = -\left(\pi_t - \overline{\pi}\right)^2 - \beta^i x_t^2 + \lambda^i x_t \tag{2}$$

$$u_t^p = -\left(\pi_t - \pi_t^e\right)^2 - c\left(\pi_t - \overline{\pi}\right)^2 - m_t M_t \tag{3}$$

where $i=\{g,b\}$, $\overline{\pi}$ is the socially optimal low inflation level (an explicit or implicit target), $M=\{0,1\}$ denotes the degree of the public's monitoring, and $m\geq 0$, $c\geq 0$ refer to the monitoring, and inflation costs, respectively. The non-negative parameters β, λ represent the policymaker's priorities for stable inflation, stable output, and high output relative to stable and low inflation. Following the conventions of this literature (see Faust and Svensson (2001)), we assume $\lambda^g > \lambda^b = 0$.

The intuition behind the players' preferences is standard with one innovation.[3] The public's utility function formalizes the concept of 'economically rational expectations' (Feige and Pearce (1976)) in which information updating is the result of a cost/benefit analysis performed by the agents.[4] As is usual in this literature we assume that the central bank is capable of controlling inflation perfectly.

Definition 1 Central bank independence, CBI=[0,1], refers to the capacity of the central bank to pursue its own objectives (targets).

Following Hughes Hallett and Weymark (2005), we assume CBI can be represented by an index defined on the unit interval.[5] In order to express more

[3] It has been shown that aversion to the output gap and inflation can be, under reasonable assumptions, derived from micro-foundations: see Woodford (2003) for a standard treatment.

[4] Equation (3) implies that the public faces a trade-off between minimizing the expectational error and the monitoring cost necessary to reach that goal. This is also in the spirit of models of rational inattention (e.g. Sims (2003) and Reis (2006)).

[5] We make no distinction between goal and instrument CBI, as elaborated by Debelle and Fischer (1994) here. For an explicit modelling of that aspect of the problem, see Hughes Hallett and Libich (2006b).

precisely who actually sets monetary policy in practice, we merge the two players as follows.

Definition 2 The monetary policymaker, m, is a pseudo player whose preferences are an average of the central banker's and the government's weighted by CBI, i.e. $u_t^m = \text{CBI}u_t^b + (1 - \text{CBI})u_t^g$.

Combining this with Eq. 2 implies

$$u_t^m = -(\pi_t - \overline{\pi})^2 - CBI\left(\beta^b - \beta^g\right)x_t^2 + \lambda^g(1 - CBI)x_t \tag{4}$$

A long-run perspective In Libich (2006) we show that, under sufficiently small shocks, the public's updating information will be independent of the shocks. Therefore we simplify our analysis at this point, and sharpen its focus, by making the economy deterministic. To do that we set $\varepsilon_t = 0, \forall t$.[6] It then follows that we can set $\beta^b = \beta^g = 0$.[7] Further, to keep the intuition of the behaviour of our public analogous to the standard rational expectation specification, we will set c=0. This does not affect the nature of our results: see e.g. Backus and Driffill (1985b)).

2.1 Uncertainty

It is apparent that the our framework now nests the classic Barro and Gordon (1983) model as a special case with $CBI_t = m_t = c_t = 0$, $\forall t$. This section now introduces the different types of government, and also the concepts of reputation, overriding and monitoring.

Definition 3 Overriding, R=1, refers to the government's temporary (one period) suppression of the central banker and hence of the degree of CBI.

We find it realistic to model overriding as a temporary interference with the central bankers decisions rather than a permanent dismissal of the central banker since the latter (the case considered in Lohmann (1992)) has never actually been observed in the industrial countries. Overriding, R_t=1, therefore leads to the government, rather than the central bank, setting inflation in period t. That in turn implies CBI_t=0 in period t.

We further assume that overriding has no *explicit* cost to the government and it cannot be *directly* observed by the public in the period in which it occurs. Following the seminal work on reputation by Backus and Driffill (1985b), we assume that there are two types of government, strong and weak, T={S,W}. Unlike their paper however, our government types differ in their discounting of the future.

Definition 4 The strong type of the government, g^s, is patient; whereas the weak type, g^W, is impatient.

[6] An important reason for disregarding the effect of shocks is to keep the uncertainty in game behaviour clearly separated from uncertainty in the economy's responses: see Section 2.2. Furthermore, focusing on the long-run or trend outcomes of the game is consistent with the fact that monitoring is a relatively long-run decision.

[7] Barro and Gordon (1983) use the same simplification despite shocks being present in their model.

This implies that $\delta_g^S = 1$; and for simplicity we will set $\delta_g^W = 0$.[8] We denote the probability of g^S by θ=[0,1] which is fixed throughout. While we assume that the public knows the discount factor, and hence incentives facing each type of government, the public can only *directly* observe the type with a one-period lag, i.e. g_{t-1}^T at t. Therefore, in every period the public has to make an assessment of g_t^T before setting inflation expectations.

Definition 5 The government's reputation is defined as the probability, $\theta_t^e = [0, 1]$, as perceived by the public, that the government is the strong (patient) type in period t: $g_t^T = g^S$.

The cases of $\theta_t^e = 1$ and $\theta_t^e < 1$ will be called *perfect* and *imperfect* reputation, respectively.[9] Past realizations of g^T, according to which the public updates θ_t^e, are assumed to be costlessly available. Under the assumption that the public updates by Bayes rule, or has a punishment scheme such as in Barro and Gordon (1983), each overriding decision can now be shown to lead to a 'punishment' by the public: a reduction in reputation, θ_{t+1}^e, which increases π_{t+1}^e and decreases output x_{t+1} (and quite possibly in the subsequent periods as well). Examples where that happens will be found in Barro and Gordon (1983), Green and Porter (1984) and Al-Nowaihi and Levine (1994).

It is apparent that there exist reasonable circumstances under which the public's punishment in terms of lost reputation is *sufficiently* large or long to discourage the *patient* type g^S from overriding.[10] Therefore, we leave the evolution of θ_t^e unmodeled and simply assume that a sufficiently large punishment mechanism applies here.[11] It then follows directly that a patient government, g^S, is *never* tempted to override; that is, $R_t^*\left(g^S\right) = 0, \forall t, M$.

This general approach has two advantages. First, our results will be general and may be applied to a wide class of specific punishment/updating mechanisms that could be studied as special cases. Second, our attention is restricted to Markov perfect equilibria—which is what most of the current literature has done (see e.g. Clarida et al. (1999)).

Importantly, we assume that the public is *not* constrained to θ_t^e forever, but has the option of monitoring in each period.

Definition 6 Monitoring, M=1, refers to the public's acquiring real-time information about the government's type.

[8] In terms of the other players' discounting, it will become apparent that the values of δ_p and δ_b do not affect our results in any way (Libich 2007).

[9] As an alternative to this interpretation of a direct interference, government reputation may also be interpreted as 'fiscal reputation' since interfering with CBI will typically come from countervailing from fiscal pressures as in the second generation interaction models discussed in the introduction and analysed by Dixit and Lambertini (2003).

[10] As a limiting example we can think of a trigger strategy scenario under which an overriding leads to loss of the government's reputation forever.

[11] We have considered several reputation updating scenarios but found that they did not add any new insights.

Specifically, M_t=1 will denote the purchase of a 100% informative signal of g_t^T before the actions in period t are made (whereas in the case of not-monitoring, M_t=0, the public's prior information does not change). In either case the government is assumed to *observe* the value of M_t in period t prior to making a move, which we believe to be realistic since the signal is being 'purchased' from that government's behaviour.

The monitoring cost will be defined, as elsewhere in the literature, as a function of two variables: (1) the degree of informativeness of the signal and (2) the degree of difficulty of obtaining that signal.

Definition 7 Transparency, TR≥0, refers to the amount of relevant information which is costlessly available to the public.

This definition includes both economic transparency (publishing information on shocks, models, forecasts etc) and goal transparency (making the objectives/targets more explicit). Furthermore, it relates to the policies of both players since all this information may help the public predict the type of the government and hence the incentives for overriding (either ex-ante or ex-post). Therefore, we postulate the monitoring cost as a decreasing function of TR: $m = f(TR)$ where $f'(.) > 0, \forall TR$. which is consistent with Faust and Svensson (2001), Imperato (2002), and Bernanke (2003). Specifically, we suppose

$$m_t = \frac{\mu}{1 + \mathrm{TR}_t} \tag{5}$$

Definition 8 Monetary policy credibility, $C \leq 0$, refers to the degree with which the public expects the optimal inflation level (target) to be achieved.

Here we follow Faust and Svensson (2001) and postulate

$$C_t = -\left|\overline{\pi} - \pi_t^e\right| \tag{6}$$

Thus the further expectations are away from their implicit or explicit target, the lower is the policymaker's credibility. Consequently C_t=0 is the case of *perfect* credibility. But a policy will lack credibility if C_t<0.

2.2 Time line

We can now summarize the sequence of steps needed to solve our policy game (Fig. 1 presents the extensive form).

1. The public updates θ_t^e by observing g_{t-1}^T.
2. There is a move of nature—a realization of the government type, $T_t = \{S, W\}$. This is a random draw given θ.
3. Unable to observe g_t^T, the public chooses from the monitoring set, $M_t = \{0,1\}$.
4. Observing the value of M_t chosen, the government chooses whether to override: $R_t = \{0,1\}$.
5. Inflation, π_t, is then set by either the central banker (in the case of R_t=0) or by the government (if R_t=1).

6. Being unable to observe π_t, and able to either able to observe g_t^T (if M_t=1) or unable to observe it (if M_t=0), the public forms inflation expectations. Note that the latter is reflected in Fig. 1 by the larger information set.
7. The pay-offs of period t are realized.

3 Results

This section reports the implications of this model of policy making.

Proposition 1 *CBI decreases average inflation unless it is overridden.*

Proof Denoting an equilibrium outcome by a star throughout, we need to show that if $R_t \neq 1$ then $\pi_t^* = f(\text{CBI})$, where $f'(.)<0$, $\forall t$, CBI. Solving backwards, using Eq. 4 and realizing that R_t=1 leads to CBI_t=0, the time-consistent inflation rate is

$$\pi_t^* = \overline{\pi} + \frac{\omega\lambda^g}{2}[1 - CBI(1 - R_t)] \tag{7}$$

which, by inspection, proves the claim. This result is similar to that reported by Rogoff (1985), but with the qualification made by McCallum (1995) included. Note that, with the exception of CBI=1 and R_t=0, we have $\pi_t^* > \overline{\pi}$ which is the usual time-inconsistency or inflation bias result in Kydland and Prescott (1977).

Proposition 2 *Equilibrium inflation is on target only if the central banker is* (1) *a fully independent and* (2) *non-overridden.*

Proof By inspection of Eq. 7. These two are the conditions that provide controllability in the classic Tinbergen (1954) sense. The second condition again revives McCallum's concern that central bank independence may be insufficient for

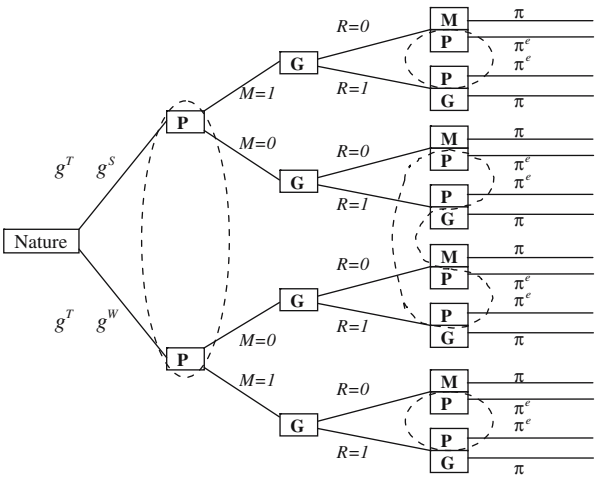

Fig. 1 Extensive form of the policy game

achieving optimal inflation outcomes. However, in contrast to McCallum, the following result shows that the danger of overriding does not fully eliminate the CBI's desirable effect.

Proposition 3 *If the public does not monitor, CBI always increases credibility, even if the central bank is overridden.*

Proof The proposition claims that, if M_t=0, then $C_t^* = f(CBI)$, with $f'(.) > 0$, $\forall t$, *CBI*,*R*. As overriding is not observable without monitoring, the public forms an expectation of it, R_t^e, and sets inflation expectations accordingly

$$\left(\pi_t^e\right)^* = \pi_t^* = \overline{\pi} + \frac{\omega\lambda^g}{} 2\left[1 - \mathrm{CBI}\left(1 - R_t^e\right)\right] \tag{8}$$

Using Eq. 8 with 6 yields

$$C_t^* = -\left|\frac{\omega\lambda^g}{2}\left[1 - \mathrm{CBI}(1 - R_t^e)\right]\right| \tag{9}$$

But, under non-monitoring, R_t^e cannot be a function of R_t which completes the proof.

Proposition 4 *If the public does not monitor, then the weak (impatient) type of government always overrides the central bank.*

Proof We need to show that if M_t=0, then $R_t^*(g^W) = 1$, $\forall t$, *CBI*. Now use Eq. 2 with Eqs. 7–8, treating R_t^e as exogenous, and disregard future periods (since $\delta_g^W = 0$) to obtain

$$\frac{\partial u^{g^W}}{\partial R} = \frac{(\lambda^g\omega)^2}{2}\left\{1 - \mathrm{CBI}[1 - \mathrm{CBI}(1 - R_t)]\right\} \tag{10}$$

The right hand side of this expression is positive which proves the claim.

Proposition 5 *If the public does not monitor and the government's reputation is imperfect, the economy never operates at potential output regardless of the type—specifically, in all non-overridden periods the economy is in a contraction. Furthermore, monetary policy lacks credibility even if the government is always strong (never impatient) and the central banker is fully independent.*

Proof A strong government never overrides the central banker due to reputational considerations, $R_t^*\left(g^S\right) = 0$, $\forall t$, *M*. In contrast, the weak type was shown in Proposition 4 to always override the banker under non-monitoring. The public will utilize this information and will set

$$\left(R_t^e\right)^* = 1 - \theta_t^e \tag{11}$$

in Eq. 8. Combining Eqs. 1, 7, 8, and 11 it follows that, under R_t=0 and R_t=1, respectively, we have the following output gaps in equilibrium

$$x_t^* = -\frac{\omega^2\lambda^g}{2}\left(1-\theta_t^e\right)\mathrm{CBI} < 0 \; and \; x_t^* = \frac{\omega^2\lambda^g}{2}\theta_t^e\mathrm{CBI} < 0 \tag{12}$$

which completes the proof. The fact that credibility may be imperfect under CBI<1, and that this then leads to below potential output is perhaps unsurprising. However, the fact that this will occur even under CBI=1, i.e. even under a fully independent and conservative central banker, is worth noting. Furthermore, this will continue to be the case even if θ=1, i.e. when the government is never weak.

Proposition 6 *If the public does not monitor, a deterioration in the government's reputation leads to a decrease in the monetary policy's credibility and to a loss of output for all ∀CBI> 0.*

Proof Equation 11 directly implies, in combination with Eq. 8, that for all values of R_t we have

$$C_t^* = -\left|\frac{\omega\lambda^g}{2}\left(1-\mathrm{CBI}\theta_t^e\right)\right| \tag{13}$$

which shows the first claim. The second claim follows from Eq. 12—x_t^* is increasing in θ_t^e for all ∀R, CBI>0.

Proposition 7 *If the public monitors, the central bank is never overridden and potential output results throughout.*

Proof We need to show that if M_t=1 then $R_t^* = 0$ and $x_t^* = 0, \forall \mathrm{CBI}, g_t^T$. Under M_t= 1 the public knows the true g_t^T, which implies it has full information about the opponents' preferences and can thus perfectly anticipate overriding, $\left(R_t^e\right)^* = R_t$. Using this constraint with Eqs. 2, 7 and 8 yields

$$\frac{\partial u^{g^W}}{\partial R} = -\frac{\lambda^g\omega\mathrm{CBI}}{2}\left[1-\mathrm{CBI}(1-R_t)\right] < 0 \tag{14}$$

That implies $R_t^* = 0, \forall g^T$. The public therefore sets $\left(R_t^e\right)^* = 0$ leading to $x_t^* = 0$ from Eq. 1 which completes the proof. We therefore conclude that monitoring discourages even a weak government from overriding the central bank since it eliminates the possibility of an inflation surprise and hence any output gains.

Corollary 1 *If the public monitors, the two types of government are observationally equivalent.*

In other words, if the public monitors, the analysis of different government types, as in Backus and Driffill (1985b) for example, may not matter. However, if the

public does not realize this, then the government's perceived reputation may be better than its true value, $\theta^e > \theta$.

These results show that caution should be exercised in concluding, on the basis that the central bank has not been overridden, that the government is strong or patient and therefore has no temptation to interfere and cause surprise inflation.

Proposition 8 *The public's monitoring:* (1) *increases monetary policy credibility* ($\forall \theta_t^e \in [0,1)$), (2) *decreases the level of inflation* ($\forall \theta_t^e \in [0,1), \mathrm{CBI} \in (0,1]$)*, and* (3) *decreases the variability of both inflation and output* ($\forall \theta \in (0,1)$).

Proof In terms of (1) Proposition 7 showed that if M_t=1 then $R_t^* = 0$ and $\left(R_t^e\right)^* = R_t$ which implies the following credibility index:

$$C_t^* = \left| -\frac{\omega \lambda^g}{2}(1 - \mathrm{CBI}) \right| \tag{15}$$

Comparing this expression with Eq. 13 proves the first claim.

In terms of (2) we have shown that under M_t=1 the central bank is never overridden (Proposition 7); and that, under M_t=0 and θ<1, the central bank is overridden in *some* periods (whenever $g_t^T = g_t^W$, see Proposition 4). Combining these results with the fact the level of inflation is increasing in R_t (unless CBI=0, see Eq. 7) proves the second claim.

In terms of part (3), under θ>0 overriding does not happen in *all* periods—the government is sometimes strong and does not override the banker, and sometimes not. This leads to fluctuating levels of inflation and output. Combining that with Proposition 7, that under M_t=1 the central bank is never overridden (which implies stable inflation and output), completes the proof.[12]

This proposition therefore suggests that the recent increases in credibility at the world's central banks are partly due to the improved outcomes achieved, partly due to monitoring itself, and partly due to the induced effect of greater monitoring on those outcomes.

Proposition 9 *The public will always monitor if the following three conditions hold:* (1) *the government's reputation is imperfect,* (2) *the central banker has some positive degree of independence, and* (3) *the (maximal) monitoring cost* μ *is sufficiently small.*

Proof We need to show that for all CBI>0, g_t^T and $m(\mu) < \overline{m}(\overline{\mu})$ (where $\overline{\mu} > 0$ is some threshold value derived below), it is true that if $\theta_t^e < 1$ then $M_t^* = 1$. For the public to find it optimal to monitor it is required that $u_t^p(M_t = 0) \leq u_t^p(M_t = 1)$. Substituting all of the above results into Eq. 3 yields

$$\theta_t^e\left[-\frac{\lambda^g \omega}{2}\left(1-\theta_t^e\right)\mathrm{CBI}\right] + \left(1-\theta_t^e\right)\left(\frac{\lambda^g \omega}{2}\theta_t^e \mathrm{CBI}\right) - \frac{\lambda^g \omega}{2}\left(1-\theta_t^e \mathrm{CBI}\right)$$
$$\leq -\mu - \frac{\lambda^g \omega}{2}(1 - \mathrm{CBI}) \tag{16}$$

[12] Under reasonable circumstances, among others, $\theta_t^e = \theta_t$, monitoring also increases the level of output.

And after rearranging implies

$$\mu \leq \overline{\mu} = \frac{\omega\lambda^g}{2}\left(1-\theta_t^e\right)(1+\mathrm{TR})\mathrm{CBI} \tag{17}$$

Equation 17 makes clear that if $\theta_t^e < 1$ (condition 1) and CBI>0 (condition 2), then there exists $0 < m(\mu) \leq \overline{m}(\overline{\mu})$ (condition 3) such that Eq. 16 is satisfied. Thus, for a sufficiently small monitoring cost the public's trade-off is resolved in favour of minimizing the expectational error by costly (but not too costly) monitoring.

Corollary 2 *Under sufficiently large monitoring cost,* $\mu > \overline{\mu}$ *, where* $\overline{\mu} = \frac{\omega\lambda^g}{2}(1+TR)$*, the public never monitors,* $M_t^* = 0, \forall t, \theta, \theta^e, \mathrm{CBI}$.

Corollary 3 *Under perfect reputation,* $\theta_t^e = 1$*, the public never monitors, even under* $\mathrm{TR} \to \infty$, i.e. $M_t^* = 0,\ \forall t, \theta, \mathrm{CBI}, \mathrm{TR}$.

Corollary 4 *Under imperfect reputation,* $\theta_t^e < 1$*, and sufficiently small monitoring cost,* $\mu \leq \overline{\mu}$*, where* $\overline{\mu} = \frac{\omega\lambda^g}{2}\left(1-\theta_t^e\right)$*, the public monitors even if CBI= 1= θ and TR= 0.*

These results follow from Eqs. 16–17 and show the advantage of our general approach—by implying additional results for the cases where $\theta_t^e \neq \theta$. The corollaries further suggest that the specifics of the public's reputation updating mechanism may or may not determine the outcomes of the game. They also show that the public may choose not to monitor for two different reasons: because monitoring costs are excessive, or because the government already has sufficient reputation.

We suppose that in developing countries Corollary 2 may often apply. But in industrial countries, the conditions of Corollaries 3 or 4 are more likely to be satisfied. And out of those two scenarios, Corollary 4 with imperfect reputation seems to be the one more likely to hold in practice. The fact that the public is 'suspicious' about the stance of future macroeconomic policies can most easily be explained by the length of time that was needed for central banks to re-establish their credibility in the 1980s and 1990s, after the inflationary excesses of the 1970s.[13]

Proposition 10 *Assume that the government's reputation is not always perfect* ($\theta_t^e \neq 1$ *for some t*) *and the central banker has some independence,* CBI>0. (1) *If* $\mu < \overline{\mu}$ *where*

$$\overline{\mu} = \frac{\omega\lambda^g}{2}\left(1-\theta_t^e\right)\mathrm{CBI} > 0 \tag{18}$$

[13] On the other hand, small monitoring costs are more likely in industrialised countries because acquiring information has become much more affordable in the era of internet and far reaching media. Furthermore, unlike the inflation and output gap costs that are borne by every member of the society, the monitoring cost may be shared. Once the signal is 'purchased' by one individual it may be passed onto others with little additional cost.

then transparency always increases social welfare. (2) *If* $\mu \geq \overline{\mu}$ *then transparency increases social welfare only if it is sufficiently strong: that is, only if* $TR \geq \overline{TR}$ *where*

$$\overline{\mathrm{TR}} = \frac{2\mu}{\omega\lambda^{g}\left(1-\theta_{t}^{e}\right)\mathrm{CBI}} - 1 > 0 \tag{19}$$

Proof TR only affects the public's utility if the public monitors. As discussed in the proof of Proposition 9 monitoring entails a trade-off since it increases the monitoring cost (through Eq. 5) but reduces the expectational error (through a more accurate prediction of R_t). The latter is implied by the fact that under M_t=1 we have $\left(R_t^e\right)^* = R_t$ and hence $\left(\pi_t^e\right)^* = \pi_t, \forall t$ from Eqs. 7 and 8, i.e. the expectational error in Eq. 3 is always zero. If the public finds it optimal to monitor, $M_t^* = 1$, then the latter expectational benefit must more than offset the former monitoring cost. Since TR reduces the monitoring cost m in Eq. 17, it is sufficient to prove the proposition by showing that, under the stated conditions, $M_t^* = 1$.

Equation 17 shows that the monitoring decision may be affected by TR. It follows from Eq. 17 that under $\theta_t^e < 1$ and $\mu < \overline{\mu}$ (conditions of claim (1)), the public always monitors regardless of the transparency level: $M_t^* = 1, \forall t, \mathrm{TR}, \theta, \mathrm{CBI} > 0$. This implies that u_t^p is always an increasing function of TR.

In contrast, if $\theta_t^e < 1$ but $\mu \geq \overline{\mu}$ (conditions of claim (2)), then the public chooses to monitor and u_t^p increases in TR only if TR is above a certain threshold. Rearranging Eq. 17 and using Eq. 3 implies $\overline{TR}$ of Eq. 19, which completes the proof.

Proposition 11 *An increase in transparency from a level* $\mathrm{TR} < \overline{\mathrm{TR}}$ *to a level* $\mathrm{TR} \geq \overline{\mathrm{TR}}$, *where* $\overline{\mathrm{TR}}$ *is from Eq. 19, reduces the variability of both inflation and output.*

Proof Note that Proposition 10 implies that such an increase is feasible, i.e. $\overline{TR} \in (0, \infty)$, only if $\theta_t^e \neq 1$ for some t and CBI>0. Under these conditions Proposition 10 implies that such an increase will induce the public to start monitoring, that is to shift from $M_t^* = 0$ to $M_t^* = 1$. This will then have the same results as reported in Proposition 8, part (3) because it will lead to fluctuating levels of output and inflation. This result is in contrast to the transparency literature initiated by Cukierman and Meltzer (1986) that has commonly reported that greater transparency leads to a flexibility/credibility tradeoff. There is a notable exception, Geraats (2001), who has a result analogous to ours.

These two propositions show how the central banker can, through greater transparency and good communication, indirectly induce public monitoring and *hence* impose discipline on the government and achieve superior monetary outcomes.

4 Robustness and empirical evidence

Over-ambitious and impatient governments Without the government's temptation to increase output many of our results would not hold. However, there seems strong evidence that the government may have just such an incentive (due to naïve voters, lobby groups, a short political horizon etc). The behaviour of many governments, in developing and developed countries alike, lends support to this assumption of impatience. Furthermore, it should be noted that since government spending is driven by existing policy programmes—in particular unsustainable welfare and pension schemes—excessive spending and inflationary pressures (depicted as $\lambda^g>0$) may result regardless of the government's preferences.

Finally, the observational equivalence in Corollary 1 implies that it may be misleading to test this assumption by examining past history of overriding or government intervention. Even if these have not been observed, the government may still have 'over-ambitious' preferences—although overriding and interference have often been discouraged in practice by the possibility of exposure through the public monitoring.

In relation to this, a number of authors, e.g. McCallum (1997) and Blinder (1997), argue that a simple recognition of the fact that $\lambda>0$ may lead to undesirable outcomes is sufficient to constrain the policymaker's behaviour. The question left unanswered, however, is under what circumstances such behaviour will be credible in the eyes of the public. Our analysis offers an answer by showing that this possibility depends on the government's (fiscal) reputation. Specifically, Proposition 1 shows that if the reputation is imperfect, then even $\theta=1$ combined with CBI=1 may not achieve full credibility.

Discrete monitoring and overriding We believe that our assumption of $R=\{0,1\}$ is realistic—there is no 'partial overriding' in the same way that one cannot be partly pregnant. It then follows that all our conclusions derived under $M=\{0,1\}$ will hold unchanged even if there were 'partial monitoring' $M=[0,1]$. This is because, in such a setting, the public would either *monitor sufficiently* to discourage overriding, $M^* = \overline{M}$, or not monitor at all, $M^*=0$. Our analysis can therefore be interpreted as the case in which the normalization $\overline{M} = 1$ has been imposed (without any loss of generality). Analogously, while the signal may be made less than 100% informative the same applies—under reasonable assumptions on the monitoring cost the public would either purchase a *sufficiently informative* signal or no signal at all.

Empirical evidence The fact that CBI decreases inflation (Proposition 1) is widely accepted and has widespread empirical supported. Grilli et al. (1991), Cukierman et al. (1992), Alesina and Summers (1993), Eijffinger et al. (1998) and Fry et al. (2000) all have papers to show that. The fact that CBI increases credibility (Proposition 3) can further be supported by Scholtes (2002) who shows that official granting of instrument independence to the Bank of England in 1997 was followed by a significant increase in the bank's credibility.

In terms of the impatient government's interference with monetary policy's independence and its economic consequences (Propositions 4, 5, and 7), there exists a large body of literature—Nordhaus (1975), Alesina and Roubini (1992), Broadbent and Barro (1997), Gartner (1999), Ireland (1999), Ruge-Murcia (2003), (2004) and Cukierman and Gerlach (2003) have analysed that case. The behaviour of some current governments, in developing and industrial countries alike, lends support for the existence of over-ambitions and impatient governments.[14] However, our analysis itself shows that this feature of preferences may be getting steadily harder to detect empirically. Corollary 1 shows that if the public monitors, the two types of government are observationally equivalent; and Proposition 9 and Corollary 4 argue that the public is likely to monitor.

The fact that a deterioration in the government's fiscal reputation leads to a decrease in the monetary policy's credibility (Proposition 6) is intuitive and even more evident in some transition and developing countries. The effects of public monitoring on economic outcomes (Proposition 8) and of transparency on welfare (Propositions 10 and 11) are difficult to test empirically due to lack of appropriate data. Nevertheless, there exists indirect evidence supporting our findings.

In terms of the latter, Chortareas et al. (2002) show transparency to lower the average rate of inflation. In line with this Debelle (1997) finds inflation targeting (characterized by high degree of transparency) to increase the policy's credibility. In terms of the former, the 'Great Moderation' (the reduction in economic volatility of the past two decades) seems to go hand in hand with the gradual reduction of monitoring costs and more disciplined and transparent policies. Rather than a one way causality, there seems to be a feedback effect between all these developments. This is partly supported by the fact that emerging and developing countries have, on average, lower transparency, less monitoring, higher inflation, and greater economic volatility.[15]

5 Summary and conclusions

In this paper we have examined the role of public monitoring and the government's (fiscal) reputation in enhancing or detracting from the credibility of monetary policy, and hence financial stability, within an economy. Initially, even in our three player setup, the standard results emerge: that inflation on average is reduced with independence at the central bank; and that central bank independence increases monetary credibility and financial stability with or without monitoring or fiscal discipline, whereas less conservatism leads to larger inflation biases and

[14] To demonstrate, since the arrival of the Euro in 1999, the Stability Pact's 3% limit on fiscal deficits has been breached by six out of 12 Eurozone members; and the debt limit (at 60% of GDP) was breached by nine of 12 members in 1999, and six of them still breached it in 2006.

[15] Fry et al. (2000) show that out of the maximum rating of 10, average TR scores for industrial, emerging and developing countries are 6.9, 5.7, and 5.1 respectively.

lower output. But this paper is concerned with a deeper level of analysis. It rapidly becomes obvious that, when we allow for the possibility of the government overriding monetary policy, and for the private sector's monitoring of this interference, central bank independence is only a necessary condition. It is far from sufficient, which is a point that would be missed by less comprehensive models. So our first conclusion is that it is important to take the government's intentions into account, as well as those of the central bank, if we are to get a realistic picture of the effectiveness of the policies and policy institutions in any economy.

Second, public monitoring and the government's reputation for sound fiscal policies are evidently partial substitutes for monetary independence. Both increase the degree of credibility for any level of central bank independence, but decrease that credibility (and hence worsen the inflation and output outcomes) if they weaken or fail. It can be argued that public monitoring is the more important of the two because with public monitoring it no longer matters what type of government (weak or strong) is in place. The sufficient conditions for controllability, lower inflation and better output are therefore monetary independence and public monitoring, with the government's reputation for prudence being in support. Central bank independence on its own won't do it, as McCallum (1995) had conjectured a decade ago. Note that in a sense the public will get the economic policies it deserves—its monitoring is what induces superior inflation and output outcomes.[16]

This last comment is an interesting reversal of this literature's usual conclusion. Here public apathy may be the potential villain of the piece, rather than a dishonest or self-interested monetary authority. However that is not entirely fair to the public. As an 'economically rational' agent (in the sense of Feige and Pearce (1976)), the public's monitoring decision is an optimal outcome of a cost/benefit analysis. We show that to increase the probability of optimal monitoring and hence of improved economic outcomes, both the fiscal and monetary policymakers can reduce the monitoring cost by increasing the transparency of their policies and improving their communication with the public. This may include publishing data, models, forecasts, policy intentions, or legislating policy targets (especially medium to long term ones such a numerical inflation target or fiscal plans), as well as giving open evidence to parliamentary or congressional committees or to an independent policy council.

These arrangements are especially important in a world where reputations are not always clear, where information is potentially incomplete, and where policymakers may have their own private reasons for not communicating too clearly or effectively. Our analysis shows that, in such cases, a policy of encouraging public monitoring will be most needed when policymakers lack reputation or need a way to tie their hands and discipline themselves indirectly.

[16] Thus Dixit and Lambertini (2003) are correct to argue that monetary policies cannot be committed if fiscal policies are not committed at the same time. But the public must know for themselves that they are committed. That can be achieved through monitoring, or because the institutional structure locks the policymakers in (Hughes Hallett and Weymark (2007)).

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