

*This Draft: January 1998*

**INFLATION CONTRACTS AND INFLATION TARGETS UNDER UNCERTAINTY:  
WHY WE MIGHT NEED CONSERVATIVE CENTRAL BANKERS\***

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**ABSTRACT**

This paper compares the relative effectiveness of inflation contracts and inflation targets in the presence of uncertainty regarding the central bank's preferences and the underlying output target. The model explains why discretion may be superior to a delegation solution. We also show that there might be the need to combine inflation targets and contracts with the appointment of a Rogoff-type 'conservative' central banker if contracts and targets cannot be made state-contingent, and that less flexible inflation targets may be appropriate with uncertain central bank preferences.

JEL Codes: E52, E58, E42

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(\*) This paper is a major revision and extension of material originally presented in Muscatelli (1995), which was presented at the Warwick Workshop on *Central Bank Independence* in May 1996. I am indebted to Ali Al-Nowaihi, Martin Cripps, Robin Cubitt, Julia Darby, John Driffill, Berthold Herrendorf, Haizhou Huang, Mervyn King, Paul Levine, Ben Lockwood, Jim Malley, Marcus Miller, Charles Nolan, Apostolis Philippopoulos, Neil Rankin, Eric Schaling, Andrew Stevenson, Lars Svensson, Yanis Varoufakis, Carl Walsh and Tony Yates for extremely useful comments on earlier versions of this paper. The usual disclaimer applies.

## 1. INTRODUCTION

The recent literature on credibility and monetary policy design has identified a possible role for principal-agent contracts and/or inflation targets in reducing inflation at little cost in terms of stabilisation policy. The interest generated by this literature is in part due to the recent moves in a number of OECD countries towards greater central bank (hereafter CB) independence. In countries where there has been little or no tradition of CB independence (e.g. the UK, France) this issue has been hotly debated given the dilemma it creates for advocates of democratic government<sup>1</sup>. The key issue is whether contracts and inflation targets are useful devices to discipline central bankers so that they will protect the economy from the inflation bias which would be generated by elected governments without pursuing policies which are in conflict with those of society (or of the median voter).

The contracts approach is developed in Persson and Tabellini (1993) and Walsh (1995). They show that a linear inflation contract can be designed which eliminates the credibility problem whilst allowing the CB flexibility on stabilization policy. These contracts may essentially be viewed as society (the principal) imposing a 'performance contract' on the CB (the agent), where the latter is penalised for failing to meet an inflation objective.

The inflation targets approach is developed independently in Svensson (1997), Herrendorf and Lockwood (1996) and Muscatelli (1995), and builds on earlier work on output targets by Persson and Tabellini (1990). In these schemes society chooses an appropriate inflation target for the CB, and deviations from this target are penalised at the same rate as society penalises inflation deviations from its preferred inflation objective. As in the case of contracts, the trade-off between credibility and flexibility is eliminated by such an arrangement.

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<sup>1</sup> See for instance Robert Chote, 'A dilemma for democracy', the Financial Times Monday 20<sup>th</sup> October 1997.

This paper compares the robustness of contract and target arrangements in the presence of uncertainty about the preferences of the agent (the CB), and about the output target which society wishes to pursue. The key results of the paper are the following. First, it can be shown that, for both types of arrangements, a role re-emerges for a Rogoff-type ‘conservative’ CB under uncertainty. Second, either type of delegation may or may not be preferable to retaining political control with discretionary policies depending on the extent to which uncertainty affects the relationship between society and the CB. Third, in an inflation target regime, the flexibility in the target imposed on the CB will depend on the relative importance of CB preference uncertainty and the variance of structural shocks in the economy.

The rest of this paper is structured as follows. In Section 2, we briefly set out the monetary policy delegation model which forms the basis of our analysis. Section 3 sets out a two-period model in which we consider how different targeting procedures might perform in the presence of CB uncertainty. Section 4 concludes.

## **2. INTRODUCING PREFERENCE UNCERTAINTY IN THE CONTRACTS AND TARGETS MODELS**

### *2.1 The Standard Inflation Bias Model with Contracts and Targets*

We first briefly review some of the standard results in the literature on monetary policy delegation and on setting optimal contracts and targets.

Consider a standard quadratic loss function for society, which attaches a penalty to positive (or negative) inflation<sup>2</sup>, and to deviations of output from some output target  $\bar{y}$  (where time-subscripts are omitted for current-period variables):

$$Z^S = \frac{1}{2}[(y - \bar{y})^2 + w\pi^2] \quad \bar{y} > 0, \quad \infty > w > 0 \quad (1)$$

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<sup>2</sup> Alternatively one could specify the cost function as assigning costs to deviations of inflation from some low, optimal, inflation target  $\bar{\pi}$  (e.g. see Svensson, 1997). This does not affect any of the results which follow.

The output target pursued exceeds the natural level of output, and  $\omega$  is the relative weight assigned to inflation in the cost function. Output is assumed to be a function of surprise inflation, plus a random error term  $\varepsilon$  which is normally distributed with mean zero and variance  $\sigma_\varepsilon^2$ :

$$y = \mathbf{p} - \mathbf{p}^e + \mathbf{e} \quad (2)$$

where the equilibrium or natural level of output is normalised at zero. The supply shock  $\varepsilon$  can be observed by the monetary authorities (the government, or the independent CB if one has been appointed) before choosing the level of inflation, but not *ex ante* by wage setters<sup>3</sup>, who set wages equal to expected inflation:

$$w = \mathbf{p}^e \equiv E_{t-1}(\mathbf{p}) \quad (3)$$

Note that in this paper we do not draw any distinction between the objectives of the government and society at large<sup>4</sup>. If the preference parameter  $\omega$  varies across individuals in society, one may think of (1) as being the government's loss function, which in turn corresponds to the loss function of the median voter. We rule out reputational equilibria of the type considered in Barro and Gordon (1983) and, as there are no structural dynamics in the model, we can consider the government's choice of policy as a one-shot game<sup>5</sup>.

In the absence of delegation (if no independent CB is appointed), the discretionary equilibrium will prevail, given by minimising (1) and treating inflationary expectations as given. This yields the following monetary policy rule:

$$\mathbf{p} = \frac{\bar{y}}{\mathbf{w}} - \frac{\mathbf{e}}{(1 + \mathbf{w})} \quad (4)$$

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<sup>3</sup> This is just a convenient device which introduces an information advantage for the policymaker, thereby providing a rationale for stabilisation policy (see Rogoff, 1985).

<sup>4</sup> This is only of interest if one wishes to consider the interactions between electoral cycles and business cycles (see e.g. Persson and Tabellini, 1990).

<sup>5</sup> The extension of the model to an infinite time horizon is trivial, as the game outcome will be identical in every period.

which shows the inflationary bias  $(\bar{y} / \mathbf{w})$  plus a 'feedback policy' term to partially offset (accommodate) supply shocks. If the government had some pre-commitment technology it could eliminate the inflation bias by minimising (1) subject to the constraint that  $\mathbf{p} = \mathbf{p}^e$ , which would yield the following policy rule:

$$\mathbf{p} = -\frac{\mathbf{e}}{(1 + \mathbf{w})} \quad (5)$$

However, this solution is time-inconsistent, and hence cannot be achieved without some appropriate institutional arrangement<sup>6</sup>. Rogoff (1985) shows that appointing a 'conservative' CB (one with a higher weight on inflation than society) can reduce the inflation bias, but at the cost of a less flexible stabilisation policy.

Persson and Tabellini (1993) and Walsh (1995) demonstrate that the adoption of a 'performance-related' CB contract can overcome the trade-off between credibility and flexibility noted by Rogoff. Suppose an independent CB is appointed whose preference parameter  $\omega$  corresponds to that of the median voter, so that its basic cost function is given by (1). In addition, society is assumed to impose a penalty or 'negative transfer',  $T$ , which is a function of the banker's performance in terms of controlling inflation<sup>7</sup>, i.e.  $T = T(\mathbf{p})$ . Thus, the CB's cost function becomes:

$$Z^{CB} = \frac{1}{2}[(y - \bar{y})^2 + \mathbf{w}\mathbf{p}^2] + T(\mathbf{p}) \quad \bar{y} > 0, \quad \omega > \mathbf{w} > 0 \quad (6)$$

The optimal contract turns out to involve a transfer  $T$  which is linear in inflation, i.e. of the form:

$$Z^{CB} = \frac{1}{2}[(y - \bar{y})^2 + \mathbf{w}\mathbf{p}^2] + \mathbf{a}\mathbf{p} \quad \bar{y} > 0, \quad \omega > \mathbf{w}, \mathbf{a} > 0 \quad (7)$$

The problem facing society is then to choose  $\alpha$  so that the incoming central banker will select the socially optimal policy. Minimising (7) given (2) we find that a

<sup>6</sup> But see McCallum (1996) for an alternative perspective. This is discussed further below.

<sup>7</sup> In line with the rest of the literature it is simply assumed that the transfer is measurable in the same units as social welfare, even though this is a non-trivial problem in practice.

contract should be set such that<sup>8</sup>  $a = \bar{y}$ . The CB will then implement the optimal inflation rule in (5).

It turns out that a delegation scheme based on setting flexible inflation targets can achieve the same result as a contract (see Svensson, 1997). Suppose again that society delegates monetary policy to an independent CB. Furthermore, assume that the CB has the same preference parameter  $\omega$  as society, and that in addition, the CB is given a flexible inflation target,  $\hat{p}$ , which it does not have to adhere to absolutely, but deviations from which are penalised at a rate  $\omega$ :

$$Z^{CB} = \frac{1}{2}[(y - \bar{y})^2 + \omega(p - \hat{p})^2] \quad (8)$$

Unlike a Rogoff-type scheme where a CB is chosen whose preferences are known to be more 'conservative' on inflation than society, the CB here is *assigned* an explicit inflation objective and a specific cost function. All that is required for this to be feasible is that society is able to set an inflation target for its delegate which is lower than its preferred target inflation rate, and for the CB to penalise deviations from this imposed target<sup>9</sup> at a rate  $\omega$ . Minimising (8), it can be shown that the CB should be set a target  $\hat{p} = -(\bar{y} / \omega)$  to achieve the optimal policy in (5).

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<sup>8</sup> The basic contract can be made more sophisticated to take account of problems such as structural uncertainty (the presence of shocks which cannot be anticipated by the monetary authorities), and imperfect inflation control on the part of the CB. By making the contract state-contingent, the optimal solution in (5) is still attainable (see Persson and Tabellini, 1993, Walsh, 1995). It may be difficult to design such state-contingent contracts in practice, but even if fully state-contingent contracts are not possible, a fixed contractual arrangement might still be desirable provided that the costs from the additional output and inflation variability due to 'policy errors' do not exceed the gains from lower output variability due to  $\varepsilon$ -type shocks. This is a familiar result in the rational expectations-new classical macroeconomics literature.

<sup>9</sup> A more natural way of specifying the inflation target cost function for the CB is as the sum of the 'economic cost' (or social welfare loss) component and a penalty (implicit reputation cost or explicit monetary penalty) for deviating from the target, i.e:  $Z^{CB} = \frac{1}{2}[(y - \bar{y})^2 + \omega p^2 + \psi(p - \hat{p})^2]$  where  $\psi$  is the weight on the inflation target penalty, and the parameters in the loss function may be subject to uncertainty. However, the nature of the solution would not alter substantially, as this merely changes the level of the inflation target required to remove the inflationary bias.

However, the result that inflation targets and contracts are equivalent and ensure an optimal policy outcome (one which is superior to discretion) is not robust to changes in the specification of the model. A strong assumption made in the above models of delegation is that the government/society knows the preferences of the agent (the central banker) when s(he) is appointed. In practice society is unlikely to know the true nature of the CB's preferences when designing contracts and targets. Indeed, the unknown nature of the CB's preferences is behind a number of recent controversies on institutional reform. In the UK, the desirability of granting greater independence to the Bank of England has been linked to the need to make the Bank fully accountable to Parliament (see Balls, 1998). In Germany, scepticism about European Monetary Union is essentially due to uncertainty about how the future European Central Bank is going to behave.

We now introduce uncertain CB preferences and output targets into the above model, and show that this leads to some potential modifications of the simple inflation target and contract scheme. Furthermore, we show that this complication may drive a wedge between the performance of contracts and inflation targets.

## *2.2 The Robustness of Contracts and Targets and the Role for a Conservative Central Bank with Preference Uncertainty*

We now assume that the central banker is selected at random from the population, so that the relative weight placed by the chosen CB on inflation and output in the cost function will be subject to an unobservable error term,  $\eta$ , relative to the preferences of society (represented by the median voter). This error term is assumed to be bounded between  $-\omega$  and 1, and to have a zero mean and variance  $\sigma_h^2$ . It is assumed to be uncorrelated with the supply shock  $\varepsilon$ .

Of course, a natural response to the problem of uncertainty in CB preferences would be to design contracts or inflation targets which are contingent

on the nature of the CB once s(he) has been appointed. However, state-contingent contracts are difficult to design, and ‘*ad hominem* preference-contingent’ contracts even more so. It may be more natural to imagine inflation targets being altered *ex post* as circumstances change, but where governments have electoral motives this might lead to a loss in credibility. In what follows we make the reasonable assumption that contracts and targets cannot be made contingent on the revelation of CB preferences. In practice the re-negotiation of targets and contracts will probably involve a high political cost to the government<sup>10</sup>.

With CB preference uncertainty, society has to choose the optimal values of  $\alpha$  in (9) in a contracts regime and  $\hat{p}$  in (10) under targeting so as to minimise the cost function (1), knowing that the CB, when selected, will choose  $\pi$  to minimise:

$$Z^{CB,c} = \frac{1}{2}[(1-h)(y - \bar{y})^2 + (w+h)p^2] + ap \quad (9)$$

$$Z^{CB,t} = \frac{1}{2}[(1-h)(y - \bar{y})^2 + (w+h)(p - \hat{p})^2] \quad (10)$$

The choice of  $\alpha$  and  $\hat{p}$  is made by society without knowing the realisation of  $\eta$ .

Immediately after  $\alpha$  and  $\hat{p}$  are set, inflationary expectations are formed. Then the supply shock  $\varepsilon$  is revealed and the CB chooses  $\pi$  so as to minimise (9) or (10).

The CB’s optimal inflation rules in the two regimes can be shown to be, minimising (9) and (10)<sup>11</sup>:

$$p^c = \frac{(\bar{y} - a)}{w} + \frac{h}{w} \left[ \frac{a}{(1+w)} - \bar{y} \right] - \frac{(1-h)e}{(1+w)} \quad (11)$$

$$p^t = \hat{p} + \frac{\bar{y}(1-h)}{w} - \frac{(1-h)e}{(1+w)} \quad (12)$$

and output in the two cases is given by (using (2)):

<sup>10</sup> For an analysis of renegotiation-proofness, see Al-Nowahi and Levine (1996) and Herrendorf (1996).

<sup>11</sup> Unlike Nolan and Schaling (1996) and Briault *et al.* (1996), the construction of (9) and (10) allows us to avoid terms in ratios of random variables and the use of a Taylor series approximation.



$$y^c = -\frac{h}{w} \bar{y} - \frac{a}{(1+w)} + \frac{e(w+h)}{(1+w)} \quad (13)$$

$$y^t = -\frac{h\bar{y}}{w} + \frac{e(w+h)}{(1+w)} \quad (14)$$

We see that the uncertainty in CB preferences introduces an important asymmetry between the optimal contract and inflation target cases. In the contract case, the optimal contract parameter can affect the variance of both output and inflation. In contrast, the choice of inflation target cannot affect the behaviour of output. This asymmetry suggests that inflation contracts might turn out to be more robust to a problem such as uncertainty in the agent's preferences. This intuition is confirmed, as we shall see below.

Next we find the optimal target and contract. Substituting (11)-(14) into (1), and computing:

$$\min_a Z^S = \frac{1}{2} \left[ \frac{h}{w} \bar{y} + \frac{ha}{w(1+w)} + \frac{(w+h)e}{(1+w)} \right]^2 + w \left[ \frac{(\bar{y}-a)}{w} + \frac{h}{w} \frac{a}{(1+w)} - \bar{y} - \frac{(1-h)e}{(1+w)} \right]^2 \quad (15)$$

$$\min_{\hat{p}} Z^S = \frac{1}{2} \left[ \frac{h}{w} \bar{y} + \frac{(w+h)e}{(1+w)} \right]^2 + w \left[ \hat{p} + (1-h) \left[ \frac{\bar{y}}{w} - \frac{e}{(1+w)} \right] \right]^2 \quad (16)$$

The contract and target arrangement which minimise society's expected costs can be shown to be (where we use  $E(\varepsilon\eta)=0$ ):

$$a^* = \frac{\bar{y}(1+w)(w+s_h^2)}{w(1+w)+s_h^2} \quad (17)$$

$$\hat{p}^* = -(\bar{y}/w) \quad (18)$$

Note also from this that the targets arrangement is certainty-equivalent, whilst the optimal contract is not<sup>12</sup>.

<sup>12</sup> Note that, as  $s_h^2 \rightarrow 0$ , (17) collapses to the solution in Section 2.1.

Substituting (17) and (18) back into (11)-(14), we can calculate the expected costs of the optimal policies under both delegation arrangements, and compare them with the expected costs under the no-delegation discretionary solution. The expected costs to society where inflation is given by the expressions in (4) and (5) (the ‘discretionary’ and ‘fully-optimal’ policies) are:

$$E(Z^{S,d}) = \frac{1}{2} (\bar{y})^2 \frac{1+w}{w} + s_e^2 \frac{w}{1+w} \quad (19)$$

$$E(Z^{S,o}) = \frac{1}{2} (\bar{y})^2 + s_e^2 \frac{w}{1+w} \quad (20)$$

In contrast, with uncertainty regarding CB preferences, the optimal contract solution yields the following expected costs:

$$E(Z^{S,c}) = \frac{1}{2} \frac{1+w+s_h^2}{(1+w)} (\bar{y})^2 + s_e^2 \frac{w+s_h^2}{(1+w)} \quad (21)$$

and the inflation target solution yields:

$$E(Z^{S,t}) = \frac{1}{2} \frac{w^2+s_h^2(1+w)}{w^2} (\bar{y})^2 + s_e^2 \frac{w+s_h^2}{(1+w)} \quad (22)$$

There are several important points which emerge from the above results.

First, note<sup>13</sup> that  $E(Z^t) > E(Z^c) > E(Z^o)$ . Both targets and contracts now create a stochastic inflation bias due to the uncertainty in CB preferences<sup>14</sup>. Inflation targets carry greater expected costs than contracts, because of the inability of the choice of target to affect output variability. Even though this makes contracts more robust in a strict sense, the fact that targets are certainty equivalent may make them more appealing. The optimal design of contracts requires knowledge of the dispersion of CB preferences (the ‘consensus’ in society of the relative costs of inflation,  $s_h^2$ ). In

<sup>13</sup> It can be shown that  $E(Z^t - Z^c) = (1/2)(\bar{y}^2 s_h^2 (1+2w) / w^2 (1+w)) > 0$

<sup>14</sup> One way of alleviating this problem of uncertainty would be to appoint a central bank board or council to run policy (see Waller, 1992), as in the case of the US.

contrast, the setting of an inflation target need not be altered in the light of new information regarding the dispersion of CB preferences. In this sense the inflation target regime may be more transparent than the contract regime<sup>15</sup>.

Second, a more natural solution in the targets case would be to specify a tighter targeting regime compared to the ‘flexible regime’ envisaged in Svensson (1997). We return to this point in Section 3.

A third point which emerges from this variant of the model is that uncertainty about the nature of the CB, which reflects the polarisation of views in society about the relative costs of inflation and output stabilisation if the central banker is chosen at random from the population, militates against delegation. Comparing (19) and (21)-(22), it is apparent that the discretionary solution might dominate if  $s_h^2 > s_e^2$ .

This can be readily verified by, for instance, computing  $E(Z^c) - E(Z^d)$  which yields:

$$\frac{1}{2} \frac{s_h^2}{(1+w)} - \frac{1}{w} \bar{y}^2 - \frac{ws_e^2}{(1+w)} \quad (23)$$

This might explain why there might be a greater desire for CB independence in those countries where the consensus on the costs of inflation is greatest (a low  $s_h^2$ ), and why there has only been a moderate shift towards greater CB independence<sup>16</sup>.

The final issue we should consider is what implications uncertainty regarding the CB’s preferences has for the choice of the central banker. Suppose that society rather than appointing a CB at random could sample in a biased way, from certain sections of the population known to be more or less conservative on average. Does society have an incentive to choose a central banker who is expected to be more or

<sup>15</sup> However, it can be shown that a fixed value of  $\alpha$  will still outperform an inflation target.

<sup>16</sup> There have only been a few major regime shifts (Canada, New Zealand, the UK). In some cases (e.g. the UK, Sweden) the shift was triggered by the collapse of existing inflation control regimes (usually exchange rate or monetary targeting) and moves towards greater

less *weight-conservative* than society on average? This biased sampling involves finding the value of  $\omega^*$  which minimises:

$$\begin{aligned} \min_{w^*} Z^{S,c} = & \frac{1}{2} \left[ \frac{h}{w^*} + 1 \right] \bar{y} + \frac{ha^*}{w^*(1+w^*)} + \frac{(w^*+h)e}{(1+w^*)} \\ & + w^* \left[ \frac{(\bar{y}-a^*)}{w^*} + \frac{h}{w^*} \frac{a^*}{(1+w^*)} - \bar{y} - \frac{(1-h)e}{(1+w^*)} \right]^2 \end{aligned} \quad (24)$$

$$\min_{w^*} Z^{S,t} = \frac{1}{2} \left[ \frac{h}{w^*} + 1 \right] \bar{y} + \frac{(w^*+h)e}{(1+w^*)} + w^* \left[ \hat{p}^* + (1-h) \left[ \frac{\bar{y}}{w^*} - \frac{e}{(1+w^*)} \right] \right]^2 \quad (25)$$

where  $a^*, \hat{p}^*$  are given in (17)-(18).

We can evaluate the first-order conditions at ( $\omega=\omega^*$ ):

$$\begin{aligned} \left. \frac{\partial Z^{S,c}}{\partial w^*} \right|_{w=w^*} &= \frac{-(s_e^2 + \bar{y}^2) s_h^2}{(1+w^2)} \\ \left. \frac{\partial Z^{S,t}}{\partial w^*} \right|_{w=w^*} &= \frac{-s_e^2 s_h^2}{(1+w^2)} - \frac{(1+3w^2 + w^3 + 3w) \bar{y} s_h^2}{w^3(1+w^2)} \end{aligned}$$

Both of these expressions are negative, suggesting that it would be preferable to appoint a central banker who is expected to be more conservative than society. The intuition behind this result is simply that a more weight-conservative CB will offset the increased variance of inflation and output generated by  $\eta$ .

### 2.3 Output Target Uncertainty and the Role for a Conservative CB

We now look at another type of uncertainty which might affect the agent's preferences, and which might drive a wedge between society and the CB's loss function. Let us now suppose that society can select a central banker with a value of  $\omega$  which matches that of society's loss function, but that there is uncertainty

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CB independence (e.g. France, Italy, Spain) have arguably been in response to exogenous

regarding the output target  $\bar{y}$  which the CB will adopt. This could be interpreted as being due to fundamental uncertainty about the NAIRU (see Staiger *et al.*, 1997, Cross *et al.*, 1997) or random fluctuations in it. The CB is then selected at random, and his/her preferences may not coincide with those of the median voter. Output or employment targets are not usually specified in delegation schemes, and it is of interest to see how contracts and inflation targets perform in these circumstances.

Once again, we introduce an error term  $\lambda$  which has zero mean and variance  $s_\lambda^2$ , and consider the CB's problem of setting the inflation rate, where the CB's loss functions are as follows:

$$Z^{CB,c} = \frac{1}{2}[(y - (\bar{y} + h))^2 + wp^2] + ap \quad (26)$$

$$Z^{CB,t} = \frac{1}{2}[(y - (\bar{y} + h))^2 + w(p - \bar{p})^2] \quad (27)$$

In this case, unlike Section 2.2, both the optimal contract and the inflation target yield the same results and are certainty-equivalent. Output and inflation under both schemes can be shown to be:

$$p = \frac{I - e}{(1 + w)} \quad (28)$$

$$y = \frac{I}{(1 + w)} + \frac{ew}{(1 + w)}$$

Again, it follows that the increased variability in inflation and output due to  $\lambda$  could be offset by appointing a CB who is more 'conservative' than society. The expected costs to society of the inflation rule in (28) by appointing a central banker with preferences  $\omega^*$  are given by:

$$E(Z) = \frac{1}{2} \left[ \frac{(w + w^{*2})s_e^2 + (1 + w)s_\lambda^2}{(1 + w^*)^2} + (\bar{y})^2 \right] \quad (29)$$

Choosing the value of  $\omega^*$  which minimises (29) yields  $w^* = w \sqrt{1 + \frac{s_h^2}{s_e^2}}$ .

Thus, a more conservative CB would reduce the costs due to the divergence of the central bank's output target from society's, but at a higher cost in terms of reacting to ( $\varepsilon$ -type) supply shocks. On balance, however, it is appropriate to delegate policy to a Rogoff-type 'conservative' CB, providing that there is some uncertainty in the appropriate output target to pursue<sup>17</sup>. As in Section 2.2, delegation with contracts/targets is only superior to discretion if the uncertainty regarding the output target is not too large, i.e. if  $(s_h^2 / 1 + w) < (\bar{y}^2 / w)$ .

#### 2.4 A Comparison with the Current Literature

There is a plethora of different papers on the robustness of contracts and target arrangements in the current literature, and it is appropriate to distinguish the contribution made here with that of related papers, which have arrived at similar or related conclusions.

The sources of stochastic inflation bias discussed here are complementary to those generated by the hysteresis effects in output in Svensson (1997), and by private information on the part of wage-setters in Herrendorf and Lockwood (1996). A similar analysis of preference uncertainty to that presented in Section 2.2 has been arrived at independently by Beetsma and Jensen (1996). All these contributions tend to lead to an argument for some weight-conservatism, but the different types of stochastic inflation bias produce differing asymmetries between contracts and targets. In a different context Lossani *et al.* (1995) introduce uncertainty in the Lohmann (1992) variant of the Rogoff delegation scheme to show

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<sup>17</sup> A more straightforward solution might be to set output/employment targets as well as inflation targets to solve this problem. However, if there is fundamental uncertainty regarding the level of the NAIRU, setting the wrong target could totally jeopardise the inflation target. It seems unlikely that this lesson of the 1960s and 1970s will be forgotten (cf. Friedman, 1968).

that appointing a conservative CB might involve major costs. All the various contributions listed above differ somewhat in their suggested solutions to the delegation problem, in line with the different sources of uncertainty.

Of course, uncertainty in CB preferences and actions has long been a matter of interest in the credibility literature (see Cukierman, 1992). More recently, Nolan and Schaling (1996) and Briault *et al.* (1996) have looked at this problem, but with the focus on the relationship in practice between accountability and the degree of central bank independence. In contrast, the focus in the present paper is on a systematic welfare comparison of delegation arrangements such as contracts and targets when there is uncertainty about CB preferences or output targets.

### **3. INFLATION TARGETS - FLEXIBLE OR NOT?**

Our model of preference uncertainty has used a Svensson-type model of inflation targeting. Unfortunately, the way in which inflation targets have been designed in practice in a number of countries in the 1990s (the UK, Finland, Canada, New Zealand) seems to bear little relation to the theoretical models proposed by Svensson (1997) and others (see Leiderman and Svensson, 1995). There are two key points to consider here. First, the standard inflation target model outlined in Section 2 relies on society imposing a target on the CB which exactly offsets the inflationary bias and which is therefore likely to be negative and which is consistently overshoot by the CB. Second, the implicit assumption is that the agent (the CB) is likely to have complete discretion to deviate from a set target (these targets are totally 'flexible') at a cost.

The real-life experience of countries which have adopted inflation targets seems to be very different. Inflation rates have tended to converge towards targets which are usually set at (or just above) a level which society might regard as optimal. Targets are not set artificially low, but are seen as way of co-ordinating

private-sector expectations on the target. Also, in many cases (e.g. the UK), CBs are asked to adhere strictly to targets, at least on average over a period of time, and have to justify systematic deviations from a target. We now modify our targets model to take this into account, and to see whether our result regarding the desirability of conservative CBs still holds using different types of inflation targets.

First we deal with the observation that inflation targets are not systematically overshoot by independent CBs. In practice the assumption that the appointed CB cares about inflation surprises is probably misplaced. As an appointed agent, the CB is likely to place his or her reputation or job tenure above any economic considerations. Stabilising output at a level deemed consistent with stable inflation and meeting an inflation target set by the principal are likely to be the only objectives which the CB is likely to care about in practice (see McCallum, 1996). But, as noted in section 2, there is no guarantee that the CB will assign the same weight on meeting the inflation target (a personal reputation cost) as society assigns to the deviation of inflation from the optimum level (an economic cost). In addition, there is no guarantee that the CB and society will agree on the level of the NAIRU. Under this interpretation, the CB is likely to have a loss function of the type:

$$Z_t^{CB} = \frac{1}{2}[(1-\mathbf{h})(y_t - \mathbf{I}_t)^2 + (\mathbf{w} + \mathbf{h})(p_t - \hat{p})^2] \quad (30)$$

where  $\eta$  and  $\lambda$  are defined as before, and where for simplicity we have assumed that the expected weight on the inflation term for the CB is equal to  $\omega$ . Note that this CB will not suffer from any systematic inflationary bias. The effect of  $\eta$  will be to cause a sub-optimal result vis-à-vis the variability of output and inflation.

Next, we introduce an expectations co-ordinating role for inflation targets. To preserve the analytical simplicity of our model, we shall do this in the context of a simple two-period model. Suppose that the CB is appointed for two periods, with  $\eta$  again unobserved. It will then minimise the expected value of (30) over the two



periods. The CB is able to observe the realisations of  $\lambda$  and  $\varepsilon$  in the two periods,  $(I_1, I_2, e_1, e_2)$  prior to setting inflation  $(p_1, p_2)$ . Society's problem is then to set a target  $\hat{p}$  so as to minimise the expected value of (1) over the two periods. (For simplicity we ignore discounting by the CB and society between the two periods to avoid any additional distortion). We consider two possible inflation target regimes. The first is the standard Svensson flexible-target regime (F), where society sets a fixed target  $\hat{p}$  for the two periods and the CB is left to do as it likes. This is a trivial extension of the model in Section 2 given the static nature of the model, and society will set a target  $\hat{p} = 0$  which will be met on average, with deviations depending on the business cycle and random shocks to the NAIRU  $(I_1, I_2, e_1, e_2)$ . In each period, inflation is given by  $p_1^F, p_2^F = (1-h)(I_1 - e_1) / (1+w)$  and output follows from (2).

A second possibility is a stricter target regime (A), where over the two periods, the CB is asked to meet the target on average. Essentially the CB will minimise  $E(Z_1^{CB}) + E(Z_2^{CB})$  subject to the constraint  $p_1 + p_2 = 2\hat{p}$ . This is a simple extension to a two-period model of the notion that inflation targets are met on average and that targets are used to co-ordinate expectations over the two-period horizon, as the outcome of the CB's behaviour in period 1 will condition its behaviour in period 2 (see Canzoneri, 1985). It is straightforward to show that in this average-targeting regime it is also optimal for society to set an inflation target equal to zero, and that we will have the following outcomes for inflation and output:

$$p_1^A = \frac{(h-1)(e_1 - I_1)}{1+h+2w}, \quad p_2^A = -p_1^A, \quad y_1^A = p_1^A + e_1, \quad y_2^A = e_2$$

We can now compare the welfare impact on society of strict targeting against flexible targeting. This turns out to be quite complex, so we restrict our attention to the special case where there is no uncertainty about the NAIRU ( $s_I^2 = 0$ ). By substituting the outcomes of the A and F regimes into (1), it can be shown that:

$$[E(Z_1^F) + E(Z_2^F)] - [E(Z_1^A) + E(Z_2^A)] = \frac{s_e^2}{2(1+w)(1+2w)^2} \left[ s_h^2(w + 6w^2 - 3) - (5w + 6w^2 + 1) \right] + \frac{(4w^3 + 7w^2 + 5w + 1)\bar{y}^2 s_h^2}{w^2(1+2w)^2}$$

Note that as  $s_h^2 \rightarrow 0$ , i.e. in the absence of CB preference uncertainty, the sign of this expression becomes unambiguously negative. That is, strict targeting becomes undesirable because it hampers inflation control by a CB which shares the same objectives as society. But in an economy where there is substantial CB preference uncertainty, strict targeting may be preferable, as society is prepared to trade off a less efficient stabilisation policy for a reduction in the risks from a stochastic inflation bias. This might explain why in countries where CB independence has been long established (e.g. Germany, the US) and there is perhaps greater consensus about the relative costs of inflation in society, the CB is essentially allowed to pursue a more flexible inflation policy with full goal independence, whilst in countries where greater CB independence and inflation targets have been introduced more recently (e.g. the UK, New Zealand), the CB is subject to a stricter and more accountable target regime<sup>18</sup>. Strict (and imposed) targets are more likely to be appropriate where the need for accountability is greater.

Not surprisingly, even under strict targeting, weight-conservatism delivers a better result, as it offsets some of the risks from the stochastic inflation bias. The problem for society is  $\min_{w^*} E(Z_1^A + Z_2^A)$ . Evaluating the first-order condition at ( $w=w^*$ ):

$$\left. \frac{\partial E(Z_1^F + Z_2^F)}{\partial w} \right|_{w=w^*} = - \frac{2s_h^2(2s_e^2 w + 5s_e^2 + 2\bar{y}^2)}{(1+2w)^3} < 0$$

which is unambiguously negative.

Our two-period static model does not allow us to consider all of the features of inflation targeting which might be of interest (e.g. reputation-building through

<sup>18</sup> This also helps to explain the finding in Briault *et al.* (1996) that the degree of goal independence across different CBs is inversely related to the degree of accountability.

learning as in Cukierman, 1992, or the question of how the costly adjustment of targets and contracts affects inflationary expectations as in Herrendorf, 1996). However, arguably these issues are orthogonal to our own analysis, and to the policy prescriptions which emerge from this paper, as set out below.

#### 4. CONCLUSIONS

The recent literature has shown that, in the context of a simple quadratic social loss model of monetary policy design, inflation targets or contracts may deliver a policy outcome which is superior to the delegation of policy to a 'weight-conservative' CB.

This paper has extended the existing literature by highlighting how weight-conservatism might still be preferable in a model where society does not know the type of CB it is appointing when designing the delegation regime, or where there is some uncertainty about the target output level, or the level of the NAIRU. In addition, it is not obvious that delegation is necessarily optimal in the presence of these sources of uncertainty. Our results on the costs of delegation under uncertainty might explain why progress towards greater central bank independence has been so slow. Much of the cross-sectional analysis on inflation performance, output variability and CB independence has taken the view (or at the very least it has implied) that greater CB independence would bring lower inflation at little or no cost<sup>19</sup>. In practice, however, institutions for inflation control emerge where there is a social consensus in support of inflation control. Indeed, our CB preference uncertainty results support the view argued in Posen (1995) that the *institutional*

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<sup>19</sup> The evidence so far from long-term interest rates in countries that have adopted targets (see Freeman and Willis, 1995, Almeida and Goodhart, 1996), is that they might have helped to lower inflationary expectations and might have lowered the inflation risk-premium embodied in long-run interest rates, but possibly at the price of slower output growth.

*design* approach to monetary policy may be misplaced<sup>20</sup>. Institutional arrangements are not the same as policy variables, and one cannot readily re-create the Bundesbank or the Fed outside Germany or the USA.

We also extend our inflation target model to take account of recent criticisms of the Svensson (1997) 'flexible targets' model. The main problem is that targets in practice seem to be set at or above society's preferred inflation outcome, and are not systematically missed by the monetary authorities. This chasm between theory and policy practice has been difficult to explain. Some authors have argued that inflation targets should be seen not as devices to remove the inflationary bias at a stroke, but as reputation-building devices which co-ordinate inflationary expectations in wage and price formation on a downward path. Using a two-period extension of an inflation target model where the CB does not tend to cause a systematic inflation bias we have shown that preference-uncertainty may cause strict targeting to be preferable to flexible targeting. In loose terms this corresponds to the degree of goal-independence afforded to the CB. Our model shows that in cases where the CB's preferences are likely to be sufficiently at variance with society's preferences, strict average inflation targets may generate a better outcome. Given the recent worries in Europe about the uncertain nature of a future ECB after EMU, this explains why many observers feel that inflation targets for the ECB could be a useful disciplinary adjunct to monetary targeting for a CB which still has to establish a reputation.

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<sup>20</sup> See Fregert and Jonung (1996) for an illuminating account of how countries manage to escape institutional arrangements for inflation control even where these are enshrined in the constitution.

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