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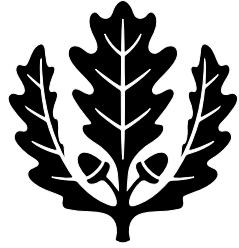
Georgios E. Chortareas
Bank of England

Stephen M. Miller
University of Connecticut

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Monetary Policy Delegation, Contract Costs, and Contract Targets

Georgios E. Chortareas
Bank of England

Stephen M. Miller
University of Connecticut

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341 Mansfield Road, Unit 1063
Storrs, CT 06269-1063
Phone: (860) 486-3022
Fax: (860) 486-4463
<http://www.econ.uconn.edu/>

Abstract

We reconsider the optimal central banker contract derived in Walsh (1995). We show that if the government's objective function places weight (value) on the cost of the contract, then the optimal inflation contract does not completely neutralize the inflation bias. That is, a fraction of the inflation bias emerges in the resulting inflation rate after the central banker's monetary policy decision. Furthermore, the more concerned the government is about the cost of the contract or the less selfish (more benevolent) is the central banker, the smaller is the share of the inflation bias eliminated by the contract. No matter how concerned the government is about the cost of the contract or how unselfish (benevolent) the central banker is, the contract always reduces the inflationary bias by at least half. Finally, a central banker contract written in terms of output (i.e., incorporating an output target) can completely eradicate the inflationary bias, regardless of concerns about contract costs.

Students of monetary economics recognize that under certain conditions, discretionary monetary policy generates an inflationary bias because of the time-inconsistency of optimal policies. That is, the central banker has the temptation to renege on a prior commitment and to generate a surprise inflation that increases output and reduces unemployment. Kydland and Prescott (1977) and Barro and Gordon (1983a,b) show that when the government and the central banker each have an expansionary bias, discretionary monetary policy leads to higher inflation.¹ Those authors assume a single policymaker (i.e., they do not consider the government and the central bank as different entities).

The existing literature proposes various remedies for reducing or eliminating the inflation bias. One approach considers appointing a "conservative" central banker -- that is, a central banker whose aversion to inflation exceeds that of society (Rogoff 1985 and Lohmann 1992). The higher aversion to inflation insulates the economy to some extent from the inflation bias. Another approach relies on targeting rules, where the government penalizes the central banker for deviating from the targeted variable (Canzoneri 1985, Garfinkle and Oh 1993, and Svensson 1997).² While these approaches generally lead to a reduction in the inflationary bias, the bias does not completely disappear because the models face a trade-off between inflation prevention and stabilization policy.

More recently, Walsh (1995) and Persson and Tabellini (1993) propose the contracting approach, (i.e., treat monetary policy delegation as a principal-agent problem),

¹ This idea of an inflationary bias, however, has received some criticism. Blinder (1997) and McCallum (1995, 1997) both question why the central bank will choose discretion with an inflationary bias over the optimal policy with no inflationary bias. That is, why should the central banker be less rational than the private sector when forming its expectations? If the central banker is rational in this sense, then the no-inflationary-bias outcome is superior to the discretionary outcome with the inflationary bias.

² While this literature discusses the penalty for deviating from the targeted variable, how the penalty

whereby the inflationary bias completely disappears. In addition, the trade-off between inflation reduction and stabilization policy also disappears.

But if central banker contracts are so useful in theory, then why do we not observe them in practice? Are there aspects of central banker practice that the relevant theoretical literature fails to capture? The principal-agent approach implicitly assumes that the government's objective function only includes the social welfare function. Indeed, Walsh (1995) excludes the cost of the contract from the government's objective function except when incomplete information about the central banker's competence allows the central banker to earn rents. Relaxing this assumption and incorporating the cost of the contract into the government's objective function³ generates interesting results.

The contracting literature's key assumption is that the central banker responds to incentives. Having a contract that imposes a penalty for higher inflation forces the central banker to choose voluntarily actions that eliminate the inflationary bias, while discretion is preserved. Recognizing that the central banker does respond to the incentive scheme offered by the government, several questions emerge. How does the degree to which the government dislikes contract costs affect the degree to which a contract can reduce the inflation bias? What effect does the central banker's responsiveness to contract costs (i.e., central banker selfishness) have on the outcomes of policy making?⁴

actually is imposed is not clear absent a central banker contract.

³ Walsh (1985, p. 156, n. 10) seems to allude to this issue when he states that "An alternative approach would assume that the government's objective is to minimize the expected loss *plus the transfer to the central banker*. ... Therefore, assuming that the government minimizes $E(V)$ instead of $E(V + T)$ involves no loss of generality." (emphasis added) As we demonstrate, this conjecture is inaccurate.

⁴ The more selfish a central banker becomes, the more weight the central banker places on the incentive scheme relative to the social loss.

Should contract costs appear in the government's objective function? Since the payment to the central banker is a transfer between agents in the economy (i.e., taxpayers to central banker), it nets out of aggregate social welfare.⁵ In addition, contract costs are probably much lower than the social benefits from eliminating the inflation bias, even if contract costs are a net loss for society. Government, however, is not indifferent to these costs. First, if government optimizes, then it will want to reduce such costs regardless of their size. Second, if such payments are financed through distortionary taxes, then the social burden of the transfer exceeds the transfer itself.⁶ We argue, however, that a more compelling case relies on a political economy view. To wit, government (and society) may feel uncomfortable with an "excessive" transfer, over and above regular salary, to the central banker based on performance, especially when the transfer from the incentive scheme is high.⁷ De jure limits may exist on the size of the transfer in that it must be politically acceptable. Moreover, private interest-groups may want to influence the central banker through an implicit contract (e.g., future employment) and the interactions of interest group and government contracts may drive the contract costs to much higher, politically unacceptable, levels (Chortareas and Miller, 1999).

Our findings can be briefly stated. First, if the government's objective function places some weight on the contract costs, then the inflation contract eliminates only a

⁵ In personal correspondence, Walsh notes that this was his original view. He now thinks that this is an inaccurate view because of distortionary taxes (see below).

⁶ Walsh makes this argument in his personal correspondence with us.

⁷ For example, in a recent interview in *The Region* (1999), Donald Brash, Governor of the Reserve Bank of New Zealand, indicates that the New Zealand legislation excludes an explicit performance contract because of the potential "public-relations" problems associated with "... giving Brash a great six-figure bonus for delivering low inflation at the very time unemployment was peaking." (p. 48). In this instance,

fraction of the inflationary bias. Second, the fraction of the inflationary bias eliminated depends on the degree of central banker's selfishness and the dislike that the government has for the contract. A more (less) selfish central banker or a government that cares little (a lot) about the cost of the contract eliminates a larger (smaller) share of the inflationary bias. Third, no matter how concerned the government is about the cost of the contract or how unselfish (i.e., benevolent)⁸ the central banker is, the contract always reduces the inflation bias by at least half. These results do not depend on the presence of incomplete information. Finally, an alternative output contract completely eliminates the inflation bias.

I. Walsh's Model

We adopt Walsh's (1995) model with slight modifications. The Lucas supply function relates output and unexpected inflation as follows:

$$y = y^n + \mathbf{a}(\mathbf{p} - \mathbf{p}^e) + \mathbf{e} , \quad (1)$$

where y^n is the natural level of output, \mathbf{p} and \mathbf{p}^e are the actual and expected inflation rates, \mathbf{e} is a well-behaved random supply shock, and the time subscripts are suppressed.

The central banker's policy instrument, the rate of money growth (m), affects the inflation rate as follows:

$$\mathbf{p} = m + \mathbf{n} - \mathbf{g}\mathbf{e} , \quad (2)$$

where \mathbf{n} is a control error or velocity shock and $(-\mathbf{g}\mathbf{e})$ is the stabilization effect of the supply shock \mathbf{e} on inflation.

political considerations obviated performance contracts at the outset.

⁸ A more benevolent central banker places higher weight on the social loss relative to the incentive contract.

The government shares the same loss function with society, which depends on inflation rate and output deviations from targeted levels (y^* and $\mathbf{p}^*=0$, respectively). That is,

$$L^G = \{(y - y^*)^2 + \mathbf{b}\mathbf{p}^2\}. \quad (3)$$

The central banker's utility function incorporates the social loss function and the optimal incentive scheme (tr) as follows:

$$U = tr - L^G. \quad (4)$$

Note that the social loss (L^G) and the incentive scheme (tr) implicitly receive the same weight in the central banker's utility function. The targeted output levels of both the government and the central banker incorporate an expansionary bias (k), so that $y^* - y^n = k > 0$.

Walsh (1995) shows that the optimal incentive scheme when the central banker's reward depends on the inflation rate is as follows:

$$tr = t_0 - 2\mathbf{a}\mathbf{k}\mathbf{p}, \quad (5)$$

where t_0 is a fixed payment and the marginal penalization rate (t^*) equals $2\mathbf{a}\mathbf{k}$. Note that the targeted money growth rate (m^*) equals zero in order to achieve the targeted inflation rate ($\mathbf{p}^*=0$).

The output level and inflation rate under the optimal (Walsh) contract (\mathbf{p}^{WC}, y^{WC}) match exactly those that prevail if credible precommitment is feasible, the first-best solution (\mathbf{p}^f, y^f). That is,

$$\mathbf{p}^{WC} = \mathbf{p}^f = \left(-\frac{\mathbf{a}}{\mathbf{a}^2 + \mathbf{b}} \right) \mathbf{e}, \text{ and} \quad (6)$$

$$y^{WC} = y^f = y^n + \left(\frac{\mathbf{b}}{\mathbf{a}^2 + \mathbf{b}} \right) \mathbf{e}. \quad (7)$$

These outcomes dominate the discretionary outcomes (\mathbf{p}^d, y^d) that imply higher inflation without output gains. That is,

$$\mathbf{p}^d = \left(\frac{\mathbf{a}}{\mathbf{b}} \right) k - \left(\frac{\mathbf{a}}{\mathbf{a}^2 + \mathbf{b}} \right) \mathbf{e}, \text{ and} \quad (8)$$

$$y^{WC} = y^f = y^d. \quad (9)$$

II. Walsh's Contract with a Cost-Conscious Government

We assume that the government cares about the costs of financing the optimal contract. In particular, the government attaches some positive weights \mathbf{w} and \mathbf{f} to the social loss function and the contract, respectively. Normalize \mathbf{w} to 1 for simplicity. Walsh (1995) implicitly sets \mathbf{f} to zero. Thus, the government's loss function is written as follows:

$$L^G = \{[(y - y^*)^2 + \mathbf{b}\mathbf{p}^2] + \mathbf{f}(t_0 - t\mathbf{p})\}. \quad (10)$$

We also parameterize the central banker's trade-off between social loss and contract costs. The weight that the central bankers attaches to the incentive scheme (\mathbf{x}) reflects his "selfishness". The weight attached to social loss is $\mathbf{w}(=1)$. Thus, the central banker's utility function is written as follows:

$$U = \mathbf{x}(t_0 - t\mathbf{p}) - [(y - y^*)^2 + \mathbf{b}\mathbf{p}^2]. \quad (11)$$

The government minimizes its loss function and the central banker maximizes its utility function subject to equations (1) and (2), and each other's actions.⁹ The central banker's reaction function is as follows:

$$m = \{\mathbf{g} - (\mathbf{a} / \mathbf{a}^2 + \mathbf{b})\}\mathbf{e} - \mathbf{n} + (\mathbf{a}^2 / \mathbf{a}^2 + \mathbf{b})m^e + (\mathbf{a} / \mathbf{a}^2 + \mathbf{b})k - \{\mathbf{x} / 2(\mathbf{a}^2 + \mathbf{b})\}t \quad (12)$$

That is, the central banker chooses m to maximize his utility function. The public's (rational) expectations for inflation are given by

$$m^e = (\mathbf{a} / \mathbf{b})k - (\mathbf{x} / 2\mathbf{b})t. \quad (13)$$

The corresponding optimal contract that sets inflation expectations to zero implies a marginal penalization rate t^* as follows:

$$t^* = (2\mathbf{a} / \mathbf{x})k. \quad (14)$$

We assume that the government cannot observe the control error (\mathbf{n}) and has no early warning (signal) about the supply-side disturbance. Therefore, the government's optimization problem generates the optimal penalization rate as follows:

$$\hat{t} = \frac{2\mathbf{a}k}{\mathbf{x}}\Omega = t^*\Omega, \quad (15)$$

and the optimal contract takes the form

$$tr = t_0 - \frac{2\mathbf{a}k}{\mathbf{x}}\Omega\mathbf{p}, \quad (16)$$

⁹ Special cases deserve mention. If $\mathbf{f} = 0$, then Walsh's model emerges. If $\mathbf{x} = 0$, then the discretionary outcome results, since the central banker does not care about contract rewards (i.e., the central banker is benevolent). If $\mathbf{x} = \infty$, then the central banker optimizes by maximizing the transfer and sets $\mathbf{p} = 0$, eliminating the inflation bias (i.e., the Walsh result applies). Finally, $\mathbf{f} = \infty$ seems unreasonable, since the social loss function disappears from the government's decision process. As such, why would the government want to offer an incentive contract in the first place? Thus, we restrict $\mathbf{f} < \infty$.

where $\Omega = (\mathbf{x} + \mathbf{f})/(\mathbf{x} + 2\mathbf{f})$. That is, the government chooses the penalization rate \hat{t} to minimize its loss.

When the government does not care about the cost of the contract (i.e., when $\mathbf{f} = 0$), then $\mathbf{W} = 1$ and equation (16) reduces to the typical Walsh contract (equation 5). When the government is highly concerned about contract costs (i.e., $\mathbf{f} \rightarrow \infty$), then $\mathbf{W} \rightarrow 1/2$ and

equation (16) becomes $tr \rightarrow t_0 - \frac{\mathbf{a}k}{\mathbf{x}}\mathbf{p}$.¹⁰

Thus, the private sector's expectations (under complete information about the government's type) are given by

$$m^e = \left(\frac{\mathbf{a}}{\mathbf{b}} \right) k (1 - \Omega). \quad (17)$$

When the government does not care about the costs of the contract (i.e., $\mathbf{W} = 1$) the contract removes the inflation bias from the private sector's expectations. In contrast, when the government is extremely selfish and very concerned about the costs of the contract (i.e., $\mathbf{W} \rightarrow 1/2$), the contract can only eliminate half of the inflation bias. In this case, the private sector's expectations approach the following:

$$m^e \rightarrow \left(\frac{\mathbf{a}}{2\mathbf{b}} \right) k \quad (18)$$

¹⁰ The intuition as to why half the inflation bias remains when $\mathbf{f} \rightarrow \infty$ is difficult. When the government alters the marginal penalization rate (t), it affects the transfer ($t_0 - t\mathbf{p}$) directly through the marginal penalization rate and indirectly through expected money growth and, thus, expected inflation. The combination of these two effects generates the form of \mathbf{W} from the government's optimization.

Proposition 1: *Unless the government places zero weight on the cost associated with the central banker's incentive scheme, a linear inflation contract cannot completely eliminate the inflation bias.*

Proof: Substituting (17) and the optimal central banker penalization rate (\hat{t}) into the reaction function of the central banker gives:

$$m = \{\mathbf{g} - (\mathbf{a}/\mathbf{a}^2 + \mathbf{b})\}\mathbf{e} - \mathbf{n} + (\mathbf{a}/\mathbf{b})(1 - \Omega)k . \quad (19)$$

Clearly, the government's optimal contract does not correspond to the contract that eliminates the inflation bias (k) from the rate of money growth. This can happen only when $W = 1$, which implies that the government does not concern itself with contract costs.¹¹

Corollary 1: *The more "selfish" the central banker is, the lower the required marginal penalization rate is in the government's optimal contract. That is,*

$$\frac{\partial \hat{t}}{\partial \mathbf{x}} < 0 \quad (20)$$

Corollary 2: *The more "cost-conscious" the government is, the lower the required marginal penalization rate is in the government's optimal contract. That is,*

$$\frac{\partial \hat{t}}{\partial \mathbf{f}} < 0 \quad (21)$$

The optimal penalization rate in the government's contract depends on the preferences of the government and the central bank (i.e., \mathbf{f} and \mathbf{x} , respectively). The more selfish is the central banker (i.e., the higher \mathbf{x}) and the more concerned the government is about contract

¹¹ Alternatively, the discretionary outcome emerges with a benevolent central banker (i.e., $\mathbf{x} = 0$). That is the incentive scheme is irrelevant to the central banker and the original Barro and Gordon (1983a, b) model results.

costs (i.e., the higher f), the less important is social welfare. The optimal penalization rate equals the Walsh (zero expected inflation) penalization rate ($2ak/x$) times the weight factor that incorporates the preferences of the central bank and the government regarding the contract.

Observe that W varies between $1/2$ and 1. For a given f , as x increases from 0 to ∞ , Ω increases from $1/2$ to 1. That is,

$$\frac{\partial \Omega}{\partial x} > 0 . \quad (22)$$

For a given x , however, as f increases from 0 to ∞ , Ω falls from 1 to $1/2$. That is,

$$\frac{\partial \Omega}{\partial f} < 0 . \quad (23)$$

Now, f only affects the optimal penalization rate through W , thus leading to Corollary 2. On the other hand, x affects the optimal penalization rate through W and through the Walsh penalization rate (t^*). An increase in x lowers t^* and raises W . The effect on the Walsh penalization rate, however, dominates the effect on W , thus leading to Corollary 1.

What is the intuition behind these findings? The Walsh penalization rate (t^*) produces the zero-expected-inflation outcome, the first-best result. The government willingly achieves this social best only if it places zero value on contract costs. To the extent that the government places some weight on contract costs (i.e., f positive), the government optimally trades-off, at the margin, deviations from the first-best social optimum against contract costs. As the government's concern for the contract increases (i.e., f increases), the optimal penalization rate deviates further from (falls further below)

the Walsh penalization rate (i.e., \mathbf{W} falls below 1). Finally, the extent to which the optimal penalization rate deviates from the Walsh penalization rate also depends on the central banker's degree of selfishness. The more selfish the central banker, the smaller the deviation from the Walsh penalization rate. As a result, if the government wants to eliminate a certain fraction of the inflation bias, then as the government becomes more cost conscious, they need to select a more selfish central banker.

Now, the inflation rate, but not the output level, with the cost-conscious (CC) optimal contract $(\mathbf{p}^{CC}, y^{CC})$ differs from both those outcomes with credible precommitment and discretion. That is,

$$\mathbf{p}^f = \mathbf{p}^{WC} \leq \left(-\frac{\mathbf{a}}{\mathbf{a}^2 + \mathbf{b}} \right) \mathbf{e} + \left(\frac{\mathbf{a}}{\mathbf{b}} \right) k(1 - \Omega) = \mathbf{p}^{CC} < \mathbf{p}^d \quad (24)$$

$$y^f = y^{WC} = y^{CC} = y^d. \quad (25)$$

III. Alternative Contract with a Cost-Conscious Government

The Walsh contract was unable to eliminate completely the inflation bias as long as the government cares about the cost of the contract. This section demonstrates that an alternative contract does completely eliminate the inflation bias even with a cost-conscious government.

The intuition is as follows. The problem of time inconsistency is due to an expansionary bias shared by the central banker and government (society). The expansionary bias leads to the inflationary bias. But the inflationary bias emerges as the implication of the expansionary bias for output. That is, because the central banker and government (society) want output about the natural rate (i.e., $z > 0$), their actions under

discretion produce undesired inflation. This inflation is only the symptom and not the disease.

Walsh's contract treats the symptom; our alternative contract treats the disease. That is, the alternative contract penalizes the central banker for deviations of output from the natural rate. Thus, the alternative contract is as follows:

$$tr = t_0 - t(y - y^n)., \quad (26)$$

Thus, the central banker maximizes his reward by setting $y = y^n$. The expansionary bias tempts the central banker to push $y > y^n$. This penalizes the central banker with a lower reward from the contract.

Now, the central banker's utility function is written as follows:

$$U = \mathbf{x}[t_0 - t(y - y^n)] - [(y - y^*)^2 + \mathbf{b}p^2]. \quad (27)$$

The government minimizes its loss function and the central banker maximizes its utility function subject to equations (1) and (2), and each other's actions. The central banker's reaction function is as follows:

$$m = \{\mathbf{g} - [\mathbf{a}/(\mathbf{a}^2 + \mathbf{b})]\}\mathbf{e} - \mathbf{n} + [\mathbf{a}^2/(\mathbf{a}^2 + \mathbf{b})]m^e + [\mathbf{a}/(\mathbf{a}^2 + \mathbf{b})]k - \{\mathbf{x}\mathbf{a}/2(\mathbf{a}^2 + \mathbf{b})\}t. \quad (28)$$

That is, the central banker chooses m to maximize his utility function. The public's (rational) expectations for inflation are given by

$$m^e = (\mathbf{a}/\mathbf{b})k - (\mathbf{x}\mathbf{a}/2\mathbf{b})t. \quad (29)$$

The corresponding optimal contract that sets inflation expectations to zero implies a marginal penalization rate t^{**} as follows:

$$t^{**} = (2/\mathbf{x})k. \quad (30)$$

The government's optimization problem generates the same optimal penalization rate. Thus, the optimal contract takes the form:

$$tr = t_0 - (2/\mathbf{x})k(y - y^n). \quad (31)$$

The contract does not depend on how much the government cares about the contract cost (i.e., \mathbf{f} does not appear in the optimal contract).

Proposition 2: *No matter what weight the government attaches to contract costs, a linear output contract can completely eliminate the inflationary bias.*

Proof: Substituting (30) into the public's (rational) expectations of inflation

$$m^e = 0. \quad (32)$$

Now, substituting (32) and the optimal penalization rate (t^{**}) into the central banker's reaction function produces

$$m = \{\mathbf{g} - [\mathbf{a}/(\mathbf{a}^2 + \mathbf{b})]\}\mathbf{e} - \mathbf{n}. \quad (33)$$

Thus, the output and inflation outcomes are equivalent to those under credible commitment.

In sum, designing a contract that attacks the disease rather than the symptom completely eradicates the symptom. That is, an output contract eliminates the expansionary (inflationary) bias.

IV. Conclusion

Since the pioneering work of Kydland and Prescott (1977) and Barro and Gordon (1983a, b), numerous authors consider the institutional design of central banking. The goal is to reduce and/or eliminate the inflationary bias of discretionary monetary policy when

the government and the central bank each have an expansionary bias. The conservative central banker (Rogoff 1985 and Lohmann 1992) and the targeting (Canzoneri 1985, Garfinkel and Oh 1993, and Svensson 1997) approaches each must confront a trade-off between inflation prevention and stabilization policy. The contracting approach (Walsh 1995, and Persson and Tabellini 1993) appears to dominate in that the inflation bias is completely eliminated without affecting stabilization policy.

This paper alters one of the assumptions in the standard contracting model (i.e., the government does not care about contract costs) and demonstrates that the contracting approach does not, in general, eliminate completely the inflation bias. First, the optimal linear inflation contract does not completely neutralize the inflation bias whenever the government places some non-zero value on the contract costs. Second, the more concerned the government is about contract costs or the less selfish (more benevolent) the central banker is, the smaller is the share of the inflation bias eliminated by the contract. Third, no matter how concerned the government is about contract costs or how unselfish (benevolent) the central bank is, the contract always reduces the inflation bias by at least half.

Substituting a linear output contract for the linear inflation contract re-establishes the finding that a contract can completely eliminate the inflationary bias, even though the central banker cares about the contract cost. The problem is at root an expansionary bias in output. This bias produces the outcome (symptom) of higher inflation. The linear output contract treats the disease; the linear inflation contract treats the symptom.

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