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Fiscal Policy and the Implementation of the Walsh Contract for Central Bankers*

Haizhou Huang

International Monetary Fund, 700 19th Street, Washington, DC 20431, USA
E-mail: hhuang@imf.org

and

A. Jorge Padilla

CEMFI, Casado del Alisal 5, 28014 Madrid, Spain
E-mail: padilla@cemfi.es

We develop a simple macroeconomic model where the time inconsistency of optimal monetary policy is due to tax distortions. If fiscal policy is exogenously fixed at its optimal level, a Walsh contract (Walsh, 1995) offered to an independent central bank implements the optimal monetary policy. When fiscal policy is determined endogenously, however, this contract is subject to strategic manipulation by the government, which results in a suboptimal policy mix. Implementing the optimal policy mix requires either that the central bank enjoy primacy over the fiscal authority or that fiscal policy be also delegated to an independent authority.

Key Words: Central banking; Optimal contracts; Monetary and fiscal policy; Strategic manipulation; Nash implementation.

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1. INTRODUCTION

Until quite recently, only two solutions were offered by the theoretical literature to the time inconsistency problem of optimal monetary policy (firstly stated by Kydland and Prescott 1977, and Calvo 1978). The first

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solution (Barro and Gordon 1983, Backus and Driffill 1985, and Barro 1986) hinged upon reputational effects,[1] while the second (Rogoff 1985) required the delegation of monetary policy to a "conservative" central banker. Both solutions were obtained within a similar game-theoretic framework, in which the relationships between players were not governed by explicit contracts. In a seminal contribution, Carl Walsh (1995) departed from this framework of analysis and offered an entirely new solution to the time inconsistency problem. His solution is based on the recent developments of contract theory within the principal-agent framework.[2] The government (the principal) writes an inflation-contingent contract with an independent central bank (the agent) to induce the latter to implement the optimal inflation rate. In contrast with previous proposals, this last solution fully eliminates the inflationary bias of discretionary policy while achieving an optimal response to shocks, even in the presence of private information.

His work, as many other previous analyses, however, neglects the interplay between monetary and fiscal policy. Many economists are becoming dissatisfied with this omission. For instance, Nordhaus (1994, p. 139) points out:[3]

> "No one would dream of designing the human anatomy by disconnecting the controls of the left and right sides of the body. Yet, for the most important economic controls in a modern economy, monetary and fiscal policies, economists today generally endorse the separation of powers as a way of optimizing noninflationary growth."

In this paper, we examine whether an incentive contract for central banks *à la* Walsh (i.e., a contract specifying an inflation-contingent remuneration scheme) can successfully implement the optimal monetary and fiscal policy mix when the interplay between the two policies is fully taken into account. To do so, we develop a simple macroeconomic model where the time inconsistency of optimal monetary policy is due to tax distortions. This model is built upon Alesina and Tabellini (1987), who showed that binding commitments to monetary policy are not necessarily welfare improving if monetary and fiscal policies are not coordinated. In contrast to them, we conduct our analysis within a contracting framework, as in Walsh (1995), and focus our attention on the attainability of the optimal policy mix.[4]

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[1]See also Canzoneri (1985) for a proposal closely related to Barro and Gordon (1983).

[2]See also Persson and Tabellini (1993), Canzoneri *et al.* (1997), and Fratianni *et al.* (1997) for related analyses on the design of institutions for monetary stability within a principal-agent framework.

[3]Similar views have been recently expressed by Goodhart (1993) and Fischer (1995). In particular, Goodhart (1993, p. 12) considers that the relevant "argument is not really about coordination [of monetary and fiscal policies], but about which policy instrument should move first and have primacy". See section 4 for further discussion of this point.

[4]Our paper is also related to Debelle (1996) and Debelle and Fischer (1994), who extend the Rogoff's (1985) model to include a fiscal authority whose preferences put

We show that if fiscal policy is exogenously fixed at its optimal level, a contract *à la* Walsh offered to an independent central bank implements the optimal monetary policy. Such a contract is shown to depend on the economy's tax rate as long as the central bank is tied by the government budget constraint and the public opinion is concerned with deviations from a desired level of public expenditure. This opens the back-door for government's intervention. The government, who retains all fiscal powers, finds it in its best interest to raise the tax rate from its optimal level in order to divert resources from the central bank's budget (which is determined by the contract) so as to finance some extra public expenditure. This results in a suboptimal Nash equilibrium in which distortionary taxation is too high and inflation is too low.

Obviously, the government would prefer to be able to precommit to the optimal tax rate since then the central bank, whose incentives are determined by the Walsh contract, would also choose the optimal inflation rate. But even when the government cannot precommit to the optimal fiscal policy, we can show that it may still prefer to delegate monetary policy to a central bank subject to the Walsh contract: e.g., this option is strictly preferred when public expenditure is highly valuable from an electoral viewpoint. This makes our problem all the more interesting.

The main lesson to draw from our analysis is that the "desirable" properties of the Walsh contract will be undermined by the opportunistic behavior of the fiscal authority.[5] To the extent that until now no country has made use of a (*strictu senso*) Walsh contract to discipline its monetary authority, our theoretical analysis constitutes an experiment whose predictions are not meant to be descriptive of today's events but intended to constitute a warning. Notwithstanding this caveat, note that if a Walsh contract (or, more generally, an inflation contingent performance contract) is used, the government's incentives to manipulate it cannot be disregarded as insignificant. First, the central bank's budget is a magnitude of macroeconomic significance. If the government can secure a share of the central bank's resources and spend them in politically sensitive programs, its payoff from behaving opportunistically is likely to be high. Furthermore, as we shall see below (see footnote 13), it is precisely when the electorate values extra spending more highly that the inflationary distortions caused by the government's opportunistic actions are largest.

more weight on government spending than the central bank's or the society's preferences do. Our model differs from theirs in several dimensions. In particular, preferences are not arbitrarily given in our model: i.e. government preferences are in line with the society's preferences and the central bank's preferences are designed via a contract.

[5]This is consistent with McCallum's (1995) view that optimal contracts for central bankers *à la* Walsh only relocate "the motivation for dynamic inconsistency" from the central bank to the government.

The paper proceeds as follows. We set up the model and discuss the nature of the time inconsistency problem in section 2. In section 3, we show that the Walsh contract solves the time inconsistency problem in our setting when fiscal policy is exogenously given, but it is subject to strategic manipulation when the government's tax rate choice is endogeneized. In section 4, we discuss alternative institutional designs which might help to implement the optimal policy mix. Section 5 concludes.

2. THE MODEL

2.1. The basic setup

As in Alesina and Tabellini (1987), we consider a deterministic economy where unexpected monetary policy only affects aggregate demand, and fiscal policy only affects aggregate supply.[6] Both monetary and fiscal policy choices are taken by the government. In this economy, output is given by:

$$y = \alpha(\pi - \pi^e - \tau),\ \alpha > 0, \tag{1}$$

where y is the log of real output; π and π^e are, respectively, the actual and expected inflation rates; and τ is the tax rate on the total revenue of firms.[7] The government's sources of revenue are thus the corporate tax and the inflation tax: $\tau + \pi$.

Let g denote the ratio of public expenditure to output, then after suitable approximations and simplifications, the government's budget constraint can be written as:

$$g = \tau + \pi, \tag{2}$$

so that in this model, for a given value of g, money creation reduces through seignorage the level of "distortionary" taxes needed to balance the budget. Notice that, as in Alesina and Tabellini, our static model assumes that public expenditure cannot be financed by issuing debt and, therefore, it is residually determined from the budget constraint once tax rates and money seignorage have been fixed.

As is standard in the related literature, the government, who is directly accountable for its actions to the general public (the electorate), sets its

[6]Our main result carries out to more complex settings including random supply shocks and asymmetric information. This is, however, the simplest model we can think of that captures the interactions between a fiscal authority and a central bank subject to a Walsh contract. For further discussion of this model and, in particular, of its micro-foundations, see Alesina and Tabellini (1987).

[7]Equation (1) implicitly assumes that money demand is not affected by fiscal policy and, therefore, that fiscal policy is not subject to time inconsistencies. Otherwise, an independent central bank could not directly control inflation, since it would be *jointly* determined by the money supply and the tax rate. Given the purpose of this paper, it should be obvious that relaxing this assumption would only strengthen our results.

monetary and fiscal policies to maximize the voters' utilities, which we take to be homogeneously given by:

$$V(\pi,\tau) = -\frac{1}{2}\left[\pi^2 + \mu_1 y^2 + \mu_2 (g-\overline{g})^2\right] \ , \mu_1 > 0,\ \mu_2 \geq 0. \qquad (3)$$

Thus, the government wishes to minimize the deviations of inflation and output from their target values, which are normalized to zero for simplicity, and, in addition, to minimize the deviations of public expenditure from a non-negative target $\overline{g}$. If $\overline{g} > 0$, the government would like to create unexpected inflation in order to finance the public expenditure target without increasing taxes and, hence, without a large cost in terms of output.

2.2. The time inconsistency problem

Suppose that the government could credibly commit to a given inflation rate, i.e. $\pi = \pi^e$, hence, $y = -\alpha\tau$. The equilibrium monetary and fiscal policies can be directly obtained from the first-order conditions associated with (3), where $y = -\alpha\tau$:[8]

$$\pi^C(\tau) = \frac{\mu_2}{1+\mu_2}(\overline{g}-\tau), \text{ and } \tau^C(\pi) = \frac{\mu_2}{\mu_1\alpha^2+\mu_2}(\overline{g}-\pi). \qquad (4)$$

Solving out these two equations together, we obtain the optimal inflation and tax rates under commitment (see Figures 1 and 2):

$$\pi^C = \mu_1\mu_2\alpha^2\overline{g}/\Delta, \text{ and } \tau^C = \mu_2\overline{g}/\Delta, \qquad (5)$$

where $\Delta = \mu_1\alpha^2 + \mu_1\mu_2\alpha^2 + \mu_2 > 0$. From (5), we can also obtain the equilibrium values of output and public expenditure under commitment: $y^C = -\alpha\tau^C < 0$ and $g^C = \tau^C + \pi^C < \overline{g}$.

The commitment solution just derived, which shall constitute our benchmark for future comparisons, is obviously time inconsistent. Indeed, for $\overline{g} > 0$, $\partial V/\partial\pi > 0$ at $\pi^e = \pi^C$, so that the government always finds it optimal to raise inflation unexpectedly in order to finance some extra public expenditure at an overall lower cost in terms of output. The time-consistent policy mix, (π^D, τ^D), is characterized by the first-order conditions associated to (3), where, in addition, we require that the expected inflation rate equals its equilibrium value. Thus, (π^D, τ^D) solves the following pair of

[8]The second-order conditions associated with this problem (as well as those of the time-consistent problem below) are trivially satisfied since $V(\pi,\tau)$ is globally concave with respect to its arguments.

equations:

$$\begin{aligned}\pi^D(\tau) &= \frac{\mu_2}{1+\mu_2}(\overline{g}-\tau) + \frac{\mu_1\alpha^2}{1+\mu_2}\tau, \\ \tau^D(\pi) &= \frac{\mu_2}{\mu_1\alpha^2+\mu_2}(\overline{g}-\pi).\end{aligned} \tag{6}$$

Comparing $\pi^C(\tau)$ and $\pi^D(\tau)$ in equations (4) and (6), respectively, we can derive for any given tax rate the inflationary bias which characterizes the discretionary monetary policy. This is equal to $\pi^D(\tau)-\pi^C(\tau) = \mu_1\alpha^2\tau/(1+\mu_2) > 0$.

Hence, in the absence of precommitment, we have that (see Figures 1 and 2):

$$\pi^D = \frac{2\mu_1\mu_2\alpha^2\overline{g}}{(\Delta+\mu_1\mu_2\alpha^2)} > \pi^C, \text{ and } \tau^D = \frac{\mu_2\overline{g}}{(\Delta+\mu_1\mu_2\alpha^2)} < \tau^C. \tag{7}$$

From (7), it follows that $0 > y^D = -\alpha\tau^D > y^C$ and $\overline{g} > g^D = \tau^D + \pi^D > g^C$. Therefore, the discretionary solution involves greater output and public expenditure levels but also a larger inflation rate than the commitment solution. In equilibrium, $\pi^e = \pi^D$, which implies that $V(\pi^D,\tau^D) < V(\pi^C,\tau^C)$. Note that, although the government would like to precommit to a given inflation rate, π^C, it cannot do so in the absence of a credible implementation mechanism.

FIG. 1. $\mu_2 > \mu_1\alpha^2$

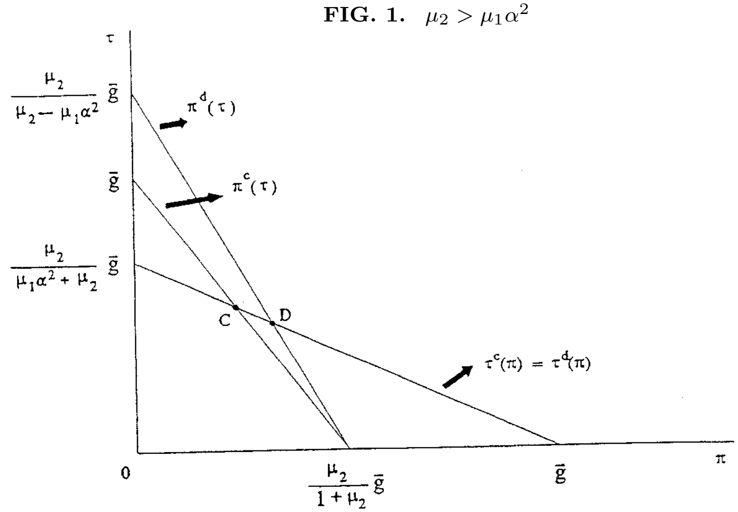
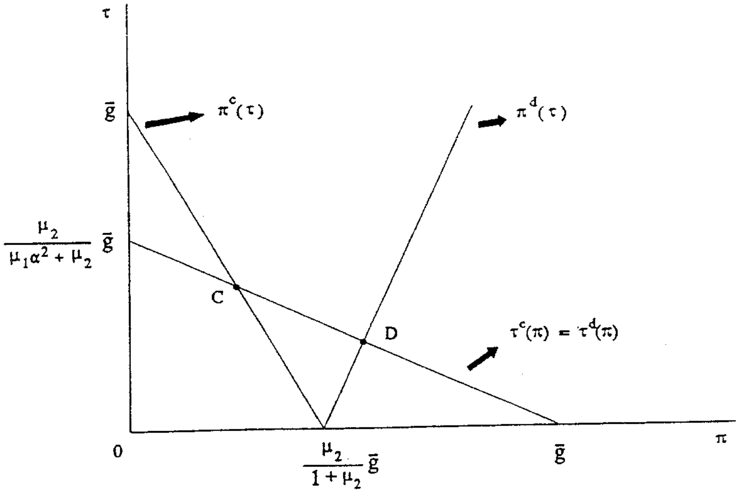


FIG. 2. $\mu_2 < \mu_1\alpha^2$



3. FISCAL POLICY AND THE WALSH CONTRACT

In this section we consider a candidate solution for the time inconsistency problem discussed above, which is closely related to that in Walsh (1995). This solution consists in delegating monetary policy to an independent central banker whose actions are governed by an inflation-contingent contract (henceforth, the Walsh contract). The government, however, retains its fiscal authority untouched. As noted by Goodhart (1993, p. 4), under this proposal, the central banker "is autonomous with respect to the powers used to achieve its statutorily defined objective, but not *independent* to choose its objectives". In fact, the government designs the central banker's contract so as to induce her to carry out a monetary policy free from the inflationary bias, $\pi^D(\tau) - \pi^C(\tau)$, which characterizes the centralized monetary policy in the absence of precommitment.

3.1. Exogenous fiscal policy

Suppose that the tax rate is exogenously given and equal to τ, then the problem of the government is simply to design t, the contract transfer to the central banker, such that the latter finds in her best interest to set an inflation rate equal to $\pi^C(\tau)$, subject to the requirement that, in equilibrium, $t \geq 0$, i.e. the central banker's reservation utility is normalized to zero.[9]

[9] Alternatively, we could have considered that the government's problem was to determine the amount of the central bank's resources which had to be transferred to the Treasury to finance the government's expenditure, subject to the central bank's budget

Given the contract transfer t, the budget constraint in (2) becomes $g+t = \tau + \pi$. Substituting this last expression and equation (1) into equation (3), we can rewrite the government's objective function as:

$$V(\pi,\tau;t) = -\frac{1}{2}\left[\pi^2 + \mu_1\alpha^2(\pi - \pi^e - \tau)^2 + \mu_2(\tau + \pi - t - \overline{g})^2\right] . \qquad (8)$$

For given inflation and tax rates, an increase in the transfer made to the central banker t reduces the level of public expenditure. Therefore, since in equilibrium $g = \tau + \pi - t \leq \overline{g}$,[10] $V(\pi,\tau;t)$ is decreasing in t.

Following Walsh (1995), we take $t = t(\pi,\tau)$ equal to $\widetilde{t}(\pi,\tau) + V(\pi,\tau;0)$ so that, for all τ, we have that:[11]

$$\frac{\partial\widetilde{t}(\pi^C(\tau),\tau)}{\partial\pi} + \frac{\partial V(\pi^C(\tau),\tau;0)}{\partial\pi} = 0, \qquad (9)$$

and

$$t(\pi^C(\tau),\tau) = \widetilde{t}(\pi^C(\tau),\tau) + V(\pi^C(\tau),\tau;0) = 0, \qquad (10)$$

i.e., $t(\pi^C(\tau),\tau)$ is equal to the central banker's normalized reservation utility. Substituting $\pi^C(\tau)$ in (4) into equation (3), we have $\partial V(\pi^C(\tau),\tau;0)/\partial\pi = \mu_1\alpha^2\tau$. Hence, (9) can be rewritten as

$$\frac{\partial\widetilde{t}(\pi^C(\tau),\tau)}{\partial\pi} = -\mu_1\alpha^2\tau. \qquad (11)$$

Solving out the differential equation in (9) subject to (10), we obtain a closed expression for the central banker's contract transfer:

$$t(\pi,\tau) = t_0 - \mu_1\alpha^2\tau\pi + V(\pi,\tau;0) \leq 0, \qquad (12)$$

where $t_0 = \mu_1\alpha^2\tau\pi^C(\tau) - V(\pi^C(\tau),\tau;0)$ is such $t(\pi^C(\tau),\tau) = 0$.

Hence, $t(\pi,\tau)$ implements $\pi^C(\tau)$ for all τ, by construction.[12] Under the Walsh contract, the central banker's objective function coincides with the

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constraint. In this case t would be negative with a finite lower bound. Although we shall use both interpretations of the problem as interchangeable when providing intuition for our results, the interpretation used in the text makes the algebra slightly simpler and facilitates analytical comparisons with Walsh (1995).

[10]Suppose that $g = \pi + \tau - t > \overline{g}$. Then setting $\pi' < \pi$ and $\tau' < \tau$ so that $g' = \pi' + \tau' - t = g - \varepsilon < g$ ($\varepsilon > 0$ arbitrarily small) unambiguously raises the government's utility, since inflation, output, and public expenditure, all get closer to their respective targets.

[11]This transformation is made here for analytical convinience. Similar results to those obtained here and in the next section would be obtained, had we considered somewhat different specifications of the contract transfer (for instance, $t(\pi,\tau) = \widetilde{t}(\pi,\tau) + V(\pi,\tau;t)$). More importantly, we are implicitly assuming that utility is transferable.

[12]Note that $t(\pi,\tau)$ is globally concave in π. Hence, $\pi^C(\tau)$, which is the solution to equation (9) above, is indeed a maximum for the central banker's problem.

government's utility function in the absence of transfers *plus* an extra term, $\tilde{t}(\pi, \tau) = -\mu_1 \alpha^2 \tau \pi$, which is introduced to correct for the inflationary bias of monetary policy in the absence of precommitment (see equation (11)). In equilibrium, the transfer made to the central banker $t(\pi^C(\tau), \tau)$ is zero, just enough to induce her to accept the contract. Therefore, if the tax rate is exogenously given at τ^C, the Walsh contract can credibly and successfully implement the commitment outcome (π^C, τ^C), maximizing the chances of re-election for the incumbent government. The tax rate, however, is not exogenous but is chosen optimally by the government. In the next section, we endogenize the tax rate when the central banker is subject to the Walsh contract derived above.

3.2. Strategic manipulation via tax rates

Once monetary policy is delegated to an independent authority, the government and the central banker will act as Nash players taking everybody else's actions as given. In this section, our main concern is to determine whether the Walsh contract derived above will implement the commitment outcome (π^C, τ^C) as a Nash equilibrium. Under the Walsh contract, the central banker's best-reply function is given by $\pi^C(\tau)$, so that π^C indeed constitutes her best reply to τ^C. We can show, however, that τ^C is *not* the government's best reply to π^C.

Given the contract transfer $t = t(\pi, \tau)$ and the inflation rate π, the government will choose $\tau = \tau^W(\pi)$ to maximize $V(\pi, \tau; t)$. The government's marginal utility of a tax increase is given by:

$$\frac{\partial V(\pi, \tau; t)}{\partial \tau} = \frac{\partial V(\pi, \tau; 0)}{\partial \tau} + \mu_2 \left[t + (g - \overline{g}) \frac{\partial t(\pi, \tau)}{\partial \tau} \right], \tag{13}$$

where, from equations (4) and (12), and after some simplifications, we have that:

$$\frac{\partial t(\pi, \tau)}{\partial \tau} = \left(\mu_1 \alpha^2 + \mu_2\right) \left(\pi^C(\tau) - \pi\right) + \mu_1 \alpha^2 \tau \frac{d\pi^C(\tau)}{d\tau}, \tag{14}$$

and

$$\frac{d\pi^C(\tau)}{\partial \tau} = -\mu_2 / (1 + \mu_2) \leq 0. \tag{15}$$

Setting $\pi = \pi^C$ and $\tau = \tau^C$ yields $\partial V(\pi^C, \tau^C; 0)/\partial \tau = 0$, $t(\pi^C, \tau^C) = 0$, and $g = g^C < \overline{g}$. Hence, for $\mu_2 > 0$,

$$\frac{\partial t(\pi^C, \tau^C)}{\partial \tau} = -\frac{\mu_1 \mu_2 \alpha^2 \tau^C}{(1 + \mu_2)} < 0, \tag{16}$$

and

$$\frac{\partial V(\pi^C, \tau^C; t(\pi^C, \tau^C))}{\partial \tau} = \frac{\mu_1 \mu_2 \alpha^2 \tau^C}{(1+\mu_2)} \left(\overline{g} - g^C\right) > 0. \tag{17}$$

From equation (17), it is clear that (π^C, τ^C) is *not* a Nash equilibrium, i.e., the Walsh contract fails to implement the commitment solution as a Nash equilibrium when fiscal policy is endogenously determined.

Intuitively, given π^C, the government prefers to set a tax rate $\tau^W(\pi^C) > \tau^C$: a marginal increase in τ reduces the transfer made to the central banker t (see equation (16)), which helps to finance some additional public expenditure at a negligible (second-order) cost in terms of output and inflation and, therefore, unambiguously raises the government's utility. More fundamentally, this result owes to the government's ability to manipulate the central banker's policy function, i.e. $d\pi^C(\tau)/d\tau \neq 0$, which in turn originates from the fact that the latter's objectives incorporate the public's concern for public expenditure together with the government's budget constraint, as long as $\mu_2 > 0$.[13] (In terms of Bulow, Geanakoplos and Klemperer (1985), the two instruments τ and π are strategic substitutes for $\mu_2 > 0$.)

In a Nash equilibrium, the government will set a tax rate τ^W to maximize $V(\pi, \tau; t)$ and the central banker will decide on an inflation rate $\pi^W = \pi^C(\tau^W)$. Hence, τ^W solves:

$$\frac{\partial V(\pi^C(\tau), \tau; t(\pi^C(\tau), \tau))}{\partial \tau} = -\mu_1 \alpha^2 \tau + \mu_2 \left(\frac{\overline{g} - \tau}{1+\mu_2}\right) \left(1 + \frac{\mu_1 \mu_2 \alpha^2 \tau}{1+\mu_2}\right) = 0, \tag{18}$$

which follows from equations (4) and (13). Note that equation (18) has two roots: one negative, which happens to be a local minimum, and one positive, which is a global maximum, as illustrated in Figure 3 below. Since, moreover, $\partial V(\pi^C(\tau), \tau; t(\pi^C(\tau), \tau))/\partial \tau$ is a continuous function that takes negative values for $\tau \geq \overline{g}$ and positive values for $0 \leq \tau \leq \tau^C$, it follows that $\tau^C < \tau^W < \overline{g}$.[14] As a result, $\pi^W < \pi^C$ and $V(\pi^W, \tau^W; t(\pi^C(\tau^W, \tau^W)) <$

[13] Note that if $\mu_2 = 0$, (π^C, τ^C) is a Nash equilibrium. In this case, however, there is no time inconsistency problem since the government need not unexpectedly inflate the economy to finance the public expenditure target. Setting $\pi = \tau = 0$ in this case is both optimal and time consistent.
As argued in section 1 above, the inflationary distortions caused by the government's opportunistic actions are largest when the electorate's valuation for g is greatest, i.e. when μ_2 is large. To see this, just note that within the relevant range (i.e. for any value of $\tau < g$), $\frac{\partial}{\partial \mu_2}\left[\frac{\partial \pi^C(\tau)}{\partial \tau}\right] > 0$.

[14] For $\tau = \tau^W \in (\tau^C, \overline{g})$ solving the first-order condition in (18), the second-order condition is obviously satisfied:

$$\frac{\partial V(\pi^C(\tau^W), \tau^W; t(\pi^C(\tau^W), \tau^W))}{\partial \tau} = -\frac{\mu_2}{\tau^W}\left(\frac{\overline{g} - \tau^W}{1+\mu_2}\right) < 0.$$

$V(\pi^C, \tau^C; t(\pi^C(\tau^C), \tau^C))$, since $t(\pi^C(\tau^W), \tau^W) = t(\pi^C(\tau^C), \tau^C)$ is equal to 0 and (π^C, τ^C) maximizes $V(\pi, \tau; 0)$.

As we argued above, the government raises τ to extract additional rents from the central banker with which to finance some extra public expenditure. The central banker, who under the Walsh contract implements $\pi^C(\tau)$, lowers π in response. In equilibrium, any further increase in τ generates a distortion in output that more than offsets the welfare gains associated to a higher expenditure level and a lower inflation. In conclusion, once fiscal policy is endogeneized, delegating monetary policy to an independent central banker operating under a Walsh contract, results in a *unique* Nash equilibrium (π^W, τ^W) featuring an *excessively large* tax rate and *too little* inflation.[15]

To conclude, notice that even if the government cannot precommit itself to the optimal tax rate, it may still prefer to delegate its monetary policy to a central bank subject to the discipline of the Walsh contract. Indeed, it is straightforward to show that this option is superior to the time-consistent discretionary policy option if $\mu_2/\mu_1$is sufficiently large, i.e. when the electorate values public expenditure more and relatively disregards the distortions caused by the extra taxes needed to finance it.[16]

4. IMPLEMENTING THE OPTIMAL POLICY MIX

As shown above, the Walsh contract is subject to the government's strategic manipulation. In order to isolate the central banker from fiscal authority interventions, and thus to implement the optimal policy mix, we have to change the central banker's objective function to make her policy decisions be unrelated to the corporate tax rate and, consequently, inde-

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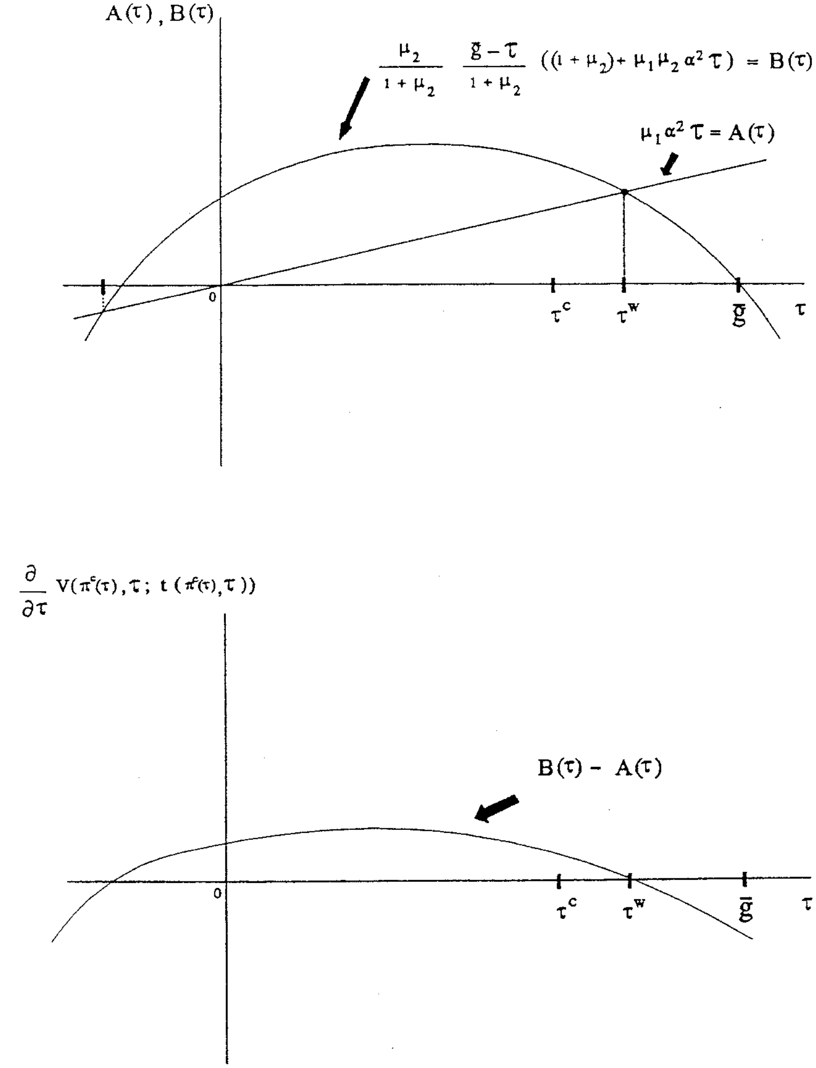
[15]In contrast with our result, Debelle and Fischer (1994) find that inflation tends to be higher in a situation of fiscal dominance, when the fiscal authority chooses the deficit and forces the central bank to finance it. This is because they assume that the fiscal authority is less concerned with inflation and has a greater preference for public expenditure than the central bank, whose preferences are exogenously given and, therefore, not manipulable.

[16]To see this formally, recall that $\pi^W < \pi^C < \pi^D$ and that $\tau^W > \tau^C > \tau^D$. The last inequality implies that $y^W < y^D$. Furthermore, after some algebraic manipulations, we have that since $t(\pi^W, \tau^W) = 0$,

$$\begin{aligned} g^W &= \pi^W + \tau^W = \frac{\mu_2 \overline{g} + \tau^W}{1+\mu_2}, \text{ and} \\ g^D &= \pi^D + \tau^D = \frac{\mu_2 \overline{g} + \tau^D}{1+\mu_2} + \frac{\mu_1 \alpha^2}{1+\mu_2}\tau^D. \end{aligned}$$

Hence, as $\mu_1/\mu_2 \to 0$, $g^D < g^W < \overline{g}$, since $\tau^W > \tau^D$. But in that case the electorate mainly cares about deviations in inflation and public expenditure from their respective targets, disregarding output deviations, so that $V(\pi^W, \tau^W; 0) > V(\pi^D, \tau^D; 0)$.

FIG. 3.


A(τ), B(τ)
$\frac{\mu_2}{1+\mu_2} \frac{\bar{g}-\tau}{1+\mu_2} ((1+\mu_2)+\mu_1\mu_2\alpha^2\tau) = B(\tau)$
$\mu_1\alpha^2\tau = A(\tau)$
0
τ^c
τ^w
$\bar{g}$
τ
$\frac{\partial}{\partial\tau} V(\pi^c(\tau), \tau; t(\pi^c(\tau), \tau))$
B(τ) - A(τ)
0
τ^c
τ^w
$\bar{g}$
τ

pendent of the government's budget constraint. Since the tax rate affects both the growth and the public expenditure targets (see equation (2)), this can only be achieved if the central banker's utility function is made effectively independent of these two targets, in contrast with the utility function implied by the Walsh contract. That is, the central banker's utility function should be changed to $t = -\left(\pi - \pi^C\right)^2$, so that she is actually "forced" to optimally choose an inflation rate equal to the target π^C. Note that, in contrast with the contract of the previous section, the government cannot manipulate the central banker's policy function under the current contract, i.e. $d\pi^C(\tau)/d\tau = 0$ for all $\mu_2 \geq 0$. Therefore, taking her choice as given, the government, who represents the public interest and holds the fiscal authority, finds it optimal to fix the tax rate at τ^C. Therefore, but quite trivially, the commitment solution is successfully implemented via a "forcing" contract.[17]

The forcing contract solution requires a constitutional change that places the central bank on top of the democratically-elected government concerning *all* economic decisions. That is, the government's economic policy must respect the constraints imposed by the monetary authority and *not* vice versa. Any conflict of interest should be resolved in favor of the central bank. This is a much stronger condition than simply letting the monetary authority to "move first and have primacy", in Goodhart's words (see footnote 3 above). For good or for bad, such a dramatic constitutional change has not been observed in any democratic society. The German Bundesbank, universally considered the paradigm of an independent central bank, certainly does not enjoys such powers. Even a *currency board*, which is not subject to intervention from fiscal policy *but* still has to take into account the "crowding-out" effect associated to a large deficit, does not have these powers either (see Osband and Villanueva (1993)).[18] Moreover, implementing this contract, even in the form of an inflation target with penalties, is against the government's own interest *ex post*: the government would be subject to a new time inconsistency problem shall it instruct the central bank to target an inflation π^C. Therefore, the forcing contract, although theoretically appealing, is unlikely to emerge in practice.

An alternative solution would be to delegate fiscal policy to an independent institution, whose objectives are optimally designed so that, given

[17]Note that "inflation targeting" is just another form of forcing contract (see Leiderman and Svensson (1995) for further discussion of this issue). This solution is also equivalent to Rogoff's (1985) proposal of delegating monetary policy on a "conservative" central banker with the particularity that, because of the absence of supply shocks, the optimal degree of conservativeness has to be infinite.

[18]The Maastricht Treaty, although it does not offer a proper forcing contract to the European Central Bank (ECB), it does attempt to isolate the ECB from the preassures stemming from the "crowding-out" effect, establishing quantitative limits to national governments' deficits. See Goodhart (1992) and Kenen (1992) for further discussions.

the inflation rate prevailing in the economy π, it chooses a tax rate $\tau^C(\pi)$. At the same time, the central banker should be offered a Walsh contract designed to implement $\pi^C(\tau)$. In equilibrium, the commitment solution is again implemented as a Nash equilibrium.

This solution relies upon delegating fiscal policy to an independent institution. This is because, in the absence of delegation, the government could not credibly commit its fiscal policy. The underlying principle here is that contracts involving a single party are neither credible nor enforceable. In any modern society, however, depriving the government of its fiscal authority (tax collection and public expenditure in our context) is equivalent to dispossessing the government of its main tool, and to removing the fundamental reason for its existence. This may explain why we have not observed anything like this in practice.

5. CONCLUSIONS

We have shown that the contract derived by Walsh (1995) to solve the time inconsistency problem of optimal monetary policy is vulnerable to strategic manipulation by the government when fiscal and monetary policies are interdependent and the government is free to exercise its fiscal authority. As a result, a suboptimal Nash equilibrium emerges in which distortionary taxation is too high and inflation is too low. Implementing the optimal policy mix would require either that: (i) the central bank have primacy over the fiscal authority (that is, her decisions be unrestricted by the government's budget constraint), or (ii) fiscal policy be delegated to an independent authority also subject to an "optimal" contract. Neither of these solutions, however, is very likely to see the light in practice since both of them involve dispossessing the executive branch of government of its core powers. Our paper thus casts doubts on the optimality of simple contractual solutions *à la* Walsh to the central bank's time inconsistency problem, and suggests that a complete solution to the problem requires consideration of the whole structure of government and, in particular, of all its policy instruments.

An interesting direction for further research is to consider the impact of alternative political constitutions on the performance of monetary and fiscal policies. For instance, we conjecture that the first-best policy mix could be implemented under a constitution in which the executive branch of government is likely to face a strong counter-balance from the legislative branch. For instance, the first best could be achieved when the legislative branch (in the U.S., the Congress and the Senate) is controlled by a political party who is ideologically committed to tax cuts (the U.S. Republican Party), while another party, who is endowed with different preferences (the U.S. Democratic Party), holds the executive power. In this setting, a contract between the legislative and the executive branches of government which restricts the discretionary power of the latter on fiscal policy is viable and may succeed in implementing the optimal policy mix.[19]

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[19] For a thorough discussion of the executive-legislative interaction and the electoral process in the U.S., see Alesina and Rosenthal (1995), specially chapter 3.

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