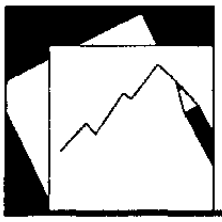
WP/01/205



IMF Working Paper

Central Bank Independence and the Design of Fiscal Institutions

Francesca Castellani and Xavier Debrun

INTERNATIONAL MONETARY FUND

 WP/01/205

IMF Working Paper

IMF Institute

Central Bank Independence and the Design of Fiscal Institutions

Prepared by Francesca Castellani[1] and Xavier Debrun[2]

Authorized for distribution by Roland Daumont

December 2001

Abstract

We study the desirability of reforming fiscal institutions along with the delegation of monetary policy to an independent central bank. The model provides a rationale for discipline-enhancing fiscal institutions and highlights some of their desirable features. Three main results emerge. First, when the government can pre-commit on fiscal strategies, fiscal discretion is optimal only if the central bank strictly targets the socially optimal inflation rate. Second, without pre-commitment technology, fiscal restraints are desirable and contingent on the strategic interaction between monetary and fiscal authorities. Third, deficit rules are generally inefficient, and instrument-specific rules based on a combination of linear and quadratic contracts with targets are called for.

JEL Classification Numbers: E52, E61, E62

Keywords: central bank independence, policy mix, fiscal rules, linear and quadratic contracts with targets.

Author's E-Mail Address: castelf5@hei.unige.ch, xdebrun@imf.org.

---

[1] Economics section, Graduate Institute of International Studies, Geneva.

[2] We benefited from insightful comments by Andrew Feltenstein and Charles Wyplosz. Of course, we are solely responsible for the remaining errors and omissions.

Contents Page

I. INTRODUCTION

Since Rogoff's (1985) seminal contribution, the delegation of monetary policy to an independent central bank has been put forward as a possible solution to the well-known inflationary bias of the time-consistent policy (Barro and Gordon, 1983). Aside from reputation building, the solution to the time-inconsistency problem involves central banks as independent agents facing incentives that differ from those of the representative government (the *principal*). In Rogoff's framework, the time-consistent inflation rate is reduced thanks to the delegation of monetary policy to a "*weight-conservative*" central banker, that is relatively more averse to inflation than the Society's median voter. In a stochastic environment, a weight-conservative central bank delivers a sub-optimal stabilization of aggregate *supply* shocks so that the optimal appointment decision depends on a trade-off between *credibility* (lower time-consistent inflation) and *flexibility* (greater output stability). Hence, weight-conservatism does not permit implementation of the optimal commitment rule, although an overriding mechanism that allows the government to temporarily return to monetary discretion improves the outcome (Lohmann, 1992). Interest in the design of monetary institutions was renewed by Persson and Tabellini (1994), Walsh (1995), and Svensson (1997) who used the principal-agent framework to investigate the role of other delegation mechanisms such as performance contracts and inflation targets. Overcoming the credibility-flexibility trade-off, those mechanisms implement the "commitment rule" as a time-consistent solution. A vast literature on the optimal design of monetary institutions rapidly developed to test the robustness of that result in more complex environments.[3] Those extensions generally conclude that monetary delegation entails costs and propose refinements to the optimal delegation scheme.

Here, we depart from the existing literature, which concentrates on the design of monetary institutions. We draw attention to the principal source of the time-inconsistency problem (i.e., the government's incentives) and study the design of *fiscal* institutions in the context of strategic interaction between the government and the independent central bank. With fiscal policy in the hands of political authorities, central bank independence results in a non-coordinated policy mix that makes monetary delegation costly, irrespective of the supporting mechanism (performance contracts, conservatism, inflation targets or any combination of these,

---

[3] The Rogoff (1985) model assumes complete information, deterministic policy preferences, a static economy, and no interaction with other policy instruments. Among the recent contributions to this rapidly expanding literature, we note Beetsma and Jensen (1998), Muscatelli (1998), Schaling et al. (1998)—uncertain central bankers' preferences—, Herrendorf and Lockwood (1997)—stochastic inflation biases—, Svensson (1997), Lockwood et al. (1998)—output persistence—, Cukierman and Lippi (1999, 2001), Guzzo and Velasco (1999), Lawler (2000)—explicit labor market institutions—, Huang and Padilla (1995), Debrun (1997, 2000), Levine and Pearlman (1998), Pina (1999), Beddies (1999), Beetsma and Bovenberg (2001), Catenaro and Tirelli (2000), Dixit and Lambertini (2001)—the interaction with fiscal policy.

see Huang and Padilla, 1996, Debrun, 1997, Levine and Pearlman, 1998, Beetsma and Bovenberg, 1998 and 2001 or Pina, 1999, among others). The impact of central bank independence on fiscal policy depends on the nature of the strategic interplay between the two policymakers, and it is determined by their objective functions and the way in which monetary policy affects the objectives of the government. Most existing studies[4] exploit the simple static framework of Alesina and Tabellini (1987). Three key assumptions characterize the latter.[5] First, the government resorts to distortionary taxation to transmit a fiscal impulse to the economy through aggregate supply. Second, deficits are ruled out so that expenditure is fully financed by seigniorage and tax revenues. Third, expenditure is desirable per se and has no effect on output and prices. We relax those assumptions by allowing for deficits (ignoring seigniorage) and demand-side effects of public spending. As a consequence, both taxation and expenditure can be the key strategic instruments of fiscal policy. Moreover, the combination of demand-side and supply-side effects of fiscal policy implies that the composition of the deficit matters as much as its size. This is reflected in the design of fiscal institutions.[6] The main contribution of the paper is thus to illustrate the conceptual link between the design of fiscal rules, the way in which fiscal policy is conducted (i.e., demand-side versus supply-side measures) and the nature of the strategic interplay among the decisionmakers involved in the determination of the macro policy mix. The discussion in this paper thus suggests that a regime of central bank independence (be it in a national or supranational context as in a monetary union) requires that specific attention be paid to fiscal policy. In particular, we shed light on the fiscal arrangements that would contribute to keeping a well-balanced policy mix once central bank independence has been chosen.

The analysis yields the following results. First, the separation of monetary and fiscal powers provides a rationale for imposing legal restraints on fiscal discretion. Though previous studies made a similar point in different models, they never formally developed the idea (Nordhaus, 1994; Agell et al., 1996, Levine and Pearlman, 1998, Pina, 1999 and Dixit, 2001). Our approach challenges the conventional wisdom on the link between fiscal rules and monetary stability. Dornbusch (1997, pp.221-2) writes: "(...) *the concern with fiscal criteria lacks a basis once an independent central bank with a precise stability mandate and a no-bailout provision are in place. (...) the dash for fiscal probity that is underway is not justifiable by a concern for sound money.*" In our paper, the need for fiscal restraints arises *because* the central bank is made

---

[4] See for instance Beddies (1999), Beetsma and Bovenberg (1997, 1998, 2001), Huang and Padilla (1995), Debelle and Fischer (1994).

[5] It must be noted that the monetary-fiscal interaction has also been analyzed with differential games. In that literature, the *dynamics* of the budget constraint and seigniorage also play the key role (see, e.g., van Aarle, 1996).

[6] The importance of the composition of deficits is widely recognized in the empirical literature on fiscal policy (see Alesina and Perrotti, 1997) but is generally ignored in strategic analyses (see however Debrun, 2000).

independent with a specific mandate for price stability. Second, despite the absence of monitoring (i.e., creative accounting) problem, our model shows that deficit rules are sub-optimal because they introduce a wedge between the marginal cost of distortionary taxation and the marginal gain from public spending. Depending upon the sequence of actions in the policy game, specific constraints on expenditure or tax instruments are required to implement the optimal policy mix. Third, if the government can take advantage of the rigid decisionmaking process and pre-commit, then fiscal rules may be superfluous if the central bank follows a strict inflation-targeting regime.

In the remainder of the paper, we proceed as follows. Section II describes the basic model. Section III presents the two standard cases of centralized policymaking (i.e., commitment and discretion). In Section IV, we show the desirability of decentralized policymaking (central bank independence) and characterize the optimal monetary arrangement assuming discretionary fiscal policies. Section V defines fiscal institutions that address the failure to properly coordinate the policy mix under central bank independence. Section VI concludes.

II. A Simple Model

We use a static aggregate supply—aggregate demand framework of a two-good small open economy. As usual, equations have a log-linear specification where variables express log-deviations from an arbitrary steady state. All parameters are non-negative and the superscript "e" denotes the rationally expected value of a variable. For analytical tractability, we assume a deterministic environment where supply shock stabilization is not an issue.

In this short-run model, a fixed proportion δ of domestic firms sell their total production on a competitive domestic market at a unit price p (non-traded good N). As the government collects an ad-valorem tax τ on the firms' total income, the total domestic production[7] of good N is given by an amended but nevertheless familiar Lucas-type supply function (see Alesina and Tabellini, 1987):

$$n_t^s = \phi\left(p_t - p_t^e - \tau_t\right) \text{ with } \phi = \beta/1-\beta \tag{1}$$

where β is the proportion of labor in a Cobb-Douglas production function.

A fixed proportion (1-δ) of firms export their production (traded good F) at a constant price of one foreign currency unit. In terms of domestic currency, the unit price of good F is equal to the nominal exchange rate S. To ease aggregation, we assume that the production technology is identical across sectors so that the domestic production of the tradable good is given by (2):

[7] Appendix I specifies the micro hypotheses underlying these relationships.

$$f_t^s = \phi\left(s_t - s_t^e - \tau_t\right) \tag{2}$$

The economy's total output equals real national income (y) and is described by equation (3):

$$y_t = y_t^s = \delta n_t^s + (1-\delta) f_t^s \tag{3}$$

The domestic price level p equates the total demand for the non-traded good N with the supply of that good. As shown in Appendix I, we can normalize the variables so as to obtain the following demand function for N:

$$n_t^d = (1-\delta)(s_t - p_t) + y_t + g_t \tag{4}$$

The variable g represents the rate of net public transfers to households and $s-p$, the real exchange rate. A depreciation of the real exchange rate stimulates activity in the traded-good sector, increasing the income of its workers and pushing up their demand for the non-traded good (see Appendix I). Our assumptions about the supply side and the demand side of the economy imply that the same Cobb-Douglas index is relevant for both consumers and producers:

$$\pi_t = \delta p_t + (1-\delta) s_t \tag{5}$$

If the base year is $t-1$, π_t represents the rate of inflation. For given expectations, the equilibrium price of the non-tradable good is given by (6):

$$n_t^s - n_t^d = 0 \Leftrightarrow p_t = s_t + \beta\left(p_t^e - s_t^e\right) + \psi g_t \text{ with } \psi = 1/(1-\delta)(1+\phi) \tag{6}$$

Combining (1), (2), (3), and (5) gives an expression for the economy's *total* output:

$$y_t^s = \phi\left(\pi_t - \pi_t^e - \tau_t\right) \tag{7}$$

Finally, we omit to model the money market and, without loss of generality, assume that the policymaker has complete control over the nominal exchange rate, s (Agell et al., 1996).

The representative agent expresses preferences over a series of macroeconomic variables entering as arguments in the social welfare function (8). For obvious tractability reasons and in line with the relevant literature, the latter is quadratic, meaning that socially optimal policies minimize the sum of deviations with respect to desirable targets (denoted by a tilde). The relative welfare weights of deviations are given by θ-parameters, with the weight of inflation normalized to unity. The instantaneous utility function is given by (8):

$$U_t^G = -\tfrac{1}{2}\left[(\pi_t - \tilde{\pi})^2 + \theta_g (g_t - \tilde{g})^2 + \theta_d d_t^2 + \theta_y y_t^2\right] \qquad (8)$$
with $\tilde{\pi}, \tilde{g} > 0$ and $d_t = g_t - \tau_t$

The variable d approximates the primary fiscal deficit ratio. From (8), it follows that a representative government should aim at achieving positive levels of inflation and net payments to households while maintaining full employment[8] and zero deficit (first best). The positive-inflation and full-employment objectives are standard. The aversion to deficits captures the instantaneous effect of the solvency constraint as perceived by the government.[9] Note also that consumers do not save so that public deficits are fully financed by external borrowing. Hence, θ_d also captures the disutility generated by current account deficits.

The rest of the paper analyzes the policy regimes of interest in this simple environment. Those regimes and their characteristics are summarized in Table 1. The table reflects the multiplicity of plausible game conjectures between monetary and fiscal authorities under decentralized decisionmaking (central bank independence). Optimal monetary and fiscal institutions emerge from the comparison between the optimal policy mix (regime CP in Table 1) and the possible regimes of decentralized policymaking, the welfare ranking among the latter being irrelevant for our purpose.

---

[8] The full-employment output is normalized to zero. Hence, there are no labor-market distortions that could justify the government targeting an employment rate higher than the "natural" rate.

[9] This straightforward treatment of the solvency requirement implies a much greater analytical tractability of the game-theoretic framework. In fact, the concept of solvency, as reflected in a well-specified intertemporal budget constraint, is hardly operational (Wyplosz, 1991). See, however, Corsetti and Roubini (1993).

Table 1. Regimes Under Consideration and Solution Concepts

	Dependent Central Bank (Benchmarks)	
Regime	CP	CTC
Fiscal policy		
Pre-commitment	X	(X) 1/
Discretion	(X) 1/	X
Monetary policy		
Pre-commitment	X	
Discretion		X
Game conjecture		
Authorities/wage setters	Cooperative	Nash
Between authorities	None	None
Ranking	Second best 2/	Worst outcome

	Independent Central Bank (Delegation) 3/		
Regime	D/OD	DSG	DSM
Fiscal policy			
Pre-commitment		X	
Discretion	X		X
Monetary policy			
Pre-commitment			X
Discretion	X	X	
Game conjecture			
Authorities/wage setters	Nash	Nash	Nash
Between authorities	Nash	Stackelberg (F)	Stackelberg (M)
Ranking	Third best 2/	Third best 2/	Third best 2/

1/ With centralized policymaking, fiscal pre-commitment/discretion is irrelevant (section III).

2/ The first best can only be achieved with nondistortionary taxation.

3/ If both monetary and fiscal authorities can pre-commit, then the game unravels to the CP regime.

CP: pre-commitment on all instruments with centralized decisionmaking.
CTC: centralized decisionmaking: time-consistent outcome.
D: delegation (central bank independence).
OD: optimal delegation.
DSG: delegation with government's Stackelberg leadership.
DSM: delegation with CB's Stackelberg leadership.

III. Centralized Decisionmaking: Commitment and Discretion

This section assumes centralized decisionmaking (i.e., a dependent central bank) and motivates the case for central bank independence. In subsection A, we derive the ex ante optimal policies, which presume government's pre-commitment capacity on both instruments. Subsection B shows that those policies are time-inconsistent because the government faces an ex post incentive to create surprise inflation in order to make up for the output loss due to distortionary taxation. Since manipulating fiscal policy entails direct social costs, the demand stimulus relies entirely on monetary expansion. In equilibrium, a familiar inflation bias à la Barro-Gordon (1983) emerges whereas fiscal policy instruments remain at their ex ante optimal levels. The fact that discretionary decisionmaking leads to an excessively loose monetary policy motivates the delegation of the monetary power to an independent central bank with a specific mandate to achieve a greater degree of price stability.

A. Pre-Commitment

In our static setup, intertemporal optimization degenerates into a period-by-period problem so that we only consider the instantaneous utility function (8) and omit the time subscripts for convenience. Optimal strategies (in terms of s, g and τ) are obtained as follows:

$$\max_{s,g,\tau} U^G \tag{9}$$

subject to (7) and perfect foresight by the wage-setters ($\pi = \pi^e$).

With a greater number of targets than instruments, the first best is not feasible so that the first-order conditions of (9) yield a second-best solution denoted by the superscript CP (for "centralized pre-commitment"):

$$s^{CP} = \tilde{\pi} - \delta\beta\left(p^e - s^e\right) - \delta\psi g \Rightarrow \pi^{CP} = \tilde{\pi} \tag{10}$$

$$g^{CP} = \frac{\left(\theta_d + \theta_y\phi^2\right)\theta_g}{\left(\theta_d + \theta_y\phi^2\right)\theta_g + \theta_d\theta_y\phi^2}\tilde{g} < \tilde{g} \tag{11}$$

$$\tau^{CP} = \frac{\theta_d}{\theta_d + \theta_y\phi^2}g^{CP} = \frac{\theta_d\theta_g}{\phi^2\theta_y\left(\theta_d + \theta_g\right) + \theta_d\theta_g}\tilde{g} < g^{CP} \tag{12}$$

$$d^{CP} = \frac{\theta_y \phi^2}{\theta_d + \theta_y \phi^2} g^{CP} > 0 \tag{13}$$

$$y^{CP} = -\phi \tau^{CP} < 0 \tag{14}$$

Equation (10) shows that the ex ante optimal monetary policy delivers the socially desirable rate of inflation, $\tilde{\pi}$. Fiscal variables reflect the trade-offs between the government's fiscal and real-activity targets. Optimal public expenditure is positive but inferior to the most desired level, $\tilde{g}$, because the aversion to deficits requires a positive taxation of firms' revenue. This positive taxation results from an optimal trade-off between the need to keep the deficit close to balance and taxes' negative effect on output. Hence, the optimal tax rate is inferior to the rate of expenditure, resulting in a positive deficit. Finally, the equilibrium output lies below its full employment level because of positive taxation, reflecting the second-best nature of the outcome.[10] We now show that this pre-commitment solution is not an equilibrium in the game between the wage-setters and the government because the latter faces an incentive to deviate from the set of strategies $\left(s^{CP}, g^{CP}, \tau^{CP}\right)$.

B. Time-Consistent Centralized Policies

The ex ante optimal solution characterized by equations (10) to (14) presupposes that the socially optimal inflation rate is incorporated into expectations and then reflected in binding nominal wage contracts. However, the unemployment resulting from positive taxation provides an incentive for the authorities to generate a surprise increase in inflation. Hence, given nominal wage contracts, it is optimal for the government to "buy" some extra employment at the cost of a positive deviation of inflation from its target. The ex ante optimal outcome is thus ex post suboptimal (i.e., time-inconsistent) and rational wage setters will not consider it. Without any binding (credible) agreement with the wage setters, an optimizing government may not assume ex ante that its optimal choice will be taken for granted by the public. Formally, it ignores the perfect foresight constraint and performs the maximization program (9) for given expectations. The resulting system of equations is then solved for rational expectations and the outcome is described by proposition 1.

---

[10] The second-best nature of the centralized pre-commitment solution is only due to the absence of a non-distortionary source of revenue for the government (see Beetsma and Bovenberg, 1997).

Proposition 1

The centralized choice of time-consistent policies (denoted by the "CTC" superscript) results in an inflation bias and leaves fiscal instruments unchanged with respect to the ex ante optimal solution. More specifically, $\pi^{CTC} = \tilde{\pi} + \theta_y \phi^2 \tau^{CTC} > \pi^{CP}$ and $x^{CTC} = x^{CP}$; $x \in \{g, \tau, d, y\}$. *As a consequence, society is worse-off under the CTC regime than under CP.*

Proof: immediate from the first-order conditions of (9).

Proposition 1 illustrates a fundamental difference between our framework and the usual "public finance" treatment of the monetary-fiscal interplay à la Alesina - Tabellini (1987). In the latter, higher inflation entails larger public revenue leading to higher expenditure, lower taxes, and higher output. The seigniorage collection argument thus establishes a mechanical linkage between monetary and fiscal choices giving rise to a long-run trade-off between output and inflation. In that context, the commitment solution "*is not unambiguously welfare improving*" (Alesina and Tabellini, 1987, p. 628) because greater price stability may lead to a suboptimal collection of seigniorage and excessive reliance on distortionary taxation. Here, the second-best fiscal strategies are time-consistent in spite of the possible use of public expenditure to generate inflation surprises and the Alesina-Tabellini argument does not apply. In fact, the demand stimulus is achieved entirely through monetary expansion because, contrary to fiscal measures, changing monetary policy entails no direct social cost. This also explains why proposition 1 sharply contrasts with Agell et al. (1996) who find an expansionary fiscal bias under centralized policymaking. Another reason for the difference is that Agell et al. (1996) assume an exogenous distortion to explain excessive unemployment, while in our setup, the latter results from the government's own taxation policy.

To summarize, this section establishes that under centralized decisionmaking (or complete central bank dependence), discretionary monetary policy is excessively loose while discretionary expenditure and taxation are optimal. In the next section, we analyze a regime where monetary policy is delegated to an independent central bank (CB) with a mandate to deliver lower inflation.

IV. Delegating Monetary Policy to an Independent Central Bank

Section III raises the question that permeates the recent theory of optimal monetary institutions. What "type" of central bank can *credibly* achieve the socially optimal inflation rate when the political authorities are unable to make credible commitments on monetary policy? In the academic literature as much as in the real world, the conventional answer has been independent monetary authorities facing specific incentives to deliver the desired level of price

stability.[11] The idea of an independent central banker maximizing a "*peculiar utility function*" was proposed by Thomson (1981, p. 357) and later formalized in the Barro-Gordon framework by Rogoff (1985). The well-documented success of independent central banks in maintaining price stability (Alesina and Summers, 1993 and Grilli et al., 1991, among others) has motivated a large number of industrial and developing countries to reform their monetary institutions, leaving the determination of monetary policy to a decisionmaker immune to direct political intervention but accountable to perform according to a mandate established by the law (Castellani, 2001).[12]

Formally, the optimal design of monetary institutions is treated as a principal-agent problem. In a first stage, the government (principal) chooses an incentives' scheme (contract) to be imposed on the central bank (agent). In the second stage, the central bank strategically interacts with the "private sector" (wage setters) in a Barro-Gordon (1983) conjecture. The optimal monetary arrangement is such that the time-consistent policy of the central bank at stage 2 is identical to the ex ante optimal policy. In other words, optimal delegation is expected to *implement* the pre-commitment strategy as a time-consistent solution of the monetary policy game (see Persson and Tabellini, 1994, Walsh, 1995 and Svensson, 1997).

In a model with endogenous fiscal policies, the independent central bank interacts strategically with the government and, as they pursue different goals, conflicts inevitably arise. This section underscores the implications of these conflicts for the optimal design of monetary institutions.[13] Following the logic of *backward induction*, subsection A characterizes the conflict between the fiscal authorities and an independent central bank aiming at low inflation (stage 2). Subsection B addresses the institutional design problem where the government determines the optimal incentives' scheme of the central banker, internalizing the coordination problem of stage 2. The analysis presupposes that, in stage 2, monetary and fiscal authorities move simultaneously (Nash-Cournot) and are unable to make credible pre-commitments. However, the government's inability to pre-commit on monetary policy—which calls for central

---

[11] An alternative approach to the institutional solution to time-inconsistency is reputation building in a repeated game (Barro and Gordon, 1983). Jensen (1997) combines both aspects to show that stability-oriented institutions are themselves credible if the costs of reversing institutions are large enough.

[12] This is referred to as "instrument independence" in Fischer (1995) and "economic independence" in Grilli et al. (1991).

[13] "*Obviously, the degree of CB independence plays a meaningful role only in the presence of differences of emphasis on alternative policy objectives between the political authorities and the CB*" (Cukierman, 1992, p. 350). The induced inefficiency of the policy mix is emphasized in different models by Nordhaus (1994), Huang and Padilla (1995), Debrun (1997, 2000), Levine and Pearlman (1998), Beddies (1999), Dixit (2001) and Castellani (2001), among others.

bank independence—does not preclude a capacity to pre-commit on fiscal instruments.[14] The combination of monetary discretion and fiscal pre-commitment amounts to assume a first-mover advantage for the fiscal authority (i.e., Stackelberg leadership). That game is analyzed in subsection C.

A. Delegation and the Policy Mix

For the sake of simplicity, we assume that the independent central bank chooses monetary policy so as to maximize the following utility function:

$$U^{CB} = -\frac{1}{2}\left\{ \left(\pi - \pi^*\right)^2 + \gamma_g \left(g - g^*\right)^2 + \gamma_d d^2 + \gamma_y y^2 \right\} \tag{15}$$

Equation (15) assumes that the CB cares about the same set of macroeconomic variables as the representative government. However, targets and relative preferences need not be the same. We might also allow for a linear inflation penalty in the spirit of Walsh (1995). But in a deterministic model, linear penalties would be tantamount to "weight-conservatism" or inflation targeting.

The unique Nash equilibrium in pure strategies is characterized by the following equations, where a superscript D stands for "delegation":

$$\pi^D = \pi^* + \gamma_y \phi^2 \tau^D \tag{16}$$

$$\tau^D = \frac{\theta_d}{\theta_d + \theta_y \phi^2} g^D \tag{17}$$

$$g^D = \left[\frac{\theta_d + \theta_y \phi^2}{\theta_d \left(\theta_g + \delta\psi\phi^2 \left(\gamma_y - \theta_y\right)\right) + \theta_y \phi^2 \left(\theta_g + \theta_d\right)} \right] \left(\theta_g \tilde{g} + \delta\psi\left(\tilde{\pi} - \pi^*\right)\right) \tag{18}$$

[14] For detailed discussions of that issue, see Beetsma and Bovenberg (1997, 1998) or Beetsma et al. (2001). Appendix IV combines monetary pre-commitment and fiscal discretion in the case of decentralized policymaking and shows that the coordination problem is similar to the one in the Nash-Cournot conjecture. That game reflects the view that only an institution independent from the political power can make credible pre-commitments.

Equations (16) to (18) establish that, were the CB and the government to share the same targets and preferences (in particular, $\pi^* = \tilde{\pi}$ and $\gamma_y = \theta_y$), the solution would be identical to the centralized time-consistent case. Clearly, the time-consistent inflation rate can be reduced below π^{CTC} only if the appointed central banker is more averse to inflation than the government ($\gamma_y < \theta_y$) and/or she targets an inflation rate below the socially desirable rate ($\pi^* < \tilde{\pi}$). Proposition 2 summarizes the consequences of appointing such a central banker.

Proposition 2

Assume discretionary monetary and fiscal policies. If the independent CB is mandated to achieve $\pi^D < \pi^{CTC}$, *then we have:* $g^D > g^{CTC}$; $\tau^D > \tau^{CTC}$; $d^D > d^{CTC}$; $y^D < y^{CTC}$.

Proposition 2 shows that a regime with an independent central bank designed to reduce the time-consistent inflation rate makes the ex ante optimal fiscal policy time-inconsistent. The reason is that CB independence does not eliminate the systematic incentive of the government to cope with the structural shortage of employment through a stimulation of aggregate demand. The loss of monetary discretion simply forces the government to use fiscal policy as a demand booster and an expansive fiscal bias arises. In contrast with Agell et al. (1996), the fiscal bias only emerges under decentralized policymaking. Reducing inflation through delegation thus entails a cost in terms of a noncoordinated policy mix. Following McCallum (1995), we might say that monetary delegation tends to "*relocate the time-inconsistency problem without really solving it.*" In this model, it is relocated in a fiscal bias characterized by excessive spending, taxation, and deficit.[15] Higher taxes also aggravate structural unemployment so that, in contrast with the usual literature, the disinflation obtained through central bank independence entails a *permanent* sacrifice in terms of employment.

B. Optimal Delegation

When choosing the monetary arrangement, the government internalizes the coordination problem described above. The optimal delegation choice equates the marginal gains from lower inflation with the marginal losses from higher expenditure, taxation, deficits, and unemployment. As suggested earlier, two mechanisms (or a combination of both) can influence the equilibrium inflation rate in the policy game: inflation targeting and the appointment of a

[15] By "excessive," we mean above the second-best levels determined in the CP case. A similar expansive fiscal bias resulting from the non-coordinated policy mix is also found in other models: Debrun (1997, 2000), Levine and Pearlman (1998), and Pina (1999).

weight-conservative governor.[16] We thus simply characterize the optimal inflation rate achievable through monetary delegation. The latter is the solution to (19):

$$Max_{\pi^D} E_{-1}\left[U^G\right] \tag{19}$$

Proposition 3

Assume discretionary monetary and fiscal policies. The optimally designed CB achieves an inflation rate π^{OD} *such that* $\pi^{CP} < \pi^{OD} < \pi^{CTC}$.

Proof: see Appendix II.

Proposition 3 shows that, given the fiscal costs of delegation, it is not incentive-compatible for the government to appoint a central banker with a mandate to achieve π^{CP}. Our result is independent of the specifics of the monetary arrangement (e.g., inflation targets, conservatism) and therefore suggests that fiscal institutions may also need reform.

In practice, it is hard to assess the empirical importance of the policy-mix coordination problem and it is even harder to figure out the effect this may have on the institutional features of independent central banks and their average performance in terms of price stability. Solid empirical evidence on the policy mix is scarce as budgetary data are only relevant on an annual basis. Existing evidence nevertheless suggests that industrial countries have a poorly coordinated policy mix characterized by overly restrictive monetary stances and excessively lax fiscal policies (Nordhaus, 1994, Mélitz, 1997, Debrun and Wyplosz, 1999).[17] Also, our results support the evidence that independent central banks tend to produce higher "sacrifice ratios" (see Gärtner, 1997, among others). The reason proposed by the model is that, in a disinflation episode, the more independent the CB, the stronger is the conflict between monetary and fiscal authorities. This brings about higher taxes and discourages economic activity.

---

[16] In the case of a Nash-Cournot policy game, the fiscal preferences and objectives of the appointed central banker do not affect the equilibrium strategies. See, however, Appendix IV.

[17] The studies of Mélitz (1997) and Debrun and Wyplosz (1999) use a panel with annual data for OECD and EU countries, respectively. They do not reject the strategic substitutability between monetary and fiscal policies that emerges from our model. Using a time-series analysis based on quarterly data for G7 countries, Muscatelli et al. (2001) identify a shift towards less intense conflict and greater complementarity. They attribute this result to a decrease in the degree of fiscal activism. In our model, this would be captured by an increase in θ_d.

C. Fiscal Pre-Commitment

Having established that delegation leads to excessively lax discretionary fiscal policies, it is interesting to analyze the case where the government can pre-commit on tax and spending rates. The assumption that pre-commitments on fiscal instruments are credible, while those on the monetary instrument are not, is conceivable because of substantial differences in the decisionmaking process characterizing monetary and fiscal policies. While monetary policy choices can be made swiftly and at no direct cost (discretion prevails), government's decisions are subject to a relatively rigid budgetary procedure that involves a budget preparation period, the vote of a law in Parliament and ex post monitoring of budget execution. That procedure may give the government the capacity to credibly pre-commit to a set of strategies knowing that the CB will always be able to react optimally in a discretionary fashion. This subsection analyzes the resulting Stackelberg game with government leadership.[18]

Monetary discretion implies that the CB always chooses its best response to fiscal decisions. The CB's strategy is thus characterized by the same expression as under the Nash game. The superscript "DSG" denotes the equilibrium values of the variables:

$$\pi^{DSG} = \pi^{*} + \gamma_{y}\phi^{2}\tau^{DSG} \tag{20}$$

The government's optimal strategy maximizes (8) subject to (7) and (20). The key difference with the Nash game is that the government realizes it cannot boost output through a demand stimulus because the CB would fully offset fiscal actions and secure its preferred trade-off between inflation and output (equation (20)). Consequently, optimal expenditure is set to achieve the optimal trade-off between the target, $\tilde{g}$, and the deficit:

$$\frac{\partial U^{G}}{\partial g} = -\theta_{g}(g-\tilde{g}) - \theta_{d}(g-\tau) = 0$$

---

[18] The Stackelberg conjecture is quite common in existing analyses of the policy mix. Arguments can be found in favor of both fiscal and monetary leadership depending upon which policymaker can be assumed to pre-commit to a strategy off its best response schedule (Beetsma and Bovenberg, 1997, 1998 and Beetsma et al., 2001). Because its results are qualitatively similar to the Nash conjecture, the Stackelberg game with monetary leadership is developed in Appendix IV. It is also worth noting that the difference between the Nash and Stackelberg conjectures is not related to the distinction between "Monetary Dominance" (MD) and "Fiscal Dominance" (FD) (e.g., Canzoneri and Diba, 1996). These concepts refer to the reaction of primary deficits to public debt accumulation and, ultimately, to the capacity of the central bank to determine the price level. If the deficit's response is such that solvency is ensured for "*any real value of the existing debt, the price level is determined in the familiar way by money supply and demand.*" They call this MD. Clearly, our model postulates MD.

Hence, in equilibrium, public expenditure is a weighted average of the target $\tilde{g}$ and the optimal tax policy, τ^{DSG}:

$$g^{DSG} = \lambda\tilde{g} + (1-\lambda)\tau^{DSG} \text{ with } \lambda = \frac{\theta_g}{\theta_g + \theta_d} \tag{21}$$

Equations (20) and (21) show that under fiscal leadership, tax policy replaces expenditure as the key strategic variable of the government. Indeed, the latter understands that the output-inflation trade-off is the only determinant of monetary policy and that the impact of taxation on output offers a strategic leverage on the CB's action. In other words, the fiscal authorities may strategically manipulate τ to induce a reaction of the CB and have an impact on demand. Not surprisingly, we find a situation very similar to what we would obtain with the Alesina-Tabellini (1987) framework - where tax policy is also the strategic variable and public expenditure a residual (see Beetsma and Bovenberg, 1997, pp. 74–75).[19]

After some manipulations of the first-order condition, we find:

$$\tau^{DSG} = \frac{\theta_d\theta_g}{\Gamma}\tilde{g} + \frac{(\theta_d + \theta_g)\gamma_y\phi^2}{\Gamma}(\tilde{\pi} - \pi^*),$$

$$\text{with } \Gamma = \phi^2\left[\theta_y + \phi^2\gamma_y(\gamma_y - \theta_y)\right](\theta_d + \theta_g) + \theta_d\theta_g \tag{22}$$

This leads to two propositions.

Proposition 4

Assume discretionary monetary policy and fiscal pre-commitment (i.e., fiscal Stackelberg leadership). If $\gamma_y > 0$ and the independent CB is mandated to achieve $\pi^{DSG} < \pi^{CTC}$, then we have $g^{DSG} > g^{CTC}$; $\tau^{DSG} > \tau^{CTC}$; $d^{DSG} > d^{CTC}$; $y^{DSG} < y^{CTC}$.

Proof: Setting $\gamma_y = \theta_y$ and $\tilde{\pi} = \pi^*$, appropriate substitutions show that:

$$x^{DSG}\Big|_{\substack{\gamma_y=\theta_y \\ \pi^*=\tilde{\pi}}} = x^{CTC}\Big|_{\substack{\gamma_y=\theta_y \\ \pi^*=\tilde{\pi}}}, \ \forall x \in \{\pi, g, \tau, y\}.$$

[19] They find an equilibrium with excessive expenditure and taxes (as in our proposition 4). However, no such bias emerges from their Nash and monetary Stackelberg leadership games.

A delegation scheme ensuring that $\pi^{DSG} < \pi^{CTC}$ requires either $\gamma_y < \theta_y$ and/or $\pi^* < \tilde{\pi}$. The proposition immediately follows from the fact that: $\frac{\partial \tau^{DSG}}{\partial \gamma_y} < 0$ and $\frac{\partial \tau^{DSG}}{\partial \pi^*} < 0$.

In general, the pre-commitment capacity of the government does not eliminate the expansive fiscal bias stemming from decentralized monetary and fiscal decisions. As in the Nash-Cournot conjecture, differences in inflation objectives and preferences, which are necessary to reduce the time-consistent inflation rate, trigger a conflict between the two policymakers. But contrary to the Nash game, the government's incentive to deviate from optimal fiscal strategies is now rooted in the CB's interest in the full employment objective. Consequently, a *monetary* arrangement isolating the CB from this induced laxity would prevent the fiscal bias.

Proposition 5

Assume discretionary monetary policy and fiscal pre-commitment (i.e., fiscal Stackelberg leadership). If the CB is mandated to exclusively target the socially desirable inflation rate (i.e., $\gamma_y = 0$ and $\pi^* = \tilde{\pi}$), then $x^{DSG} = x^{CP}$ with $x \in \{\pi, g, \tau, d, y\}$.

Proof: Solve the system (20-22) for $\gamma_y = 0$ and $\pi^* = \tilde{\pi}$ and compare with the CP solution.

The intuition behind proposition 5 is straightforward. If the CB is indifferent to the level of employment, the government loses its strategic leverage on monetary decisions and can credibly commit to optimal expenditure and tax policies. At the same time, the CB can achieve the optimal inflation rate. Obviously, the result would break down if the authorities were expected to play an active role in stabilizing the economy in the wake of supply shocks. In this case, the well-known trade-off between credibility and flexibility would be restored. Nevertheless, proposition 5 represents a powerful argument in favor of a "strict" form of inflation targeting.[20]

V. Fiscal Institutions and Coordination of the Policy Mix

It is clear from the analysis carried out above that central bank independence is costly. Monetary policy delegation leads either to a fiscal bias (excess spending) when the government lacks pre-commitment capacity, or to a strategic manipulation of the fiscal regime if the

[20] Inflation targeting is "strict" in the sense that it allows no trade-off between inflation and output. This is different from assuming that inflation is the only goal in the CB's objective function since no restriction is imposed on the fiscal arguments in the CB objective function (deficit and expenditure). These arguments become important when the CB enjoys a pre-commitment capacity while fiscal discretion prevails (see Appendix IV).

government is able to pre-commit. As no monetary arrangements can overcome the coordination failure affecting the policy mix (see proposition 3), granting instrument-independence to the CB calls for reform of the fiscal institutions to preserve the second-best fiscal strategies prevailing in the centralized decisionmaking system. Such a reform restores the optimality of appointing a central banker with a mandate to deliver the socially desirable inflation, $\tilde{\pi}$.

In the remainder of the section, we formally characterize this new fiscal framework using the contract metaphor popularized by Walsh (1995).

A. Fiscal Institutions as Contracts

The analysis of macroeconomic institutions as "contracts" is based on three ideas easily interpretable in terms of real-world arrangements. First, any legislation affecting the incentives of policymakers can be interpreted as a "contract" between a representative agent of society (the "principal," for instance a law-making body) and the policymaker (the "agent") to ensure that the latter actually implements socially optimal policies. Second, the "contract" provides precise performance criteria to help identify deviations from the socially optimal policy. Failure to comply with those criteria negatively affects the utility of the policymaker. Finally, the credibility of the legislation (i.e., contract), that is its effectiveness, lies in the fact that commitments on institutional structures are intrinsically stronger than commitments on policy actions (see Jensen, 1997 for a formal treatment of this argument).

We see two main shortcomings when the contractual approach is applied to the design of fiscal institutions. First, the contract overlooks the specific sanctions for a government deviating from the second-best fiscal strategies. Only some key features of the rules, whose violation triggers the sanctions, can be identified. Second, the effectiveness of the contract pre-supposes a strong enforcement procedure so that a policy mistake effectively reduces the policymaker's utility. The enforcement issue is fairly minor in the central banker appointment problem considered by Walsh (1995) and the rest of the literature. In case of deviation from the social optimum, the government may credibly fire the CB governor, refuse her a pay rise, threaten not to reappoint her, override her decisions, and so on.

In the case of fiscal institutions, enforcement may be a problem when it is hard to distinguish the policymaker (the agent) from the lawmaker (the principal). Although democracies are characterized by the separation of powers, it would be naïve not to suspect collusion between the legislative and the executive branches when it comes to formally sanctioning decisions of the latter, which in principle is backed by the former through the vote of a budget law. Of course, the enforcement problem is less acute if the legal limits on fiscal discretion are embedded in a supranational legislation, as in economic and monetary unions. One can easily imagine enforcement stemming from peer pressure by other Member States, or some supranational bureaucratic procedures whose independence is guaranteed by international treaty. The new fiscal institutions could also be part of external obligations as with the conditionality attached to a program supported by the IMF. The fact that optimal fiscal

restraints may not be implemented because a country intrinsically lacks the capacity to commit to domestic institutions does not reduce the interest of the analysis, which simply shows that such fiscal arrangements exist. Their efficient implementation[21] is beyond the scope of this paper.

Before deriving the fiscal rules supporting the optimal sanction scheme, it is important to keep in mind that the nature of the fiscal bias is contingent on the CB mandate. First, if the CB adopts an inflation target π^* inferior to the government's most preferred rate $\tilde{\pi}$, then we observe a *linear expansionary* bias of the same nature as the Barro-Gordon bias affecting discretionary monetary policies. This is the type of fiscal distortion identified by Agell et al. (1996) and Debrun (1997) among others. Second, if the CB is conservative in the sense of Rogoff (1985) (i.e., $\gamma_y < \theta_y$), then fiscal policy is biased towards excessive activism. Formally, the term $\delta\psi\phi^2\theta_d(\gamma_y - \theta_y)$ emerges in the denominator of (18). This is a nonlinear distortion, which is typical of coordination failures between policymakers. In our model, this implies that the fiscal rules used to trigger sanctions will either be linear, quadratic, or a combination of both.

B. Optimal Rules

The sanctions faced by the government in case of deviation from the second-best strategy are broadly defined in utility terms and triggered by the violation of fiscal rules. Let us define the sanction scheme as a continuous, twice differentiable function $S(f)$ where $f \in \{g, \tau, d\}$ and such that the government now maximizes $U^S = U^G - S(f)$. In reality, fiscal rules often involve some definition of the fiscal balance, typically the overall fiscal balance or the primary surplus, but they may also take the form of expenditure caps or limits on effective tax rates.

The Suboptimality of Deficit Rules

Proposition 6 establishes that deficit rules (i.e., $f = d$) are suboptimal in the sense that they cannot implement the second-best fiscal strategies as time-consistent policies.

Proposition 6

Assume a regime of monetary delegation in which the government is subject to a sanction scheme $S(f)$ where $f \in \{g, \tau, d\}$. If the resulting time-consistent solution implements the second-best fiscal strategies $(g^{CP}, \tau^{CP}, d^{CP})$, then $f \neq d$.

---

[21] See Casella (1999) who proposes tradable deficit permits in the Europen Monetary Union.

Proof: The proof by contradiction is straightforward (see appendix 3).

The intuition behind proposition 6 is that a deficit rule simultaneously affects the marginal costs/benefits of taxes and expenditures and consequently disturbs the socially optimal trade-off between taxation and public spending. For instance, if the fiscal bias originates in excess spending, a deficit limit leaves the government with the option of increasing taxes whereas the desirable fiscal adjustment should take the form of spending cuts accompanied by an endogenous (socially optimal) tax cut. Hence, optimal fiscal restraints need to focus on the fiscal instrument at the origin of the expansionary bias. In other words, when an adjustment is necessary, the rules should leave no choice as to the way the adjustment ought to be implemented. The desirable adjustment depends on the nature of the policy game: Nash or Stackelberg.

Discretionary Fiscal Policies: Expenditure Caps

With discretionary monetary and fiscal policies, the fiscal bias arises because of the incentive to stimulate aggregate demand directly through public spending. Optimally, the fiscal regime of the country should provide for sanctions $S(g)$ such that $\frac{\partial U^S}{\partial g} = \left.\frac{\partial U^G}{\partial g}\right|_{CP}$.

Straightforward calculus shows that $S(g) = \delta\psi \int \left[\left(\tilde{\pi} - \pi^*\right) + \frac{\phi^2\left(\theta_y - \gamma_y\right)\theta_d}{\theta_d + \theta_y\phi^2} g \right] dg$. Setting the integration constant equal to $g^{CP}\left[-\left(\tilde{\pi} - \pi^*\right) - \frac{\phi^2\left(\theta_y - \gamma_y\right)\theta_d}{\theta_d + \theta_y\phi^2} g^{CP} \right]$ ensures that $S\left(g^{CP}\right) = 0$. In words, we make sure that the government will not be punished when it complies with the second best, which is a sufficient condition to satisfy the participation constraint:

$$S(g)\big|_{discretion} = \delta\psi\left[\left(\tilde{\pi} - \pi^*\right)\left(g - g^{CP}\right) + \frac{\theta_d\phi^2\left(\theta_y - \gamma_y\right)}{2\left(\theta_d + \theta_y\phi^2\right)}\left(g^2 - \left(g^{CP}\right)^2\right) \right]$$

The linear part of the sanction scheme is isomorphic to the Walsh contracts for central bankers and copes with the linear bias resulting from the difference in the inflation objectives of the two authorities. The quadratic component deals with the conflict arising from different preferences between the two authorities. Notice that we can also find an efficient contract in the class of *quadratic contracts with targets* (QCT). The sanction scheme would then be of the form $S(g) = -\mathrm{K} + \Omega\left(g - g^T\right)^2$ with g^T, the expenditure target and K, an arbitrary constant ensuring that the participation constraint is satisfied. As emphasized by Jensen (2000) in another context, such contracts are easily interpretable in terms of inciting the policymaker to target a certain value for an objective or an instrument, a type of arrangement that admittedly finds many concrete applications in the institutional constraints imposed on policymakers in various areas.

In our model, however, the optimal QCT would remain undetermined in the case where the independent CB had the same relative preference for employment as the government ($\gamma_y = \theta_y$) because it could not address the purely linear distortion resulting from different inflation objectives.

Fiscal Pre-Commitment: Tax Ceilings

A similar procedure can be used to find the optimal sanction scheme when the fiscal authority is a Stackelberg leader. In that case, the sanctions should discourage the government from strategically manipulating the taxation of firms. Again, the sanctions would be proportional to the deviations between actual and socially optimal tax decisions and exhibit a linear as well as a quadratic component:

$$S(\tau)\big|_{leadership} = \gamma_y \phi^2 \left[\left(\tilde{\pi} - \pi^*\right)\left(\tau - \tau^{CP}\right) + \frac{\phi^2}{2}\left(\theta_y - \gamma_y\right)\left(\tau^2 - \left(\tau^{CP}\right)^2\right) \right]$$

This result confirms that fiscal rules are only necessary when the CB cares about the full employment objective (i.e., $\gamma_y \neq 0$).

C. Discussion of the Results and Possible Extensions

From a theoretical perspective, the contract metaphor is convenient to characterize the institutional environment macroeconomic policymakers face, and address the optimal design of these institutions in a general and explicit way. We show that legislation introducing specific fiscal criteria as well as compliance incentives for the government is an efficient means to deal with the lack of coordination of the policy mix resulting from central bank independence. In a rather intuitive way, the optimal institutional framework prescribes that when the choice of an instrument diverges from its most desirable value, the policymaker should face punishment inciting her to avoid deviations.

Interestingly, this type of arrangement reflects real-world institutions. Constitutional rules, international treaties, or more specific arrangements like the conditionality attached to programs supported by the IMF often limit fiscal discretion. Kopits (2001) provides a comprehensive survey of the use of fiscal rules in practice. His paper is rich in examples proving that "contracts" (that is, legal arrangements linking some form of sanction or reward to the compliance with fiscal rules) are widespread in industrial as well as developing countries.

As mentioned earlier, the model is silent on the effectiveness of these institutions. In fact, making desirable policies more credible through institutional reforms might simply transform the problem of noncredible policies into a problem of noncredible institutions (McCallum, 1995, and Jensen, 1997). There is no doubt that hardly reversible arrangements like a Constitution or an international treaty lend more credibility to the fiscal stability rule than less

visible or less transparent legal provisions. Although this "relocation issue" is crucial in the analysis of the institutional framework for macroeconomic policymaking, the optimal design of the rules supporting these mechanisms has an interest in itself. In particular, our analysis suggests that deficit rules constitute a suboptimal class of fiscal contracts, emphasizing the need to go beyond the net figure of a fiscal deficit and look at its composition as well. The analysis also tends to validate the "targeting" of fiscal instruments as it proposes sanctioning both positive and negative deviations from desirable values of the policy instruments. However, simple quadratic contracts with targets may not always be optimal. The presence of a linear component to the contract means that it may be optimal to explicitly reward an overshooting of the fiscal stability target.

The appealing features of the contractual approach should remind us of some obvious caveats. Even in the context of our simple model, the contracts described here are extremely demanding in terms of information. For instance, they require certainty or at least consensus about some key economic relations. They also postulate that the optimal policies under a hypothetical regime ("centralized pre-commitment") can be translated into a set of desirable targets. Finally, our model does not characterize shock stabilization policies. Such an extension would add a discussion on the necessity to make the fiscal institutions state-contingent. However, the combination of quadratic and linear contracts (already necessary in the deterministic case) should allow for keeping optimal fiscal contracts state-independent, as recently established by Jensen (2000) in the context of a two-country model of monetary policy coordination.

VI. Conclusion

This paper adopts the contractual approach to institution design to assess the possible benefits of reforming fiscal institutions when the central bank is granted instrument-independence. The model shows that discipline-enhancing institutions may provide for an adequate coordination of the policy mix, allowing central bank independence to deliver its full potential in terms of macroeconomic stability. In the absence of such coordination, inflation, structural unemployment, taxes, public expenditure, and the primary deficit would remain suboptimally high.

The novelty of this paper is to derive explicit fiscal arrangements allowing an optimal policy mix when monetary and fiscal powers are separated. Using the contract metaphor, we show that a combination of linear and quadratic contracts with targets implement the second-best state of the economy as a time-consistent solution of the game between the government and the central bank. When the fiscal authority can make credible pre-commitments, fiscal rules are unnecessary provided that the central bank adopts a regime of strict inflation targeting. The theoretical results also show that deficit rules are generally suboptimal. Optimal rules are instrument-specific. Whether the fiscal adjustment should fall on expenditure or revenue depends on the nature of the strategic interaction between the government and the central bank. With discretionary fiscal policies, expenditure targets should be set, whereas revenue targets appear optimal when the government enjoys a first-mover advantage over the central bank.

We derived these results under the simplest assumptions: static model, complete information, and a deterministic economy. Extensions to a more general environment would help to refine the design of fiscal rules, possibly by making them state-contingent. However, the key qualitative features unveiled here (suboptimality of deficit rules, desirability of linear *and* quadratic rules with targets and instrument-specific arrangements) should remain valid.

REFERENCES

Agell, J., L. Calmfors and G. Jonsson, 1996, "Fiscal Policy when Monetary Policy is Tied to the Mast," *European Economic Review*, Vol. 40, No. 7, pp. 1413–40.

Alesina A. and G. Tabellini, 1987, "Rules and Discretion with Noncoordinated Monetary and Fiscal Policies," *Economic Inquiry*, Vol. 25, No. 4, pp. 619–30.

Alesina, A. and L. Summers, 1993, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit and Banking*, Vol. 25, No. 2, pp.151–162.

Alesina, A and R. Perrotti, 1997, "Fiscal Adjustments in OECD Countries: Composition and Macroeconomic Effects," *Staff Papers*, International Monetary Fund, Vol. 44, No. 2, pp. 210–48.

Al-Nowaihi, A. and P. Levine, 1996, "Independent but Accountable: Walsh Contracts and the Credibility Problem," *CEPR Discussion paper*, No. 1387 (London: CEPR).

Barro, R. and D. Gordon, 1983, "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, Vol.12, No. 1, pp. 101–21.

Beddies, C., 1999, "Monetary Policy and Public Finances: Inflation Targets in a New Perspective," *Staff Papers*, International Monetary Fund, Vol. 46, No. 3, pp. 293–314.

Beetsma, R. and A.L. Bovenberg, 1997, "Designing Fiscal and Monetary Institutions in a Second-Best World," *European Journal of Political Economy*, Vol. 13, No. 1, pp. 53–80.

Beetsma, R. and H. Jensen, 1998, "Inflation Targets and Contracts with Uncertain Central Banker Preferences," *Journal of Money, Credit and Banking*, Vol. 30, No. 1, pp. 384–403.

Beetsma, R. and A.L. Bovenberg, 2001, "The Optimality of a Monetary Union Without a Fiscal Union," *Journal of Money, Credit and Banking*, Vol. 33, No. 2, pp. 179–204.

Beetsma, R., X. Debrun, and F. Klaassen, 2001, "Is Fiscal Policy Coordination in EMU Desirable?" IMF Working Paper 01/178 (Washington: International Monetary Fund).

Bryson, J., H. Jensen and D. Van Hoose, 1993, "Rules, Discretion and International Monetary and Fiscal Policy Coordination," *Open Economies Review*, Vol. 4, No. 2, pp. 117–32.

Canzoneri, M. and B. Diba, 1996, "Fiscal Constraints on Central Bank Independence and Price Stability," *CEPR DiscussionPaper*, No. 1463 (London: CEPR).

Castellani, F., 2001, "Central Bank Accountability Under Complete Information, *HEI Working Paper*, No. 2001/04, Graduate Institute of International Studies, Geneva.

Casella, A., 1999, "Tradable Deficit Permits: Efficient Implementation of the Stability Pact in the European Monetary Union," *Economic Policy*, No. 29, pp. 321–47.

Catenaro, M. and P. Tirelli, 2000, "Reconsidering the Pros and Cons of Fiscal Policy Coordination in a Monetary Union: Should We Set Public Expenditure Targets?" mimeo, University of Milano-Bicocca.

Corsetti, G. and N. Roubini, 1993, "The Design of Optimal Fiscal Rules for Europe after 1992," in Torres, F. and F. Giavazzi (eds.), *Adjustment and Growth in the European Monetary Union*, Cambridge University Press.

Cukierman, A., 1992, *Central Bank Strategy, Credibility and Independence* (Cambridge, Massachussets: MIT Press).

Cukierman, A. and F. Lippi, 1999, "Central Bank Independence, Coordination of Wage Bargaining, Inflation and Unemployment: Theory and Some Evidence," *European Economic Review*, Vol. 43, No. 7, pp. 1395–1434.

Cukierman, A. and F. Lippi, 2001, "Labour Markets and Monetary Union: A Strategic Analysis," *The Economic Journal*, Vol. 111, No. 473, pp. 541–65.

Debelle, G. and S. Fischer, 1997, "How Independent Should a Central Bank Be?" in S. Eijffinger et al. (eds.), *Independent central banks and economic performance*, Elgar Reference Collection (Cheltenham, United Kingdom).

Debrun, X., 1997, "A Simple Model of Fiscal Restraints under Monetary Union," *Cahier de Recherche*, No. 199 (Belgium: University of Namur).

Debrun, X. and C. Wyplosz, 1999, "Eleven Governments and One Central Bank," *Revue d'Economie Politique*, Vol. 109, No. 3, pp. 387–420.

Debrun, X., 2000, "Fiscal Rules in a Monetary Union: A Short Run Analysis," *Open Economies Review*, Vol. 11, No. 4, pp. 323–58.

Dixit, A., 2001, "Games of Monetary and Fiscal Interactions in the EMU," *European Economic Review*—EEA Papers and Proceedings, Vol. 45, No. 4–6, pp. 589–613.

Dixit, A. and L. Lambertini, 2001, "Monetary-Fiscal Policy Interactions and Commitment Versus Discretion in a Monetary Union," *European Economic Review*—EEA Papers and Proceedings, Vol. 45, No. 4–6, pp. 977–87.

Dornbush, R., 1997, "Fiscal Aspects of Monetary Integration," *American Economic Review*—AEA Papers and Proceedings, pp. 221–23.

Fischer, S., 1995, "Central-Bank Independence Revisited," *American Economic Review*—AEA Papers and Proceedings, Vol. 85, No. 2, pp. 201–06.

Gärtner, M., 1997, "Central Bank Independence and the Sacrifice Ratio: The Dark Side of the Force," *Swiss Journal of Economics and Statistics*, Vol. 133, No. 3, pp. 513–38.

Grilli, V., Masciandaro, D., and G. Tabellini, 1991, "Political and Monetary Institutions and Public Finance Policies in the Industrial Countries," *Economic Policy*, No. 13, pp. 341–92.

Guzzo, V. and A Velasco, 1999, "The Case for a Populist Central Banker," *European Economic Review*, Vol. 43, No. 7, pp. 1317–44.

Herrendorf, B. and B. Lockwood, 1997, "Rogoff's Conservative Central Banker Restored," *Journal of Money, Credit and Banking*, Vol. 29, No. 4, pp. 476–95.

Huang, H. and J. Padilla, 1995, "Fiscal Policy and the Sub-Optimality of the Walsh Contract for Central Bankers," *LSE Financial Market Group Discussion Paper*, No. 223 (London).

Jensen, H., 1997, "Credibility of Optimal Monetary Delegation," *American Economic Review*, Vol. 87, No. 5, pp. 911–20.

Jensen, H., 2000, "Optimal Monetary Policy Cooperation Through State-Independent Contracts with Targets," *European Economic Review*, Vol. 44, No. 3, pp. 517–39.

Kopits, G., 2001, "Fiscal Rules: Useful Policy Framework or Unnecessary Ornament?" IMF Working Paper 01/145 (Washington: International Monetary Fund).

Lawler, P., 2000, "Centralised Wage Setting, Inflation Contracts and the Optimal Choice of Central Banker," *The Economic Journal*, Vol. 110, No. 463, pp. 559–75.

Levine, P. and J. Pearlman, 1998, "Monetary Union: the Ins and Outs of Strategic Delegation," *CEPR Discussion Paper*, No. 1800 (London: CEPR).

Lohmann, S., 1992, "Optimal Commitment in Monetary Policy: Credibility Versus Flexibility," *American Economic Review*, Vol. 82, No. 1, pp. 273–86.

McCallum, B.T., 1995, "Two Fallacies Concerning Central-Bank Independence," *American Economic Review*, Vol. 85, No. 2, pp. 207–11.

Mélitz, J., 1997, "Some Cross-Country Evidence About Debt, Deficits and the Behaviour of Monetary and Fiscal Authorities," *CEPR Discsussion paper*, No. 1653 (London: CEPR).

Muscatelli, A., 1998, "Optimal Inflation Contracts and Inflation Targets with Uncertain Central Bank Preferences: Accountability Through Independence?," *The Economic Journal*, Vol. 108, No. 447, pp. 529–42.

Muscatelli, A., P. Tirelli, and C. Trecroci, 2001, "Monetary and Fiscal Policy Interactions Over the Cycle: Some Empirical Evidence," mimeo, Universities of Glasgow, Milano-Bicocca and Brescia.

Persson, T. and G. Tabellini, 1994, "Designing Institutions for Monetary Stability," in Persson, T. and G. Tabellini (eds.), *Monetary and Fiscal Policy, Volume 1: Credibility* (Cambridge: MIT Press).

Pina, M. A., 1999, "Can Conservatism be Counterproductive? Delegation and Fiscal Policy in a Monetary Union," *The Manchester School*, Vol. 67, Supplement, pp. 88–115.

Rogoff, K., 1985, "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics*, Vol. 100, No. 4, pp.1169–89.

Sargent, T. and N. Wallace, 1981, "Some Unpleasant Monetarist Arithmetic," *Quarterly Review*, Federal Reserve Bank of Minneapolis, Fall, pp.1–17.

Schaling, E., M. Hoeberichts, and S. Eijffinger, 1998, "Incentive Contracts for Central Bankers Under Uncertainty: Walsh-Svensson Non Equivalence Revisited," Paper presented at the 53rd European Meeting of the Econometric Society, Berlin.

Svensson, L., 1997, "Optimal Inflation Targets, Conservative Central Banks and Linear Inflation Contracts," *American Economic Review*, Vol. 87, No. 1, pp. 98–114.

Thomson, E., 1981, "Who Should Control the Money Supply?," *American Economic Review*, Vol. 71, No. 2, pp. 356–61.

van Aarle, B., 1996, *Essays on Monetary and Fiscal Policy interaction: Applications to EMU and Eastern Europe*, Center Dissertation Series, No. 24, Tilburg University.

Walsh, C., 1995, "Optimal Contracts for Central Bankers," *American Economic Review*, Vol. 85, pp. 150–67.

Wyplosz, C., 1991, " Monetary Union and Fiscal Discipline," *CEPR Discussion Papers*, No. 488 (London: CEPR).

MICROECONOMIC ASSUMPTIONS

A. The Supply Side

The economy has 2 sectors: traded and nontraded goods. In a short-run analysis, we may assume that each sector represents a *fixed* proportion of total productive capacity. A proportion $\delta \ (0 < \delta < 1)$ of the production sector consists of firms selling output in the domestic market. They are labeled as N-firms. A proportion $1-\delta$ consists of firms (F) selling output in the world market. In both sectors, firms of equal size use the same technology represented by a Cobb-Douglas production function. The capital stock of each firm is fixed and normalized to 1 and the current level of output Y depends on the current level of labor input L:

$$Y^k = (1+\zeta)AL^{\beta} \text{ with } 0 < \beta < 1 \text{ and } k \in \{N, F\} \tag{23}$$

where the variable ζ represents an economy-wide, zero-mean and non auto-correlated TFP shock expressed in percentage of output.

The government's fiscal policy affects optimal production choices through an ad valorem tax on the firms' revenue. The representative N-firm's production is determined by the profit-maximizing quantity of labor hired by the firm:

$$Max_L \Pi^N = (1-\tau)PY^N - W^N L - R \tag{24}$$

P, R and W^N represent the unit price of the domestic N-good, the cost of capital, and the sector-specific nominal wage rate,[22] respectively. The variable τ symbolizes the effective tax rate on the firm's revenue.

In the labor market, the supply is perfectly elastic to the real wage. Sector's monopoly unions set nominal wage contracts so as to minimize expected squared log-deviations with respect to a real product wage target Q: $Max_{\ln(W^N)} 0.5E\left\{\left(\ln(W^N) - \ln(P) - \ln(Q)\right)^2\right\}$. This yields $W^N = E\{P\} \times Q$. The optimal production is given by the following expression:

[22] Wages are formed noncompetitively at the sector level by monopoly unions. There is no equalization across sectors in the short term.

$$Y^N = \left(A\left(1+\zeta\right)\right)^{\frac{1}{1-\beta}}\left\{\frac{(1-\tau)\beta P}{E\{P\}\times Q}\right\}^{\frac{\beta}{1-\beta}} \tag{25}$$

We normalize total production as an index constructed on the basis of a hypothetical base year 0 where the economy suffered no shock and no distortion of any kind. Let us define the nondistorted state of the economy as: $\tau_0 = \zeta_0 = 0$. Posing $Q = (1+\rho)$, ρ represents the mark-up rate over a competitive product wage rate set equal to 1. Hence at time 0, $Q = 1$. The resulting output index for sector N is the following:

$$\frac{Y^N}{Y_0^N} = \left(1+\zeta\right)^{\frac{1}{1-\beta}}\left\{\frac{(1-\tau)\dfrac{P}{P_0}}{E\left\{\dfrac{P}{P_0}\right\}(1+\rho)}\right\}^{\frac{\beta}{1-\beta}} \tag{26}$$

Defining lower case letters as $x = \ln\left(\frac{X}{X_0}\right)$ and considering first-order Taylor approximations for $\ln(1-\tau)$, $\ln(1+\zeta)$ and $\ln(1+\rho)$, we obtain the familiar log-linear supply function (27) where the superscript "e" designates the rationally expected value of a variable (i.e., $E\{x\} = x^e$):

$$\begin{aligned} y^N &= -\tilde{y} + \frac{\beta}{1-\beta}\left(p - p^e - \tau\right) + \mu \\ \text{where } \mu &= \frac{1}{1-\beta}\zeta,\ \tilde{y} = \frac{\beta}{1-\beta}\rho > 0 \end{aligned} \tag{27}$$

The traded good sector (F-firms) is assumed to sell its product at the fixed unit price of one dollar. Each unit of output sold in the world market thus increases total income by *S*, the nominal exchange rate. The perfect elasticity of foreign demand for the domestic-traded good reflects our "small economy" assumption. Consequently, exporters' profit maximization problem becomes:

$$Max_L \Pi^F = (1-\tau)SY^F - W^F L - R \tag{28}$$

Replicating the procedure used to find (27), we can write:

$$y^{II} = -\tilde{y} + \frac{\beta}{1-\beta}\left(s - s^{e} - \tau\right) + \mu \tag{29}$$

In the text, we assume the absence of labor market distortion ($\tilde{y} = 0$) and shocks ($\mu = 0$).

B. The Demand Side

The assumption of identical production technologies in both sectors implies similar labor demand functions. On average, a share δ of households get their income from sector N and a share $1-\delta$ from sector F. Households spend their total income[23] to purchase the domestic (N) good and a foreign good (Z) whose price is fixed in dollar terms and set equal to 1 for convenience. Preferences are Cobb-Douglas. To eliminate differences among price indices, we impose preference weights δ and $1-\delta$ on the consumption of domestic and foreign goods respectively.[24] A representative household getting its income from the domestic industry faces the following maximization problem:

$$\begin{aligned} &Max_{N,Z} V = N^{\delta} Z^{1-\delta} \\ &\text{s.t. } PY^{N}(1+g) = PN + SZ \end{aligned} \tag{30}$$

The budget constraint shows the impact of fiscal policy on the household's income. The variable g is defined as a rate of net transfers affecting the real disposable income. Solving (30) yields the demand function for the N-good by the typical N-industry worker:

$$N^{N} = \delta Y^{N}(1+g) \tag{31}$$

We can also normalize the demand to make it comparable with the previously defined output and income indices. Denoting the base year by a subscript 0, we write:

$$\frac{N^{N}}{N_{0}^{N}} = \delta \frac{Y^{N}}{Y_{0}^{N}} \frac{Y_{0}^{N}}{N_{0}^{N}}(1+g) \tag{32}$$

---

[23] Consumers are myopic and do not save. Consequently, a change in fiscal policy has no Ricardian effect and any fiscal deficit triggers a current account deficit.

[24] The use of δ and $1-\delta$ as preference parameters in the utility function also ensures that when $g = \tau$, the domestic demand for foreign goods and the supply of domestic goods to the rest of the world are equal so that the current account is in equilibrium.

Since $g_0 = 0$, $\frac{Y_0^N}{N_0^N} = \delta^{-1}$. Taking the logarithm of (32) and using a first-order Taylor approximation for $\ln(1+g)$, we obtain a log-linear demand function for N-good consumed by the workers employed in industry N:

$$n^N = y^N + g \tag{33}$$

Let us now consider a representative household getting its income from industry F. The maximization problem is given by (34):

$$Max_{N,Z} V \text{ s.t. } SY^F(1+g) = PN + SZ \tag{34}$$

Assuming that $S_0 = P_0$, we normalize the demand function for the N-good as:

$$\frac{N^F}{N_0^F} = \delta \frac{S}{P} \frac{Y^F}{Y_0^F} \frac{Y_0^F}{N_0^F}(1+g) \tag{35}$$

Given that $\frac{Y_0^F}{N_0^F} = \delta^{-1}$, we obtain a log-linear demand for the N-good by the workers employed in industry F:

$$n^F = s - p + y^F + g \tag{36}$$

The aggregate demand index for N-good is computed as follows:

$$\begin{aligned} n &= \delta n^E + (1-\delta) n^F \\ &= y + (1-\delta)(s-p) + g \end{aligned} \tag{37}$$

with $y = \delta y^N + (1-\delta) y^F$, the economy's aggregate income.

The (log-linear) Cobb-Douglas price index is defined as:

$$\pi = \delta p + (1-\delta) s \tag{38}$$

That CPI index turns out to be relevant for describing the aggregate supply function in a familiar form. Assuming $\rho = \mu = 0$, we combine (27), (29) and (38) to find the aggregate output index, y^s. The latter is equal to the aggregate income index, y:

$$y^s = \frac{\beta}{1-\beta}\left(\pi - \pi^e - \tau\right) = y \tag{39}$$

PROOF OF PROPOSITION 3

First, note that optimal delegation cannot yield a rate of inflation superior or equal to the time-consistent rate under centralized policymaking (regime CTC). A strictly superior rate would mean a greater deviation from the most desired inflation rate and distorted fiscal choices with respect to the centralized (optimal) policy regime. An equal rate would require $\pi^* = \tilde{\pi}$ and $\gamma_y = \theta_y$. In that case, fiscal strategies would not be distorted with respect to the second best (regime CP) and delegation would be equivalent to the centralized time-consistent solution (regime CTC). Consequently, delegation is Pareto-superior to CTC only if it aims at implementing lower time-consistent inflation so that $\pi^{OD} < \pi^{CTC}$.

To prove that $\pi^{OD} > \pi^{CP}$, we evaluate the first derivative of $E_{-1}U^G$ with respect to the inflation rate in the delegation regime under the conjecture that the government wants to implement the second-best inflation rate, i.e., $\pi^{OD} = \pi^{CP}$. For the sake of simplicity and without loss of generality, we assume that the chosen delegation scheme achieving the first-best rate is such that $\pi^* = \tilde{\pi}$ and $\gamma_y = 0$. Hence, we obtain:

$$g^D = \left[\frac{\theta_d + \theta_y\phi^2}{\theta_d\left(\theta_g - \delta\psi\phi^2\theta_y\right) + \theta_y\phi^2\left(\theta_g + \theta_d\right)}\right]\theta_g\tilde{g}$$

Consequently, we may write:

$$\left.\frac{\partial E_{-1}\left\{U^G\right\}}{\partial\pi^D}\right|_{\pi^D=\tilde{\pi}} = \left[\frac{\left(\theta_g+\theta_d\right)\left(\theta_d+\theta_y\phi^2\right)+\theta_d^2}{\theta_d\left(\theta_g-\delta\psi\phi^2\theta_y\right)+\theta_y\phi^2\left(\theta_g+\theta_d\right)}-1\right]\frac{\delta\psi\theta_g\left(\theta_d+\theta_y\phi^2\right)}{\theta_d\left(\theta_g-\delta\psi\phi^2\theta_y\right)+\theta_y\phi^2\left(\theta_g+\theta_d\right)}\tilde{g}$$

The fact that $0<\delta<1$ and $0<\psi<1$ ensures that $\theta_d\left(\theta_g-\delta\psi\phi^2\theta_y\right)+\theta_y\phi^2\left(\theta_g+\theta_d\right)>0$. Moreover, it is straightforward to show that $\left[\frac{\left(\theta_g+\theta_d\right)\left(\theta_d+\theta_y\phi^2\right)+\theta_d^2}{\theta_d\left(\theta_g-\delta\psi\phi^2\theta_y\right)+\theta_y\phi^2\left(\theta_g+\theta_d\right)}\right]>1$, which implies $\left.\frac{\partial E_{-1}\left\{U^G\right\}}{\partial\pi^D}\right|_{\pi^D=\tilde{\pi}} > 0$. The conjecture $\pi^{OD} = \tilde{\pi}$ is therefore not an optimum and the fact that $\frac{\partial^2 E_{-1}U^G}{\partial\pi^{D^2}} < 0$ implies $\pi^{OD} > \pi^{CP}$ and completes the proof.

PROOF OF PROPOSITION 6

We prove proposition 6 by contradiction. We will show that if the fiscal sanction scheme is based on a deficit rule, it cannot implement $\left(g^{CP}, \tau^{CP}, d^{CP}\right)$ as a time-consistent solution of the policy game.

To simplify algebraic exposition, let us assume that the fiscal authorities face a *linear* fiscal bias, which is the case when $\gamma_y = \theta_y$ and $\pi^* < \tilde{\pi}$. We may therefore conjecture that the optimal sanction scheme is also linear: $S(d) = \chi\left(d - d^{CP}\right)$ where χ is the marginal utility loss of a deviation from the second-best deficit. The first-order conditions for optimal expenditure and taxes can be written as:

$$\left.\frac{\partial U^S}{\partial g}\right|_{\gamma_y=\theta_y} = -\left(\pi^* - \tilde{\pi}\right)\delta\psi - \theta_g\left(g - \tilde{g}\right) - \theta_d\left(g - \tau\right) - \chi = 0 \tag{40}$$

$$\frac{\partial U^S}{\partial \tau} = \theta_d\left(g - \tau\right) - \theta_y\phi^2\tau + \chi = 0 \tag{41}$$

Plugging (41) into (40), it is straightforward to compute the value of χ (denoted by $\tilde{\chi}$) ensuring that optimal expenditure is at its second-best value: $g^D\big|_{\tilde{\chi}} = g^{CP}$:

$$\tilde{\chi} = \frac{\theta_d + \theta_y\phi^2}{\theta_y\phi^2}\delta\psi\left(\tilde{\pi} - \pi^*\right) \tag{42}$$

Substituting back (42) into (41), we find:

$$\tau^D\big|_{\tilde{\chi}} = \frac{\theta_d}{\theta_d + \theta_y\phi^2}g^{CP} + \frac{\delta\psi}{\theta_y\phi^2}\left(\tilde{\pi} - \pi^*\right) \tag{43}$$

We have $\tau^D\big|_{\tilde{\chi}} > \tau^{CP}$ and, as a result, $d^D\big|_{\tilde{\chi}} < d^{CP}$. This proves that a deficit rule cannot achieve the second best because it induces the government to raise more revenue for a given level of expenditure.

MONETARY STACKELBERG GAME

In the case of monetary leadership, the government takes monetary policy as given and the expressions characterizing the optimal policies are similar to the Nash-Cournot case:

$$g^{DSM} = \frac{\theta_g}{\theta_g + \theta_d}\tilde{g} + \frac{\theta_d + \theta_y \delta\psi\phi^2}{\theta_g + \theta_d}\tau^{DSM} - \frac{\delta\psi}{\theta_d + \theta_g}\left(\pi^{DSM} - \tilde{\pi}\right) \tag{44}$$

$$\tau^{DSM} = \frac{\theta_d}{\theta_d + \theta_y\phi^2} g^{DSM} \tag{45}$$

The optimal monetary policy is found by maximizing (15) subject to (7), (44) and (45). The leadership position of the CB implies that it takes into account the influence of monetary policy on the fiscal variables. As a consequence, the optimal monetary policy becomes contingent on the fiscal preferences of the central banker. This substantially complicates the characterization of the equilibrium inflation rate:

$$\pi^{DSM} = \pi^* + \gamma_y\phi^2 A\tau^{DSM} + \frac{\gamma_g\delta\psi}{\theta_d + \theta_g}\left(g^{DSM} - g^*\right) + \left[\frac{\gamma_d\delta\psi}{\theta_d + \theta_g}\left(1 - \frac{\theta_d}{\theta_d + \theta_y\phi^2}\right)\right]d^{DSM} \tag{46}$$

$$\text{with } A = 1 + \frac{\theta_d\delta\psi}{\left(\theta_d + \theta_y\phi^2\right)\left(\theta_d + \theta_g\right)} > 1$$

The inflation rate will most probably be greater under monetary leadership than in the other two regimes of decentralized policy making presented above. The only source of ambiguity stems from the expenditure objective of the central banker that can always be set arbitrarily high so as to contradict this statement.

The first reason why the CB could deliver higher inflation is that it internalizes the positive impact of higher inflation on unemployment. This effect takes place through the induced fall in public expenditure and thereby taxes (see the parameter $A > 1$ in equation (46)). The second reason is that the CB also internalizes the effect of higher inflation on the public deficit. Therefore, the more the CB cares about a zero deficit, the greater the incentive to increase inflation.[25] Finally, fiscal variables affect the optimal monetary policy through a third channel: the CB's objective regarding the expenditure target. If the CB's preferred level lies below the government's choice, then there is an additional incentive to increase inflation in order to reduce

[25] A close argument is given in Beetsma and Bovenberg (1997). In their case, the central bank internalizes the positive impact of inflation on the government's budget constraint (through seigniorage and, if unexpected, on the real debt burden).

the gap between actual expenditure and the CB's objective. The converse is true if the CB's objective is greater than the government's optimal strategy.

In light of these additional complexities, the determination of the optimal delegation scheme might become complicated. In fact, the delegating authority should have perfect control over the central banker's preferences regarding fiscal variables and not only the output-inflation trade-off.[26] To cope with the obvious lack of tractability of the closed form solution for the system (44–46) and to facilitate comparison with the previous results, we limit our investigation to the case where $\gamma_g = \gamma_d = 0$. This amounts to assuming that the government makes the delegation decision among a subset of potential central bankers who disregard the fiscal variables when deciding upon monetary policy. Alternatively, we may say that the delegation scheme can effectively prohibit an independent CB from considering fiscal variables when deciding on monetary policy.

Accordingly, the system (44–46) is reduced to the following set of equations:

$$\pi^{DSM} = \pi^* + \gamma_y A \tau^{DSM} \tag{47}$$

$$\tau^{DSM} = \frac{\theta_d}{\theta_d + \theta_y \phi^2} g^{DSM} \tag{48}$$

$$g^{DSM} = \left[\frac{\theta_d + \theta_y \phi^2}{\theta_d \left(\theta_g + \delta \psi \phi^2 \left(A \gamma_y - \theta_y \right) \right) + \theta_y \phi^2 \left(\theta_g + \theta_d \right)} \right] \left(\theta_g \tilde{g} + \delta \psi \left(\tilde{\pi} - \pi^* \right) \right) \tag{49}$$

Contrary to the Nash-Cournot case, the fact that the CB and the government share the same inflation objectives and preferences regarding the output-inflation trade-off does not yield the same result as in the time-consistent solution under centralized policymaking. Indeed, the nonlinear bias remains because the CB is aware that more inflation leads to lower taxes and unemployment. As a result, public expenditure and taxes are lower and employment higher.

As far as the delegation decision is concerned, we do not observe qualitative changes with respect to the Nash-Cournot case. The solutions are isomorphic so that reproducing proposition 3 in the case of monetary leadership is straightforward.

---

[26] For recent analyses on the role of uncertainty in the CB's utility function, refer to Beetsma and Jensen (1998), Muscatelli (1998), and Schaling et al. (1998).