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for a Conservative ECB?  
When the policy mix matters**

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# ***A Nominal Income Growth Target for a Conservative ECB?***

***When the policy mix matters.***

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## ***Abstract***

This paper contributes to the *goal-versus-instrument independence* debate for the ECB, exploring how alternative monetary arrangements perform when the fiscal authority pursues a strategy of debt reduction in the long term but retains fiscal flexibility in response to supply shocks. If fiscal policy is countercyclical, a constant nominal income growth target should be assigned to a conservative central banker. In fact, as the fiscal authority and the central bank act independently in setting their countercyclical policies, an activist central banker causes excess volatility of inflation.

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## ***1. Introduction***

The Stability and Growth Pact (SGP) and the European Central Bank (ECB) Statute provide the institutional framework for fiscal and monetary policies within the European Monetary Union. The fiscal guidelines set strict limits to the size of budget deficits, making exception for large adverse shocks. The rationale for such fiscal rules may be found in the political distortions that generate incentives to excessive debt accumulation (Beetsma and Bovenberg, 1997; Beetsma and Uhlig, 1999). In fact, several EMU members have pledged to gradually reduce debt/GDP ratios<sup>1</sup>. If this happens, the SGP will leave some room for countercyclical fiscal policies in "normal times". On the monetary side, the Maastricht Treaty preserves the ECB legal independence from political powers and defines price stability as the Bank primary objective. The ECB is not only independent from governments, but also not really accountable to any parliamentary body (De Haan, Amtenbrink and Eijffinger, 1998). This monetary regime *de facto* resembles an extreme form of *goal independence*, and several observers worry that the ECB will be concerned with inflation only. A number of scholars have argued that the ECB should be granted *instrument independence* and thus be made accountable for achieving a predetermined inflation target (CEPR, 1995; Persson and Tabellini, 1996; Tabellini, 1998). The reason why inflation targeting should be preferred lies in the familiar credibility-versus-flexibility dilemma. In fact, theoretical models of inflation targeting show that if the inflation target is suitably set below the socially optimal inflation rate, society can remove the inflation bias without incurring the output distortions caused by goal-independent weight-conservative bankers *à la* Rogoff. But under output persistence (Svensson, 1997), inflation targets show some weakness too. In particular, the socially optimal inflation rate is achieved only by state contingent targets. This would require

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<sup>1</sup> IMF estimates suggest that balanced structural positions will be achieved by the year 2001 (IMF, 1998, p.92). This implies that the average debt/GDP ratio will fall correspondingly.

frequent adjustments, possibly undermining the credibility of the policy regime itself. Beetsma and Jensen (1999) argue that being state-independent, nominal income growth targeting does not suffer from this shortcoming and should be preferred to inflation targeting.

This paper contributes to the *goal-versus-instrument independence* debate for the ECB, exploring how alternative monetary arrangements perform when the fiscal authority pursues a strategy of debt reduction in the long term but retains fiscal flexibility in response to shocks<sup>2</sup>. Countercyclical policies are often conceived as the exclusive domain of monetary policy, which provides a more flexible instrument. In fact, what matters is whether fiscal policy is sufficiently flexible to respond to shocks. Empirical evidence suggests that European governments have made substantial use of their fiscal and debt policies for stabilisation purposes (Sorensen and Yoshua, 1998). Therefore, our modelling choice is motivated by the belief that – setting aside national differences – the regime outlined above captures some important aspects of the conduct of fiscal policy within EMU.

Following Jensen (1994), we present a model where time inconsistency in monetary policy is the result of labour market imperfections and tax distortions. The latter are caused by the need to finance public expenditures and debt service payments. As a first step, we consider a policy of debt reduction in a deterministic framework. We find that the optimal inflation target is negative whenever the inflation bias caused by tax and labour market distortions is large relative to the socially optimal inflation rate. There are two reasons why this is likely to be the case for EMU. On one hand, limited money holdings prevent seigniorage (Gros, 1993), suggesting that the optimal inflation rate should be small. On the other, tax and

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<sup>2</sup> It is worth mentioning from the start that we do not address the issue of co-ordination among national fiscal authorities facing a super-national monetary authority. We postulate just one fiscal and one monetary authority in our model.

labour market distortions blight many European economies (Daveri and Tabellini, 1997; IMF, 1998). Furthermore, due to the gradual reduction of debt, the inflation target turns out to be inversely related to current debt levels and time-dependent. These are unappealing features that undermine the role of the target as focal point in expectations co-ordination. In fact, negative targets are systematically missed while time-dependent and debt-related ones are subject to frequent updating, due to the persistence of debt and distortionary taxation.

The mentioned shortcomings do not affect nominal growth income targeting. In fact, in presence of persistence, the optimal inflation rate can be obtained by assigning to the central bank a state independent and non negative target for nominal income growth. However, we are able to show that in a stochastic environment nominal income growth targeting fails to remove the inflation bias volatility. It follows that when persistence has a fiscal root, it is desirable to supplement nominal income growth targeting with weight conservatism, i.e. to assign the nominal income growth to a weight-conservative central bank.

Delegation of monetary policy to a weight-conservative central banker is appealing for another reason too. As long as the fiscal instrument and the debt policy aim at stabilising shocks, assigning the conduct of monetary policy to a weight-conservative central banker allows to reduce inflation variability without sacrificing stabilisation. Since the fiscal authority and the central bank act independently in setting their countercyclical policies, the central bank implements "myopic" policies, which takes debt as given and neglects the intertemporal effects of inflation responses to shocks. Hence, when both authorities care about output stabilisation, excess volatility of inflation arises. As the ranking of the monetary regimes depends on the policy mix, the paper provides theoretical content to the claim that EMU needs a political pillar to engineer fiscal policies and so complement a strong and goal-independent ECB. It is worth noting that in our framework concerns about co-ordinated

fiscal authorities acting strategically to weaken the disciplining effect of an independent central bank (Beetsma and Bovenberg, 1998) would not arise. Fiscal authorities have an incentive to set strategically tax distortions in order to increase the inflation bias only if seigniorage revenues are not too small relative to their budget. But as stressed above, this is unlikely to be the case within EMU.

The rest of the paper is organised as follows. Section 2 presents the model. Section 3 discusses the welfare implications of adopting alternative monetary regimes in a context where the fiscal authority pursues debt reduction. Section 4 is concerned with stabilisation policies. Section 5 concludes.

## ***2. The model***

The Jensen's model (Jensen, 1994; Beetsma et al. 1996) describes an economy where the government provides a certain amount of public goods  $G_s$  financed by means of distortionary taxes  $t_s$ , seigniorage revenues  $k_0 p_s$  and public debt accumulation  $D_s$ . The government's budget constraint is defined as follows<sup>3</sup>:

$$D_s = D_{s-1}(1+r) + (G_s - t_s - k_0 p_s) \quad (1)$$

To limit analytical complexities, the *real* interest rate  $r$  is assumed constant and government debt fully indexed, as in Jensen (1994) and Beetsma and Bovenberg (1997). In the following, we set  $k_0 = 0$ . In fact, within EMU seigniorage revenues from anticipated inflation are a tiny percentage of GDP, due to the limited amount of money holdings<sup>4</sup>.

For the moment, we also assume that the aggregate per-period supply function

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<sup>3</sup> For a derivation of equation (1), see Jensen (1994).

<sup>4</sup> Gros (1993) estimates that seigniorage revenues range between 0.3% and 0.6% of GDP. The potentially large revenues from the use of unanticipated inflation - when debt is imperfectly indexed - are another source of time inconsistency that we do not consider for sake of analytical tractability.

$$y_s = \mathbf{p}_s - \mathbf{p}_s^e - \mathbf{t}_s - \tilde{u} \quad (2)$$

is deterministic<sup>5</sup> and depends on inflation surprises  $(\mathbf{p}_s - \mathbf{p}_s^e)$ , distortionary taxes  $\mathbf{t}_s$  and labour market imperfections  $\tilde{u}$ <sup>6</sup>. The government minimises the following intertemporal loss function:

$$W_t^G = \sum_{s=t}^{\infty} \mathbf{b}^{s-t} L_s^G \quad (3)$$

where  $\mathbf{b}$  is a discount factor and  $L_s^G = \frac{1}{2} [y_s^2 + k_1 (G_s - \tilde{G})^2 + k_2 (\mathbf{p}_s - \tilde{\mathbf{p}})^2]$  is the per-period loss function.  $\tilde{G} > 0$  and  $\tilde{\mathbf{p}} \geq 0$  define the socially optimal levels of expenditures and inflation<sup>7</sup>.

In the case of *discretion*<sup>8</sup>, inflation, taxes and the stock of debt carried over to the next period are determined optimising:

$$V(D_t) = \min_{\mathbf{p}_t, \mathbf{t}_t, D_t} \left\{ \frac{1}{2} [y_t^2 + k_1 (G_t - \tilde{G})^2 + k_2 (\mathbf{p}_t - \tilde{\mathbf{p}})^2] + \mathbf{b}V(D_t) \right\} \quad (4)$$

subject to (1) and (2).

Policy variables are chosen so as to balance marginal benefits and costs. In the case of inflation, the perceived beneficial impact on output must offset the adverse effect on inflation itself. As the tax rate is concerned, the marginal benefits of a tax-financed increase in expenditures must equate the marginal output costs of higher taxes<sup>9</sup>. Finally, debt issued is such that the marginal gains from a debt-financed increase in current expenditures<sup>10</sup> equals

<sup>5</sup> The role of supply shocks will be discussed in section 4.

<sup>6</sup> Following Alesina and Tabellini (1987), we define  $\mathbf{t}_s$  as a tax rate on the total revenue of firms. Labour market imperfections are a consequence of monopolistic unions.

<sup>7</sup> The Jensen model allows for a socially optimal inflation rate that is endogenously determined by the seigniorage motive. Since we assume  $k_0 = 0$ ,  $\tilde{\mathbf{p}}$  is exogenous, as in Svensson (1997).

<sup>8</sup> We closely follow Jensen (1994).

<sup>9</sup> Observe that the conditions determining the optimal inflation and tax rate are static in nature. In a deterministic framework, current inflation and taxes have an impact only on the present state of the economy. In fact, under rational expectations they are fully anticipated.

<sup>10</sup> Raising expenditures is obviously beneficial as long as they are below target.

the discounted value of future losses imposed by a debt increase – reduced availability of resources for future public spending. Under rational expectations, the open-loop solutions for inflation and taxes as well as the optimal relationship between current and expected expenditures in any future period are obtained:

$$\mathbf{t}_t^d = -\tilde{u} - k_1(G_t - \tilde{G}) \quad (5)$$

$$\mathbf{p}_t^d = \tilde{\mathbf{p}} - \frac{k_1}{k_2}(G_t - \tilde{G}) \quad (6)$$

$$(G_t - \tilde{G}) = (1+r)^j \mathbf{b}^j (G_{t+j} - \tilde{G}) \quad (7)$$

The tax rate is increasing in the expenditures gap: for any  $G_t$  below target, the policymaker has an incentive to levy distortionary taxes. As monetary policy aims to offset output distortions, inflation responds to the expenditures gap as well. To obtain the optimal level of expenditures gap  $(G_t^d - \tilde{G})$  under discretion, we proceed as follows. Having imposed the standard no-Ponzi-Game condition, the intertemporal budget constraint takes the form<sup>11</sup>:

$$\sum_{s=t}^{\infty} (1+r)^{-(s-t)} (G_s - \tilde{G}) + \frac{1+r}{r} \tilde{G} + (1+r)D_{t-1} = \sum_{s=t}^{\infty} (1+r)^{-(s-t)} \mathbf{t}_s \quad (8)$$

Substituting (5), (6) and (7) into (8) yields:

$$G_t^d - \tilde{G} = -\frac{(1+r)}{(1+k_1)\mathbf{I}} \left[ \frac{\tilde{G} + \tilde{u}}{r} + D_{t-1} \right] \quad (9)$$

where  $\mathbf{I} = (1+r)^2 \mathbf{b} / (1+r)^2 \mathbf{b} - 1$ .

Inserting (9) into (5) and (6), closed loop solutions for the tax and the inflation rate are obtained:

$$\mathbf{t}_t^d = -\tilde{u} + k_1 \frac{(1+r)}{(1+k_1)\mathbf{I}} \left[ \frac{\tilde{G} + \tilde{u}}{r} + D_{t-1} \right] \quad (10)$$

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<sup>11</sup> The term  $(1+r)\tilde{G}/r$  appears in (8) because we express current and future expenditures as deviations from the target.

$$\mathbf{P}_t^d = \tilde{\mathbf{P}} + \frac{k_1}{k_2} \frac{(1+r)}{(1+k_1)\mathbf{I}} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} + D_{t-1} \right] \quad (11)$$

It is easy to check that the inflation rate is increasing in present and future labour market distortions, while the policymaker responds to the latter by lowering taxes only if the marginal loss imposed by deviations of expenditures from target is small, in a relative sense<sup>12</sup>.

Substituting into equation (1) for  $G_t^d$  and  $\mathbf{t}_t^d$  we characterise debt dynamics:

$$D_t^d = \frac{D_{t-1}^d}{(1+r)\mathbf{b}} - \frac{(1+r)\mathbf{b} - 1}{(1+r)\mathbf{b}} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} \right] \quad (12)$$

which are stable only if  $(1+r)\mathbf{b} > 1$ .

The steady-state solution of the model (Jensen 1994) implies that the government accumulates negative debt (financial claims on the private sector) in order to finance current expenditures and to subsidise labour market distortions. This conclusion is perhaps questionable and obviously difficult to reconcile with empirical evidence<sup>13</sup>. However, the present paper is not concerned with the discussion of steady states. We wish to focus on the link between monetary and fiscal policy during a phase of debt reduction. As Jensen's (1994) model provides a plausible description of the relations between public debt dynamics, distortionary tax policy and the inflation bias, we choose to retain its original features.

Let us assume stability, i.e.  $(1+r)\mathbf{b} > 1$ . Equation (10) shows that labour market distortions weaken the policymaker's incentive to levy taxes and therefore increase the

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<sup>12</sup> That is,  $k_1 < (1+r)\mathbf{b}r / ((1+r)\mathbf{b} - 1)$ . As  $k_1 \geq 0$ , we postulate  $(1+r)\mathbf{b} \geq 1$ . It will be clear in a moment that this is not a restrictive assumption.

<sup>13</sup> In fact, there are theoretical reasons why positive debt levels obtain in steady state. Cukierman and Meltzer (1989) argue that accumulation of public debt allows bequest-constrained individuals to raise their consumption levels at the expenses of future generations. Alternatively, the policymaker may wish to limit the savings available to her opponent in the event of an electoral defeat (Persson and Svensson, 1989; Alesina and Tabellini, 1990). As a result, politico-economic equilibria emerge where the policymaker uses debt to subsidise the consumption of such bequest-constrained individuals. To capture this effect, Tirelli

expenditures gap. The outstanding stock of debt generates an identical effect because debt service payments reduce the amount of resources available for public spending. The size of the parameter  $I$  is crucial to define how current expenditures respond to the forcing variables – labour market distortions and the amount of inherited debt. For what concerns the latter, the adjustment of expenditures to an increase in debt is inversely related to the policymaker’s discount factor. A relatively large  $I$  – a relatively small  $\beta$  – implies that a limited amount of resources is devoted to the reduction of debt. This delays adjustment, but raises expenditures in the short term, allowing the policymaker to keep down current taxes and inflation.

As far as monetary policy is concerned, the impossibility of exploiting monetary surprises to offset output distortions implies that, absent supply shocks and the seigniorage motive, the first best monetary policy would be a simple constant inflation rule,  $p_t = \tilde{p}$ . To achieve this outcome, a number of policy regimes can be envisioned. The policymaker can either delegate monetary policy to a goal-independent central banker, characterised by weight conservatism<sup>14</sup>, or assign an inflation target<sup>15</sup> as well as a nominal income growth target<sup>16</sup> to an instrument-independent central bank. One may wonder why we consider targeting nominal income growth as our supply function does not exhibit persistence. In our model, current taxes are a function of debt carried over from the past – see equation (10). In turn, the latter depends on past output realisations. As a result, current and past output are linked through the debt persistence parameter. In fact,  $y_s = \mathbf{a}y_{s-1}$ , where  $\mathbf{a} = 1/(1+r)\mathbf{b}$ <sup>17</sup>.

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(2000) modifies the loss function in (3) assuming that a policy of debt reduction is costly for the policymaker. He shows that debt levels may be positive in steady state.

<sup>14</sup> As in Rogoff (1985).

<sup>15</sup> As in Svensson (1997).

<sup>16</sup> As in Beetsma and Jensen (1999).

<sup>17</sup> For a proof, see Appendix 1.

### 3. Monetary delegation: weight or target conservatism?

To model the choice among the different monetary regimes, we postulate that the central banker's intertemporal loss function is:

$$W_t^B = \sum_{s=t}^{\infty} \mathbf{b}^{s-t} L_s^B \quad (13)$$

where  $L_s^B = \frac{1}{2} \left[ y_s^2 + \mathbf{g}_2 (\mathbf{p}_s - \mathbf{p}_s^b)^2 + k_3 (\mathbf{p}_s + y_s - y_{s-1} - \mathbf{r}_s^b)^2 \right]$  is the per-period loss function.

Note that  $\mathbf{p}_s^b < \tilde{\mathbf{p}}$  defines a target-conservative (relative to inflation) central banker while the parameter  $\mathbf{g}_2 \geq 1$  describes the central banker's degree of weight conservatism.  $\mathbf{r}_s^b$  is the central banker's nominal income growth target and thus the parameter  $k_3$  measures the utility loss imposed by deviations of nominal income rate of change from target<sup>18</sup>. Institutional design boils down to selecting the optimal value for each of the above parameters, namely:  $\mathbf{p}_s^b$ ,  $\mathbf{g}_2$ ,  $\mathbf{r}_s^b$ ,  $k_3$ . Accomplishing this task requires specific assumptions about fiscal and monetary authorities' interactions. We postulate that they act non-cooperatively and confine our analysis to Markov equilibria. A linear Markov perfect equilibrium in the game between the policymaker and the central banker is characterised by a set  $(\mathbf{p}_t, \mathbf{t}_t, D_t)$  such that the pair  $(\mathbf{t}_t, D_t)$  minimises (3) taking  $\mathbf{p}_t$  as given and  $\mathbf{p}_t$  minimises (13) taking  $\mathbf{t}_t$  and  $D_t$  as given. In each period, expectations about inflation are already formed when the policy is selected and thus the central banker sets the inflation rate to equate its current marginal benefits and costs. The open-loop solution for inflation is:

$$\mathbf{p}_t^B = \frac{1}{\mathbf{g}_2 + 2k_3} \left[ \mathbf{g}_2 \mathbf{p}_t^b + 2k_3 \mathbf{r}_t^b + 2k_3 k_1 (G_{t-1} - \tilde{G}) - k_1 (1 + 2k_3) (G_t - \tilde{G}) \right] \quad (14)$$

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<sup>18</sup> The reason why we assume that the central bank is not concerned with the level of expenditures is twofold. First, the Maastricht Treaty explicitly forbids monetary financing of public deficits. Second, a loss function akin to (3) for the central banker would yield identical results under the assumption that  $k_0 = 0$ . On the other hand, equation (13) posits that the central bank does worry about output distortions while accounting for the extreme hypothesis that the ECB might be concerned with inflation only.

The policymaker takes current expectations as given but is aware that current debt accumulation has an impact on future inflation<sup>19</sup> and thus on inflation expectations formed at time  $t$ . It follows that she may wish to engage in strategic use of debt, as suggested in Beetsma and Bovenberg (1997). While taxes are chosen as in (5), debt is issued up to the point that the current marginal benefits, in the form of increased expenditures, equates marginal costs, that is: reduced resources for future expenditures and higher inflation expectations. Thus, the first-order condition for  $D_t$  is:

$$k_1(G_t - \tilde{G}) = (1+r)\mathbf{b} \left\{ k_1 E_t(G_{t+1} - \tilde{G}) + k_2 E_t(\mathbf{p}_{t+1} - \tilde{\mathbf{p}}) \frac{\partial E_t \mathbf{p}_{t+1}}{\partial D_t} \right\} \quad (15)$$

Inflation as low as under precommitment can be achieved by delegation of monetary policy to a weight-conservative central banker, i.e. by setting  $\xi \rightarrow \infty$ ,  $\mathbf{p}_s^b = \tilde{\mathbf{p}}$  and  $k_3 = 0$ . Since deviations of inflation from the socially optimal rate are infinitely costly, the central banker implements  $\mathbf{p}_t^B = \tilde{\mathbf{p}}$ , no matter what taxes are currently selected or what debt is carried over from the past. The policymaker realises that debt policy has no impact on inflation expectations<sup>20</sup> and thus any incentive to use debt strategically disappears<sup>21</sup>. It follows that both debt level and the tax rate are as under commitment.

Alternatively, the optimal inflation rate can be obtained by delegation of monetary policy to a target conservative central banker, i.e. by setting  $\xi = 1$  and  $k_3 = 0$  and assigning

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<sup>19</sup> The more debt is issued at time  $t$ , the more the policymaker has to rely on taxes to finance any given amount of public expenditures in the future. As a consequence, the incentive to use inflation to offset the distortionary effects of taxes on output increases.

<sup>20</sup> This implies that the derivative of future inflation with respect to debt is zero and thus the last term in curly brackets on the R.H.S of (15) drops.

<sup>21</sup> Beetsma and Bovenberg (1997) argue along the same lines: "Intuitively, the incentive facing the first-period fiscal authority to employ debt strategically originates in the inability to commit monetary policy in the second period. If this problem is removed by properly adjusting the preferences of the central bank, the first period fiscal authority no longer perceives any need to use debt strategically in order to move second-period monetary policy closer to the social optimum." (p.890).

to the central banker a state dependent inflation target,  $\mathbf{p}_t^*$ <sup>22</sup>. As apparent from equation (11), the inflation bias is debt-related and thus the optimal inflation target has to be set period by period after choosing the amount of debt to be carried over to the future. This procedure eliminates any incentive to affect inflation expectations through debt policy. In fact, no matter what debt level is selected, the inflation target is adjusted to it to make sure that next period inflation is the socially optimal one, i.e.  $\mathbf{p}_{t+1}^B = \tilde{\mathbf{p}}$ <sup>23</sup>. This is obtained by the following state contingent inflation target  $\mathbf{p}_t^*$ :

$$\mathbf{p}_t^* = \tilde{\mathbf{p}} - \frac{k_1}{k_2} \frac{(1+r)}{(1+k_1)I} \left[ \frac{\tilde{G} + \tilde{u}}{r} + D_{t-1} \right] \quad (16)$$

However,  $\mathbf{p}_t^*$  has some unappealing features. First, a time-dependent and debt-related target is likely to require frequent revisions and this may undermine its role as a focal point for the co-ordination of expectations<sup>24</sup>. Second, (16) implies that the target must increase over time if the policymaker pursues a strategy of debt reduction. Finally, within EMU the inflation bias caused by distortionary taxation is likely to be large relative to  $\tilde{\mathbf{p}}$ <sup>25</sup>. This implies that  $\mathbf{p}_s^*$  is negative unless public debt is substantially reduced<sup>26</sup>.

Beetsma and Jensen (1999) suggest that a nominal growth income target escapes some of these criticisms. As it will shown shortly, the latter is state-independent and it allows the central banker to deliver the socially optimal inflation rate. To see that, observe that

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<sup>22</sup> While working on this version of the paper, we became aware that a similar result is obtained by Beetsma and Bovenberg (1999) in a two-period model.

<sup>23</sup> In this case too, the derivative of future inflation with respect to debt is zero and the last term in curly brackets on the R.H.S of (15) disappears.

<sup>24</sup> As a matter of principle, in a deterministic environment there is no need to adopt a period by period adjustment procedure. A sequence of targets  $\Pi = \{\mathbf{p}_t^*, \dots, \mathbf{p}_T^*\}$ ,  $T \rightarrow \infty$  could be announced at time  $t$  and kept in place for the foreseeable future. Even if it is of any relevance in a deterministic environment, such sequence of inflation targets is of little help in a stochastic one, as discussed in the next section.

<sup>25</sup> Absent the seigniorage motive, one may ask why should be  $\tilde{\mathbf{p}} > 0$  especially if one takes into account the adverse effects of inflation on long-term growth (Barro, 1995). Akerlof, Dickens and Perry (1996) argue that a little inflation might “grease the wheels” of the labour market.

setting  $\mathbf{p}_t^b = \tilde{\mathbf{p}}$ ;  $\mathbf{r}_t^b = \tilde{\mathbf{p}}$  and using (5), (14) and (15), the closed loop solution for inflation can be written as follows<sup>27</sup>:

$$\mathbf{p}_t^B = \tilde{\mathbf{p}} - \frac{1}{\mathbf{g}_2 + 2k_3} \left\{ \frac{k_1}{(1+k_1)\hat{\mathbf{I}}} \frac{1-2k_3[(1+r)\hat{\mathbf{b}}-1]}{\hat{\mathbf{b}}} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} + D_{t-1} \right] \right\} \quad (17)$$

where  $\hat{\mathbf{b}} = \mathbf{b} \frac{1 - \mathbf{c}k_2(1+2k_3)}{1 - \mathbf{c}(1+r)\mathbf{b}2k_2k_3}$ ;  $\mathbf{c} = \frac{1}{(\mathbf{g}_2 + 2k_3)^2} \frac{k_1[(1+r)(1+2k_3) + 2k_3]}{1+k_1}$  and

$\hat{\mathbf{I}} = (1+r)^2 \hat{\mathbf{b}} / [(1+r)^2 \hat{\mathbf{b}} - 1]$ . Finally, if  $k_3 = 1/2[(1+r)\mathbf{b} - 1]$ ,  $\mathbf{p}_t^B = \tilde{\mathbf{p}}$  for any  $\boldsymbol{\xi}$ .

To summarise, in a deterministic framework all the policy regimes we examine allow to obtain the optimal inflation rate. How to choose among them? Because it is state independent, nominal income growth targeting can be preferred to inflation targeting. Moreover, one could argue that when it comes to compare nominal income growth targeting and delegation to a weight-conservative central banker, a deterministic framework is not appropriate. In the next section, we analyse the working of the different policy regimes in a stochastic environment.

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<sup>26</sup> Negative targets have been subjected to open criticism as they are systematically missed. For a discussion of this point, see DeGrauwe (1996) and Persson and Tabellini (1997). Linear contracts *à la* Walsh (Walsh, 1995) would be immune from this criticism.

<sup>27</sup> Derivation of (17) can be found in Appendix 2.

#### 4. Supply shocks and monetary regimes

In a stochastic framework, the aggregate supply function takes the following form:

$$y_s = \mathbf{p}_s - \mathbf{p}_s^e - \mathbf{t}_s - \tilde{u} + \mathbf{e}_s \quad (18)$$

where  $\mathbf{e}_s$  is a random disturbance i.d. with zero mean and finite variance  $\mathbf{s}_e^2$ . Under persistence, the impact of supply shocks on policy variables is twofold. In each period  $t$ , random disturbances to output call for stabilisation. As policy variables respond to current shocks, actual values for the latter differ from expected ones. Because of its timing, institutional design for monetary policy can ensure only that expected inflation equals the socially optimal rate. One would then be tempted to conclude that the policy regimes outlined in the previous section should be judged on this ground. However, under persistence current shocks have also intertemporal effects. In our model, as current debt is sensitive to current supply shocks, inflation expectations reflects past realisations of supply disturbances. As a consequence, the inflation bias exhibits volatility. A proper comparison of policy regimes should take into account how each of them scores on this ground too. We now proceed to attempt such comparison.

To start with, consider the Markov equilibrium in the game between fiscal and monetary authority outlined above, when the economy is affected by random shocks. The first order conditions for the tax rate amounts to:

$$\mathbf{t}_t^B = -\tilde{u} - k_1(G_t - \tilde{G}) + \mathbf{e}_t + (\mathbf{p}_t - \mathbf{p}_t^e) \quad (19)$$

The fiscal authority finds it optimal to tax away any unexpected output increase in order to finance expenditures. This implies that – for a given level of expenditures – the flexibility of the tax instrument will isolate output from shocks and from monetary surprises. Simultaneously solving for the tax rate and the inflation rate, the following open-loop solutions obtain:

$$\mathbf{p}_t^B = E_t \mathbf{p}_t^B - \frac{k_1(1+2k_3)}{\mathbf{g}_2 + 2k_3} [(G_t^B - \tilde{G}) - E(G_t^B - \tilde{G})] \quad (20)$$

$$\mathbf{t}_t^B = -\tilde{u} - k_1(G_t^B - \tilde{G}) - \frac{k_1(1+2k_3)}{2k_3 + \mathbf{g}_2} [(G_t^B - \tilde{G}) - E(G_t^B - \tilde{G})] + \mathbf{e}_t \quad (21)$$

The non co-operative equilibrium between the fiscal and the monetary authority implies that inflation responds only to the expenditures gap. However supply shocks still have an impact on inflation through their effect on current expenditures:

$$G_t^B - \tilde{G} = E(G_t^B - \tilde{G}) + \frac{\mathbf{e}_t}{(1+k_1)\hat{I} + \frac{k_1(1+2k_3)}{2k_3 + \mathbf{g}_2}} \quad (22)$$

An adverse supply shock triggers a tax reduction that causes a simultaneous fall in expenditures. Inflation therefore rises above its expected level, weakening the response of taxes to shocks. We are now able to comment on the sensitivity of expenditures to shocks, which is inversely related to three factors. The first is the trade-off between expenditures and distortionary taxation, defined by parameter  $k_1$ . The willingness to bear the cost of distortionary taxation increases with it, and the sensitivity of expenditures to shocks falls accordingly. The second factor is related to the policymaker's intertemporal preferences: the larger is  $I$ , the more the policymaker uses debt policy to spread adjustment onto future periods. The third factor is the impact of the inflation surprise on taxes in period  $t$ , which limits the response of the fiscal instrument to shocks. This effect explains why expenditures are more sensitive to a change in the labour market distortions and the amount of inherited debt than to stochastic disturbances.

Turning to the analysis of monetary regimes, consider first nominal income growth targeting. As we know from the previous section, in a deterministic environment nominal income growth targeting can be preferred to inflation targeting for it allows the central bank to target state-independent values. Unfortunately, a state-independent target fails to remove

the volatility of the inflation bias in a stochastic framework. In such environment, because of debt persistence, the deterministic component of inflation is a function of past shock realisations. In fact, setting  $\mathbf{p}_t^b = \tilde{\mathbf{p}}$ ;  $\mathbf{r}_t^b = \tilde{\mathbf{p}}$  and using (20), (21) and (22), the closed loop solution for expected inflation can be written as follows<sup>28</sup>:

$$E\mathbf{p}_t^B = \tilde{\mathbf{p}} - \frac{1}{\mathbf{g}_2 + 2k_3} \left\{ \frac{k_1}{(1+k_1)\hat{\mathbf{I}}} \frac{1-2k_3[(1+r)\hat{\mathbf{b}}-1]}{\hat{\mathbf{b}}} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} + D_{t-1} \right] \right\} + \frac{1}{\mathbf{g}_2 + 2k_3} \frac{k_1(1+r)}{(1+k_1)\hat{\mathbf{I}}} (1+2k_3) \left[ 1 - \frac{1+k_1}{(1+k_1)\hat{\mathbf{I}} + \frac{k_1(1+2k_3)}{\mathbf{g}_2 + 2k_3}} \right] \mathbf{e}_{t-1} \quad (23)$$

By selecting  $k_3 = 1/2[(1+r)\mathbf{b}-1] \equiv k_3^*$ , (23) reduces to:

$$E\mathbf{p}_t^B = \tilde{\mathbf{p}} + \frac{1}{\mathbf{g}_2 + 2k_3^*} \frac{k_1(1+r)}{(1+k_1)\hat{\mathbf{I}}} (1+2k_3^*) \left[ 1 - \frac{1+k_1}{(1+k_1)\hat{\mathbf{I}} + \frac{k_1(1+2k_3^*)}{\mathbf{g}_2 + 2k_3^*}} \right] \mathbf{e}_{t-1} \quad (24)$$

Hence, under nominal income growth targeting the volatility of the inflation bias persists. To remove the latter a state contingent nominal income growth target would be required. But such target is open to the same criticisms a state dependent inflation target stirs up. Under persistence, there is a role for a weight conservatism. A weight-conservative central banker would reduce inflation expectations and the inflation bias volatility would fall. For this reason, it appears desirable to assign a constant nominal income growth target to a weight-conservative central banker.

However, weight-conservative is counterproductive as far as output stabilisation is concerned and this militates against delegation of monetary policy to weight-conservative central banker. In the following we show that when fiscal policy is countercyclical, a case can be made for appointing a weight-conservative central banker. We cast our argument in

<sup>28</sup> Derivation of (23) can be found in Appendix 2.

terms of inflation targeting vs. goal independence, but the same result would obtain considering a state dependent nominal income growth target. Thus, we concentrate our attention on delegating monetary policy to either a weight or a target inflation conservative central banker, that is on the setting of either  $\mathbf{p}_t^b = \mathbf{p}_t^*$  and  $\mathbf{g}=1$  or  $\mathbf{p}_t^b = \tilde{\mathbf{p}}$  and  $\mathbf{g} \rightarrow \infty$ .

For the sake of clarity, let us state the open-loop solutions for the tax and the inflation rate and the expenditures gap when nominal income growth does not enter the central banker loss function, i.e.  $k_3 = 0$  in expression (13). By manipulation of (20), (21) and (22), we obtain:

$$\mathbf{p}_t^B = E_t \mathbf{p}_t^B - \frac{k_1}{\mathbf{g}_2} \left[ (G_t^B - \tilde{G}) - E(G_t^B - \tilde{G}) \right] \quad (25)$$

$$\mathbf{t}_t^B = -\tilde{u} - k_1 (G_t^B - \tilde{G}) - \frac{k_1}{\mathbf{g}_2} \left[ (G_t^B - \tilde{G}) - E(G_t^B - \tilde{G}) \right] + \mathbf{e}_t \quad (26)$$

$$G_t^B - \tilde{G} = E(G_t^B - \tilde{G}) + \frac{\mathbf{e}_t}{(1+k_1)\mathbf{I} + \frac{k_1}{\mathbf{g}_2}} \quad (27)$$

The expected values for the policy variables are identical under weight and target conservatism. On the other hand, their variance will differ. It is straightforward to show that an increase in the degree of weight conservatism lowers the volatility of inflation but raises that of expenditures and taxes. However, the impact of  $\mathbf{g}$  on the variance of expenditures becomes negligible when  $\mathbf{I}$  is relatively large. To understand this, consider the time pattern of debt obtained by substituting (25), (26) and (27) into (1):

$$D_t^B = \frac{D_{t-1}^B}{(1+r)\mathbf{b}} - \frac{(1+r)\mathbf{b} - 1}{(1+r)\mathbf{b}} \left[ \frac{\tilde{G} + \tilde{u}}{r} \right] - \left[ 1 - \frac{(1+k_1)}{(1+k_1)\mathbf{I} + \frac{k_1}{\mathbf{g}_2}} \right] \mathbf{e}_t \quad (28)$$

Comparing the expected welfare losses under the two regimes, we obtain:

$$EW^G(\mathbf{p}_t | \mathbf{p}_t^*, \mathbf{g}=1) - EW^G(\mathbf{p}_t = \tilde{\mathbf{p}}) = \frac{1}{2} \frac{k_1}{1-\mathbf{b}} \left[ \frac{\left(1+k_1 + \frac{k_1}{k_2}\right)}{\left[(1+k_1)\mathbf{I} + \frac{k_1}{k_2}\right]^2} - \frac{1}{(1+k_1)\mathbf{I}^2} \right] \mathbf{s}_e^2 \quad (29)$$

Some tedious algebra shows that the weight-conservative central banker improves welfare

whenever<sup>29</sup>  $\mathbf{I} > 1 + \left[1 + \frac{k_1}{(1+k_1)k_2}\right]^{\frac{1}{2}}$ . This result derives from the lack of co-ordination in the

game between the central bank and the fiscal authority, where the former does not take into account the role of debt as a shock absorber. By taking debt as given, the central bank ignores the intertemporal effects of monetary policy response to shocks. Output stabilisation by the central bank gives the fiscal authority more room in the use of taxes and it reduces the volatility of debt. But the volatility of debt has no cost for society, while inflation volatility has. Thus, it would be optimal to shift the burden of stabilisation from monetary policy to debt policy<sup>30;31</sup>. From this standpoint, the paper adds to the literature on the relevance of co-ordinated actions among fiscal and monetary authorities. The above result also stresses the importance of flexibility in the use of both debt and taxes<sup>32</sup>.

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<sup>29</sup> This constraint is very likely to be met in practice. For a real interest rate  $r = 5\%$  and under the extreme assumption  $\mathbf{b} = 1$ , the weight-conservative banker is preferred unless  $1 + [k_1 / (1+k_1)k_2] > 95$ .

<sup>30</sup> Our result can be interpreted also in terms of a trade-off between current and future inflation volatility.

<sup>31</sup> In the above discussion, we allow for the inflation target to be adjusted period by period. As mentioned, such state contingent arrangement has stimulated a number of criticisms. To meet the latter, one could consider to select the optimal target sequence at the time of institutional design so that the inflation target for any future period is known at time  $s = t$ . Unfortunately, this institutional arrangement increases volatility in expenditures and adversely affect the loss function, strengthening the case for a weight-conservative central banker. This occurs because the predetermined target cannot remove the stochastic component of the inflation bias, and the fiscal authority attempts to affect next period expectations via debt policy, neglecting the adverse implications on current period inflation. Proofs are available from the authors upon request.

<sup>32</sup> For a proof, see Appendix 3. Observe that we are not invoking the return to demand management policies. Our focus is on the supply side. When an adverse shock hits the economy both taxes and expenditures fall, the former more so than the latter.

Lengthy manipulations show that adoption of a nominal income growth target, instead of an inflation target, would not remove the inefficiency of monetary policy, which in turn would stimulate the strategic use of debt.

## ***5. Conclusions***

Two results emerge from this paper. The first is that, due to the persistence of debt and distortionary taxation, a strategy based on holding the ECB accountable by means of a nominal income growth target – rather than an inflation target – presents shortcomings too. In particular, we argue that it is desirable to supplement nominal income growth targeting with weight conservatism, i.e. to assign a constant nominal income growth target to a weight-conservative central banker. The second is that if fiscal policy is countercyclical, as some would argue, then delegating monetary policy to a conservative central banker enhances welfare. It follows that co-ordination of countercyclical national fiscal policies would be welcome, given the ECB institutional conservatism.

### ***Appendix 1***

To establish that in our model output exhibits persistence, observe that absent supply side shocks and under rational expectations, supply function (2) turns into:

$$y_s = -\mathbf{t}_s - \tilde{\mathbf{u}} \quad (\text{A.1.1})$$

Substituting (10) into (A.1.1), we obtain:

$$y_s = -k_1 \frac{(1+r)}{(1+k_1)} \mathbf{I} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} + D_{s-1} \right] \quad (\text{A.1.2})$$

Inserting (12) into (A.1.2), we have:

$$y_s = -k_1 \frac{1}{(1+k_1)} \mathbf{I} \mathbf{b} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} + D_{s-2} \right] \quad (\text{A.1.3})$$

Equation (A.1.2) generalises to:

$$y_{s-1} = -k_1 \frac{(1+r)}{(1+k_1)} \mathbf{I} \left[ \frac{\tilde{\mathbf{G}} + \tilde{\mathbf{u}}}{r} + D_{s-2} \right] \quad (\text{A.1.4})$$

From (A.1.4) an expression for  $D_{s-2}$  can be derived and substituted into (A.1.3), giving rise to:

$$y_s = \mathbf{a} y_{s-1} \quad (\text{A.1.5})$$

where  $\mathbf{a} = 1/(1+r)\mathbf{b}$ .

## Appendix 2

To derive equation (17) and (23), observe equation (14) provides the open loop solution for inflation in any period. Thus, after setting  $\mathbf{p}_{t+1}^b = \mathbf{r}_{t+1}^b = \tilde{\mathbf{p}}$ , the open loop solution for inflation at time  $t+1$  can be written as:

$$\mathbf{p}_{t+1}^B = \tilde{\mathbf{p}} + \frac{1}{\mathbf{g}_2 + 2k_3} \left[ 2k_3k_1(G_t - \tilde{G}) - k_1(1 + 2k_3)E(G_{t+1} - \tilde{G}) \right] \quad (\text{A.2.1})$$

To proceed, we need to compute the last term in curly brackets in equation (15) in the text:

$$k_1(G_t - \tilde{G}) = (1+r)\mathbf{b} \left\{ k_1E_t(G_{t+1} - \tilde{G}) + k_2E_t(\mathbf{p}_{t+1} - \tilde{\mathbf{p}}) \frac{\partial E_t \mathbf{p}_{t+1}}{\partial D_t} \right\} \quad (\text{A.2.2})$$

Observe that from equation (1) and making use of the open loop solution for taxes, we obtain:

$$(G_s - \tilde{G}) = \frac{1}{1+k_1} \left[ D_s - (1+r)D_{s-1} - (\tilde{G} + \tilde{u}) \right] \quad (\text{A.2.3})$$

Thus:

$$(E_t \mathbf{p}_{t+1}^B - \tilde{\mathbf{p}}) \frac{\partial E_t \mathbf{p}_{t+1}^B}{\partial D_t} = \mathbf{c} \left[ 2k_3k_1(G_t - \tilde{G}) - k_1(1 + 2k_3)E_t(G_{t+1} - \tilde{G}) \right] \quad (\text{A.2.4})$$

where  $\mathbf{c} = \frac{1}{(\mathbf{g}_2 + 2k_3)^2} \frac{k_1[(1+r)(1+2k_3) + 2k_3]}{1+k_1}$

Substituting (A.2.4) into (A.2.2), we obtain:

$$(G_t - \tilde{G}) = (1+r)\hat{\mathbf{b}}E_t(G_{t+1} - \tilde{G}) \quad (\text{A.2.5})$$

where  $\hat{\mathbf{b}} = \mathbf{b} \frac{1 - \mathbf{c}k_2(1+2k_3)}{1 - \mathbf{c}(1+r)\mathbf{b}2k_2k_3}$ .

The final step consists of inserting (A.2.5) into (A.2.1). In a deterministic framework, we obtain (17); in a stochastic one, (23) emerges.

### Appendix 3

To illustrate the importance of flexibility in the use of both debt and taxes, we proceed as follows. Consider the case where the fiscal authority is constrained to implement a balanced budget rule. Equation (1) becomes:

$$D_{s-1}(1+r) = \mathbf{t}_s - G_s \quad (\text{A.3.1})$$

where  $D_{s-1} = D_0$  is exogenous and fixed. The policy rules defined in equation (25) and (26) still hold and the expenditures gap amounts to:

$$G_t - \tilde{G} = - \left[ \frac{\tilde{G} + \tilde{u} + (1+r)D_0}{(1+k_1)} \right] + \frac{\mathbf{e}_t}{1+k_1 + \frac{k_1}{\mathbf{g}_2}} \quad (\text{A.3.2})$$

In this case, the second best outcome for monetary policy is achieved by assigning to the central banker in each period the following inflation target:

$$\mathbf{p}_s^* = \tilde{\mathbf{p}} - \left[ \frac{\tilde{G} + \tilde{u} + (1+r)D_0}{(1+k_1)} \right] \frac{k_1}{k_2} \quad (\text{A.3.3})$$

Moreover, the policymaker's discount factor no longer affects the sensitivity of expenditures to shocks. In each period the difference between the expected welfare losses under the two monetary regimes amounts to:

$$EL^G(\mathbf{p}|\mathbf{p}^*, \mathbf{g}=1) - EL^G(\mathbf{p}=\tilde{\mathbf{p}}) = - \left[ \left( 1+k_1 + \frac{k_1}{k_2} \right) (1+k_1) \right]^{-1} \frac{k_1}{k_2} \mathbf{s}_e^2 \quad (\text{A.3.4})$$

When the policymaker cannot use debt policy, it is always preferable to retain monetary flexibility. In fact, the increased volatility of inflation is more than compensated by the reduction in expenditures variability. On the other hand, the availability of debt policy is of little help if political constraints limit the policymaker's ability to react to shocks. Consider the extreme case where the fiscal authority can choose the size of the deficit but taxes must be set before shocks are observed.

The first order condition for the tax instrument becomes:

$$-E(y_t) + k_1(G - \tilde{G}) = 0 \quad (\text{A.3.5})$$

and the solutions for inflation is:

$$p_t^B = p_t^b - \frac{k_1}{g_2}(G_t - \tilde{G}) - \frac{1}{1+g_2}e_t \quad (\text{A.3.6})$$

Debt, taxes and expenditures follow the deterministic pattern outlined in section 2, whilst monetary policy takes up the burden of stabilising output. It is straightforward to show that in this case welfare losses are always smaller when  $\xi = 1$  and the optimal inflation target for a deterministic environment [see expression (16)] is adopted.

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