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A CASE FOR FISCAL POLICY CO-ORDINATION IN EUROPE

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ABSTRACT

In this paper we analyse the impact of fiscal policy co-ordination in a monetary union on the size of the spending bias, inflation and the optimal degree of conservatism of the central bank. Our main result is that, when the fiscal authorities internalise the spillover effects originating from their loose fiscal stances, the size of the inflation bias decreases. As a result, the optimal degree of conservatism declines as well. Moreover, we show that the Stability Pact can be seen as an optimally designed linear penalty in the utility function of the fiscal authorities. This is able to achieve the same desired result as fiscal policy co-ordination but without an explicit commitment to it.

Key Words*: EMU, Fiscal and Monetary Policy Co-ordination, Central Bank Independence, Stability and Growth Pact.*

JEL Code*: E50, E58, E61, F15.*

1 Introduction

The main concern often expressed in the past about the European Monetary Union (EMU) was that it would reduce countries' flexibility in the use of inflation as a source of revenue and that

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it would lead to a somewhat unacceptable loss of sovereignty in the management of monetary policy. Now that EMU is a reality, however, a new concern has arisen. The question is: is fiscal policy co-ordination desirable ?

In this paper we provide an argument in favour of co-ordination. This is based on the fact that governments perceive that a unilateral fiscal expansion determines a real exchange rate appreciation, which in a monetary union is entirely reflected into a change of the relative prices. Hence they have an incentive to increase public expenditure relative to foreign countries because higher domestic prices will reduce the real product wage[1] and boost output.

We show that, when the fiscal authorities fail to internalise the spillovers originating from their fiscal stances, both government expenditures and tax distortions are excessively high. As a result, output deviations from its natural level increase and the traditional *time-inconsistency* problem of monetary policy worsens.

Our main result is that co-ordination internalises these inefficiencies therefore removing both the fiscal bias - temptation to spend more than the socially optimal level - and its impact on the size of the more traditional inflation bias. This also reduces the optimal degree of conservatism of the central bank (ECB). In fact, in so far as that the fiscal authorities engage in expansionary fiscal policies, the central bank will have to pursue a tighter monetary policy in order to deliver a particular rate of inflation.

Still how to achieve co-ordination is not an easy matter. In the paper we also suggest an alternative mechanism based on a *principal agent* micro-framework - that we define *à la Walsh* - that can be used to obtain the same positive results of fiscal policy co-ordination, but without an explicit commitment to it.

Our framework is very close in spirit to van der Ploeg (1990 and 1993), which provides a modern version of the Mundell-Flemming open-economy model, and Levine and Pearlman (1998), which analyses the fiscal and monetary policy interactions between the “ins and outs” to a monetary union. Here we develop a relatively more simple model of monetary union, based on micro-foundations. We endogenise fiscal policy and concentrate on the case where

the real exchange rate is the only channel of policy transmission. Our contribution is to introduce an explicit balanced budget rule and analyse the important distortionary effects of a tax levied on income.

The paper proceeds as follows: sections 2 and 3 consider the issues of time inconsistency of monetary and fiscal policies. Section 4 presents a simple application of the Walsh contracts, while section 5 goes one step further and computes the optimal degree of central bank independence. Section 6 summarises and concludes.

2 The Model

Let us consider *n+1* interdependent economies with identical economic structures and specialising in the production of one good. Goods are imperfect substitutes in consumption, while capital stock is exogenously fixed. Countries run balanced budgets and are able to finance their public expenditure only by raising taxation[2].

The demand side of the model closely follows Levine and Pearlman (1998). We assume that in country i [$i = 0,n$] C_{ij} units of good j are imported from country j [$j = 0, n$].[3] Given the total consumption expenditure C_i, consumers in country i choose the units of consumption $\{C_{ij}\}_{j=0,n}$ to maximise an expected utility function $E_{-1}(U_i)$ where:

$$U_i = \sum_{j=0}^{n} g_{ij} \log C_{ij} + h_i \log G_i \qquad g_{ij} = \frac{1}{n+1} \quad ; \quad \sum_{j=0}^{n} g_{ij} = 1 \qquad (1)$$

subject to:

$$C_i = \sum_{j=o}^{n} E_{ij} C_{ij} \qquad (2)$$

[1] We assume that nominal wages are fixed a period ahead and cannot be revised.
[2] The introduction of seignorage would not alter the substance of our results.
[3] All variables are dated at time *t*. A subscript *+1* indicates time *t + 1* and a subscript *-1* indicates time *t - 1*.

E_{ij} is the real exchange rate between country i and j and g_{ij} is the share of good j in the consumption of the representative consumer of country i. Government spending G_i is assumed to fall exclusively on domestic goods. Equation (1) states that the utility of individuals depends on the levels of both government and private consumption, where the latter is allocated equally between domestic and foreign goods.

Straightforward calculations show that the demand in country i is:

$$Y_i = \frac{1}{(n+1)}\left[C_i + \sum_{j=0;j\neq i}^{n} C_j E_{ij}\right] + G_i \qquad (3)$$

where the first two terms stand, respectively, for domestic and foreign consumption and G_i is public expenditure. We can now express all exchange rates relative to country zero and drop subscript *0* for notational convenience. The demand equation for country *0* is therefore:

$$Y = \frac{1}{(n+1)}\left[C + \sum_{j=1}^{n} C_j E_j\right] + G_i \qquad (4)$$

We are now ready to move on to the supply side. Consider country *0*. We assume that production is described by a Cobb-Douglas production function:

$$Y = \bar{K}_{-1}^{b}\left(\bar{A}L\right)^{1-b} \exp(-u) \qquad (5)$$

where *u* is a supply shock[4], $\bar{K}$ is the exogenous capital stock and $\bar{A}L$ are the effective units of labour. Wage setters have disposable real wage targets and set one period nominal wage contracts at time *t-1* to minimise an expected utility $E_{t-1}(U_t)$ of the type (small letters denote logs):

$$U_t = \left(w - p^c - t - \bar{w}\right)^2 \qquad (6)$$

where, t is a distortionary income tax and $\bar{w}$ is the wage target. p^c is the consumer price index, defined as:

$$p^c = p + \frac{1}{(n+1)} \sum_{i=0}^{n} e_i \tag{7}$$

e_i the log of the real exchange rate of country i relative to country *0.* Observe that equation (6) implies that wage setters only care about a real *post-tax* wage target, while they regard any employment target as unimportant[5].

The demand for labour is obtained by equating the marginal productivity of labour to the real wage:

$$w - p = f(\bar{K}_{-1}, \bar{A}) - b\, l - u \tag{8}$$

where $f\left(\bar{K}_{-1}, \bar{A}\right) = \log(1-b) + (1-b)\log \bar{A} + b \log \bar{K}_{-1}$

The supply-side of the model is completed with an exogenous partial indexing arrangement $k \in (0,1)$ linking the nominal wage to the CPI so that:

$$w = \bar{w} + k\left[p^c - E_{-1}\left(p^c\right)\right] \tag{9}$$

Differentiating (6) with respect to w and combining this result with (9) we have an expression for the real product wage:

$$w - p = -(1-k)\left[p^c - E_{-1}(p^c)\right] + \frac{1}{(n+1)} \sum_{i=o}^{n} (e_i) + \bar{w} + E(t) \tag{10}$$

Hence, the final equation for employment is derived by combining (8)-(10) to obtain:

[4]Assumptions about the shocks are presented later on in the paper.

$$l = \bar{l} + \frac{1}{b}\left[(1-k)\left(p^c - E_{-1}\left(p^c\right)\right) - \frac{1}{(n+1)}\sum_{i=0}^{n} e_i\right] - \frac{E(t)}{b} - e \qquad (11)$$

with $e = \mu / b$ and $\bar{l} = \frac{1}{b}[f(\bar{K}_{-1}, A) - \bar{w}]$. The following assumptions are made about the supply shocks:

$$e_i \sim iid(0, s^2); i = 0, n$$
$$E(e_i e_j) = j\, s^2; i, j = 0, n, i \neq j; -\frac{1}{n} \leq j \leq 1$$

Equation (11) shows that employment depends upon the familiar surprise price effect, which can be eliminated with full indexation (*k=1),* the expected level of income taxation and the supply shock. Employment also depends upon the real exchange rate, i.e. the relative price. This happens because a real exchange rate appreciation contracts the real wage as shown by (10).

Let us now define $p = p^c - p^c_{-1}$ the CPI inflation of country *0* and $\tilde{p} = p - E_{-1}(p)$ the inflation surprise. Likewise we define $\tilde{e}_i = e_i - E_{-1}(e_i)$. The next step in the model is to express all variables in deviation form about a baseline steady state, where policy instruments are set at their optimal values. Lower case variables will denote either a proportional change relative to the steady state (e.g. $y = \frac{Y - \bar{Y}}{\bar{Y}}$, with $\bar{Y}$ the steady-state path), or an absolute change, such as inflation rates or $g = G/Y - \bar{G}/\bar{Y}$). Demand and supply equations of country *0* in a linearised form will then be[6]:

$$\left(1 - \frac{\bar{G}}{\bar{Y}}\right) y = \frac{\bar{C}}{\bar{Y}(n+1)}[c + \sum_{i=1}^{n}(e_i + c_i)] + g \qquad (12)$$

$$y = \frac{(1-b)}{b}\left[(1-k)\tilde{p} - g_2 \sum_{i=1}^{n} \tilde{e}_i - \frac{1}{(n+1)} E\left(\sum_{i=1}^{n} e_i\right) - E(t)\right] - e \qquad (13)$$

[5] Introduction of an employment target would complicate the algebra without affecting the nature of the results.

Equating demand and supply in the domestic and foreign country we get an expression for the surprise exchange rate effect:

$$e_i - E(e_i) = \tilde{e}_i = \frac{-e + e_i - m_1(\tilde{g} - \tilde{g}_i)}{a + (1-b)/b} \tag{14}$$

where

$$m_1 = \frac{1}{(1 - \overline{G}/\overline{Y})}$$

$$a = (\overline{C}/\overline{Y})m_1$$

(14) shows that a domestic public expenditure surprise determines a surprise appreciation of the exchange rate, whereas the opposite is true in the case of a foreign surprise. The combination of (13) and (14) gives our reduced form of output for country *i*:

$$y_i = c\tilde{p} - y\, e_i - \frac{1-y}{n}\sum_{j=0;\, j\neq i}^{n} e_j + \frac{m_1(1-y)}{n}\left[n\tilde{g}_i - \sum_{j=0;\, j\neq i}^{n}\tilde{g}_j\right] +$$
$$m_2\left[nE(g_i) - E\left(\sum_{j=0;\, j\neq i}^{n}\tilde{g}_j\right)\right] - \frac{(1-b)}{b}E(t_i) \tag{15}$$

where:

$$c = \frac{(1-b)}{b}(1-k)$$

$$y = \frac{[a + g_2(1-b)/b]}{[a + (1-b)/b]}$$

$$m_2 = \frac{g_2(1-b)m_1}{b(a + (1-b)/b)}$$

[6] On the supply side we have also proceeded to apply the transformation: $y = (1-b)l - be$.

Hence, employment depends upon the inflation surprise of the union, the relative spending surprise and on the expected level of tax distortions. Finally, it is negatively related to the country's supply shock and on the sum of the shocks in the remaining *n* countries (this will depend on the degree of openness of the economy which is captured by $(1-\gamma)$).

It is important to observe that (15) implies a potentially negative transmission of fiscal policy. This is related to the fact that, for a given level of public expenditure in the home country, an expenditure increase in the rest of the union results in a real exchange rate appreciation abroad, which - as we have seen in (10) - reduces the real product wages and increases foreign production. For the home country, however, this is equivalent to a real depreciation, with consequent opposite long run effects on its level of output. Of course this transmission does not take place in practice because, when countries are identical, they will all behave in the same way with relative prices resulting unaltered.

3 The Game

The game involves *n+2* players: *n+1* Governments (Fiscal Authorities, abbreviated with FA) and *1* Central Bank (ECB). The loss function in deviation form of the fiscal authorities is:

$$U_i^{FA} = p_i^2 + b_{FA}\left(y_i - \bar{y} + be_i\right)^2 + c_{FA} g_i^2 \tag{16}$$

(16) implies that the government has a bliss point at the baseline inflation and government spending / GDP ratio[7], and a stochastic output target $\bar{y} - be$ relative to the socially suboptimal natural rate. Similarly, the loss function of the ECB is:

$$U^{ECB} = \sum_{i=0}^{n}\left[p_i^2 + b_{ECB}\left(y_i - \bar{y} + be_i\right)^2 + c_{ECB} g_i^2\right] \tag{17}$$

In our modelling framework, monetary and fiscal policies are discretionary and they both have a response advantage relative to wage setters. Inflation and government spending are chosen in

[7] Observe that both individuals and the fiscal authorities care about public expenditure. This is not assumed to be of the 'hole in the ground' variety (van der Ploeg 1993) and yields direct utility (see equation 1).

each period after nominal wage contracts and expectations of inflation for that period are formed, and current shocks have been observed.

The sequence of events is as follows:

1. Expectations of inflation and government spending are formed by wage setters for each country

2. The supply shocks occur in each economy and are observed by both the private sector and the policymakers. All can respond except wage setters.

3. The ECB and the Fiscal Authorities independently and simultaneously set inflation and government spending in response to shocks.

The ECB minimises (17) with respect to average inflation, with output being given by equation (15); at the same time, fiscal policy is assumed to be conducted purely in terms of government expenditure, i.e. the fiscal authorities minimise (16) with respect to g.

Two scenarios are examined:

- fiscal policies in EMU countries are not co-ordinated;
- fiscal policies are co-ordinated.

First Scenario (FPNC)

The First Order Conditions when fiscal authorities do not co-ordinate are:

$$\sum_{i=0}^{n}\left[p_i + b_{ECB}c\left(y_i + be_i - \bar{y}\right)\right] = 0 \tag{18}$$

$$b_{FA}m_1\left(1-y\right)\left(y_i + be_i - \bar{y}\right) + c_{FA}g_i = 0 \tag{19}$$

We now separate the first order conditions into deterministic (expectational) $(\bar{p},\bar{g},\bar{y})$ and stochastic components $(\tilde{p},\tilde{g},\tilde{y})$. Since we are dealing with a model in deviation form, we can then identify any positive deterministic components as a bias. Hence, calculating the deterministic component of output from (15), we get that the inflation and fiscal biases are respectively:

$$\bar{p} = b_{ECB} c \left(\bar{y}^{\ast} - \bar{y} \right) = b_{ECB} c \left[\bar{y}^{\ast} + \frac{(1-b)}{b} \bar{g} \right] \tag{20}$$

$$\bar{g}_{FPNC} = \frac{b_{FA} \mu_1 (1-\gamma) \bar{y}^{\ast}}{c_{FA} - x} \tag{21}$$

where $x = b_{FA} \mu_1 (1-\gamma)(1-b)/b$.

Observe that (20) implies the existence of an important spillover effect of the fiscal bias on the inflation bias. This derives from the fact that, when the central bank anticipates that the fiscal authorities will relax their fiscal stances, it will expect output to further deviate from its natural rate. Hence, if it cares at all about output, it will be tempted to deliver a higher rate of inflation. This of course only happens in absence of full wage indexation ($k \neq 1$), i.e. when a direct employment stabilisation role for monetary policy still exists.

Second Scenario (FPC)

When fiscal policies are co-ordinated, fiscal authorities are not tempted to engineer expenditure surprises any longer. This happens because they are aware that these have no effects on output and that they will not be affected by public expenditure externalities. Therefore, while the first order condition for the monetary authority remains unaltered, the one of the FAs becomes:

$$\sum_{i=o}^{n} (y_i + b e_i - \bar{y}^{\ast}) \frac{\partial y_i}{\partial g_i} + c_{FA} \sum_{i=0}^{n} g_i = 0 \tag{22}$$

Since $\frac{\partial y_i}{\partial g_i} = 0$ we get:

$$\bar{g}_{FPC} = 0 \tag{23}$$

The spending bias is zero if fiscal authorities act co-operatively. Hence, the negative spillover on the inflation bias disappears.

< FIGURE 1 ABOUT HERE >

Fig. 1 b summarises the above results. Any shifting in the upper right of the graph represents a worsening of what we may call the economy's *structural inefficiency* because both the inflation and the spending bias increase. The ideal point to be for a country is *0*, where both biases are absent. However, the perceived existence of a stabilisation role for both fiscal and monetary policies moves the equilibrium in the upper right of the graph (point B). The main result of the paper is that, when we endogenise tax distortions, the inflation bias becomes a function of the spending bias. Graphically, the line of the inflation bias is no more horizontal as implied in Levine and Pearlman (1998) (fig. 1c-1d), but it has a positive slope equal to $b_{ECB} c\,(1-b)/b$. Therefore, the higher the spending bias, the higher the inflation bias will be. As shown in (20), such spillover effects arise in the model *via* the deterministic component of output, which is itself proportional to the spending bias. Observe that, if we go back to the more simple case where trade unions only have a real wage target, the deterministic component of output is zero. This means that the relationship between the two biases also disappears. In this case the inflation bias simply becomes:

$$\bar{p} = b_{ECB} c\,(\bar{y} - \bar{y}) = b_{ECB} c\,\bar{y} \qquad (24)$$

This is the same result obtained by Rogoff (1985). In this particular case where spillover effects are absent, the only relevant element which is able to reduce the inflation bias is the degree of conservatism of the central bank captured by the term b_{ECB} .

4 Co-ordination Through a Walsh Mechanism

In this section we sketch a possible institutional arrangement that could substitute fiscal policy co-ordination. The idea comes from a recent paper by Walsh (1995). He attempts to solve the time inconsistent problem of monetary policy by proposing a contract between the central bank and the government based on a principal-agent framework. Such a contract is structured in such a way that the outcome of the central bank's maximisation problem results in the socially

optimal monetary rule. We observe that our case here is rather different for two reasons. Firstly, we do not explicitly address Rogoff's output stabilisation problem. Secondly, the distinction between the agent and the principal (Ecofin?) is not well defined. However, we can still work on the idea that, if the fiscal authorities spend more than the socially optimal level, they will be subject to a fine.

Suppose that the sovereign fiscal authorities face a loss function of the kind $L = JU + pg$, where JU is the money value of the utility function[8] and p is a linear penalty in public expenditure of the kind implied by the Stability Pact. When minimising its loss function, each fiscal authority will take into account the fact that it will be subject to a disutility whenever its level of public expenditure exceeds the socially optimal one. The new loss function that each fiscal authority now faces is:

$$L^{FA}_i = U^{FA}_i + p_i g_i = p_i^2 + b_{FA}(y_i - \bar{y} + be_i)^2 + c_{FA} g_i^2 + p_i g_{i.} \tag{25}$$

Therefore, the optimal punishment which is able to achieve the zero level of fiscal bias is :

$$p_i = b_{FA}[1 - (1-\gamma)\bar{y}] = l\bar{y}b_{FA} \tag{26}$$

(Proof. See Appendix A)

As (26) shows, the punishment is directly linked, by a factor l, to the employment target and the weight that the fiscal authorities are giving to it. Provided the penalty is *credible*, the effect of this punishment will be to reduce the level of public expenditure in each country. This leads us back to the optimal result obtained under the scenario of co-ordination.

5 Simulations

So far the degree of central bank independence has been considered as exogenously fixed. What happens if this assumption changes? Unfortunately, the model in this case becomes too complicated for an analytical solution to be worked out. Therefore, we need to recur to simulation techniques. The aim of our simulation exercise is to find the optimal degree of

independence of the ECB (as later defined) and to see how such a degree depends on the supply shock correlation. We start by remembering that for EMU members $\tilde{p}_i - \tilde{p} = \tilde{e}_i$, which implies, as we have already seen, that:

$$\tilde{e}_i = \frac{-e + e_i - m_1(\tilde{g} - \tilde{g}_i)}{a + (1-b)/b} \tag{27}$$

Substituting (27) back into the linearised supply side equation, and assuming that expected public expenditures are the same for all $n+1$ countries, we get:

$$y = (c\tilde{p} - e) + \frac{aZ}{n+1}(-ne + \sum_{i=1}^{n} e_i) - \frac{1}{n+1}(aZ-1)m_1(n\tilde{g} - \sum_{i=1}^{n}\tilde{g}_i) - \frac{(1-b)}{b}E(t) \tag{28}$$

with $Z = \dfrac{1}{a + \dfrac{(1-b)}{b}}$

Since $-\dfrac{1}{n+1}(aZ-1) = \dfrac{1-y}{n}$ and $t = g$, we can rewrite (28) as:

$$y = (c\tilde{p} - e) + \frac{aZ}{n+1}(-ne + \sum_{i=1}^{n} e_i) + \frac{1-y}{n}m_1(n\tilde{g} - \sum_{i=1}^{n}\tilde{g}_i) - \frac{(1-b)}{b}E(g) \tag{29}$$

Using the definition of output given by the above equation (29), we can then derive the two loss functions of the fiscal authorities to be minimised with respect to b_{ECB}. These are:

$$\begin{aligned}
&L^{FPNC} = E[p^2 + b_{FA}(y + be - \bar{y})^2 + c_{FA}g^2] = \\
&= [b_{FA} + (b_{ECB}c)^2][\bar{y} + \frac{(1-b)}{b}\bar{g}]^2 + c_{FA}\bar{g}^2 \\
&+ [b_{FA} + (b_{ECB}c)^2][\frac{(1-b)^2}{(1+b_{ECB}c^2)^2(n+1)}(1+nr)s^2] \\
&+ \frac{b_{FA}(-aZ+b)^2 + \frac{1}{c_{FA}}(m_1 b_{FA}(-aZ+b)(1-y))^2}{1 + b_{FA}m_1^2(1-aZ)(1-y)/c_{FA}}\frac{n}{n+1}(1-r)s^2
\end{aligned} \tag{30}$$

[8] We can assume that J is equal to unity for simplicity.

in the case of fiscal policy non co-ordination, and:

$$L^{FPC} = E[p^2 + b_{FA}(y + be - \bar{y})^2 + c_{FA}g^2) =$$
$$[b_{FA} + (b_{ECB}c)^2][\bar{y}^2 \frac{(1-b)^2}{(1+b_{ECB}c^2)^2(n+1)}(1+nr)s^2] \qquad (31)$$
$$\frac{b_{FA}(aZ-b)^2}{1+b_{FA}m^2{}_1\ (1-aZ)^2 \Big/ c_{FA}} \frac{n}{n+1}(1-r)s^2$$

when fiscal authorities act co-operatively.

The simulation results (see appendix B for details) are summarised in figures 2 - 4. The optimal level of central bank independence is negatively related to the degree of correlation of the supply shocks: the closer the correlation coefficient to 1 (i.e. the more symmetric the shocks become), the lower the optimal level of central bank independence. This is computed as the ratio b_{FA}/b_{ECB}. The reason for this downward slope is due to the fact that, when shocks are symmetric, relative prices do not adjust automatically. Hence, the central bank should put more weight on output stabilisation and less on the goal of reducing the inflationary bias. (this follows from equation (14)[9]). A second result is that the optimal degree of central bank independence remains substantially unaffected by the decision to co-ordinate fiscal policies in a model without distortionary taxation. However, the picture changes once we introduce distortions. In this case, co-ordination lowers both the optimal degree of conservatism of the ECB and the government welfare loss. This is a consequence of the fact that co-ordination removes the spillover effects on the inflation bias. It is important to observe that, without fiscal policy co-ordination, the welfare loss of the fiscal authorities is always higher for all correlation coefficients in the case with distortionary taxes. This is due to the fact that the presence of distortions pushes fiscal authorities to spend even more therefore creating a sort of vicious circle.

6 Conclusion

[9] The same result is obtained in Levine and Pearlman (1998).

In this paper we argue in favour of fiscal policy co-ordination in a monetary union. We show that, when the fiscal authorities internalise the important spillover effects originating from their excessively expansionary fiscal policies, they reduce the structural inefficiencies - inflation and spending biases - that otherwise are likely to characterise their economies. Such a positive result can be obtained either with the explicit co-ordination of fiscal policies or with the introduction of a credible penalty in public expenditure - of the kind implied by the stability pact - in the utility function of each fiscal authority. Finally, our simulation results suggest that, when fiscal authorities act co-operatively, the optimal degree of conservatism of the central bank declines. This happens because, to the extent that national authorities engage in expansionary and inflationary fiscal policies, the monetary authorities will have to pursue a tighter monetary policy in order to achieve a particular inflation rate.

Now that EMU is on its way, we believe these could be additional arguments in favour of co-operation and a more rigid application of the stability pact.

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Appendix A: Punishement " *'a la Walsh "*

If the fiscal authorities know that they will be punished when they spend too much, they will take account of this when calculating their first order condition. Their FOC will then be modified as follows:

$$b_{FA}\mu_1(1-\gamma)(y_i + be_i - \bar{y}_i) + c_{FA}g_i + p_i = 0 \qquad (A1)$$

Rewriting the above expression only in terms of deterministic components we get:

$$b_{FA}\mu_1(1-\gamma)(\bar{y}_i - \bar{y}_i) + c_{FA}\bar{g}_i + p_i = 0 \qquad (A2)$$

This yields:

$$\bar{g} = \frac{b_{FA}\mu_1(1-\gamma)\bar{y} - p}{c_{FA} - x} \qquad (A3)$$

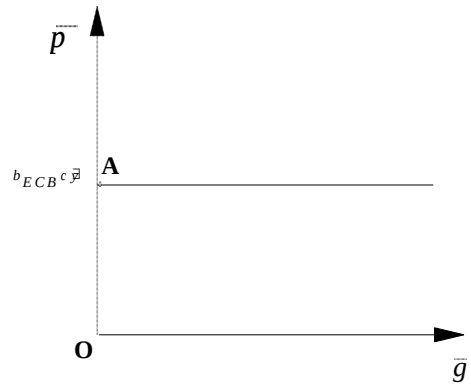
Hence, the bias is equal to zero if the punishment p is $p = b_{FA}(1-\gamma)$.

Appendix B: Simulation Calibrations

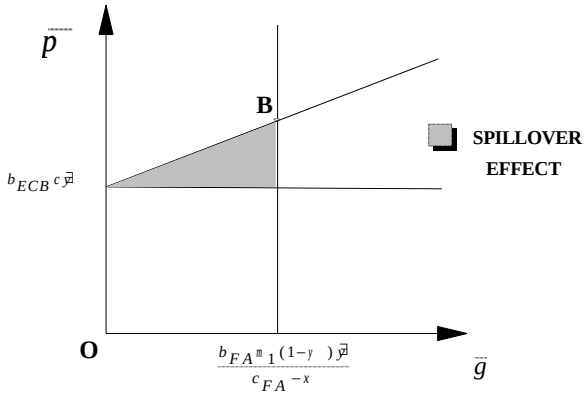
The number insiders has been set equal to 11, which corresponds to the number of countries who going to adopt a single currency by the year 2002. Note, however, that our model assumes identical economies and therefore it would consider two countries like Germany and Luxembourg, for example, as being exactly the same. One way to think of this is as a future situation where the actual number of member states is much greater than 11 (UK, Greece etc. become insiders). For what concerns the rest of the calibrations, these remain in line with the chosen set in Levine and Pearlman (1998), with the difference that here trade unions have a wage target rather than an employment target (v=1, a=0). In particular, we assume an unemployment rate of 5 per cent for the European Union whereas the variance of the supply shocks is assumed to be 3 per cent. Other important values are $\overline{C}/\overline{Y} = 0.6$, $\overline{G}/\overline{Y} = 0.2$, *and k=0.5.* b_{FA} *is calibrated to give an annual inflation rate of 5 per cent.*

FIG. 1

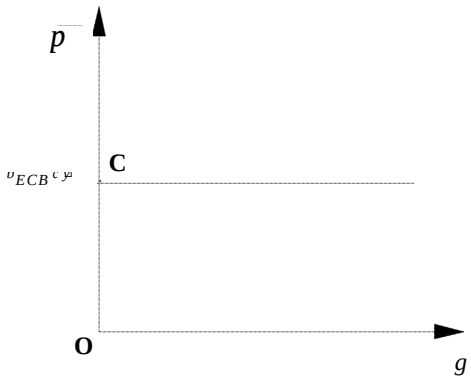
a) WITH TAX (FPC)



b) WITH TAX (FPNC)



c) WITHOUT TAX (FPC)



d) WITHOUT TAX (FPNC)

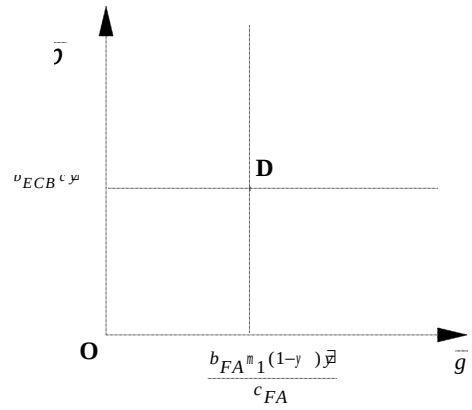


FIG. 2 FISCAL POLICY NON CO-ORDINATION

Case with distortionary tax

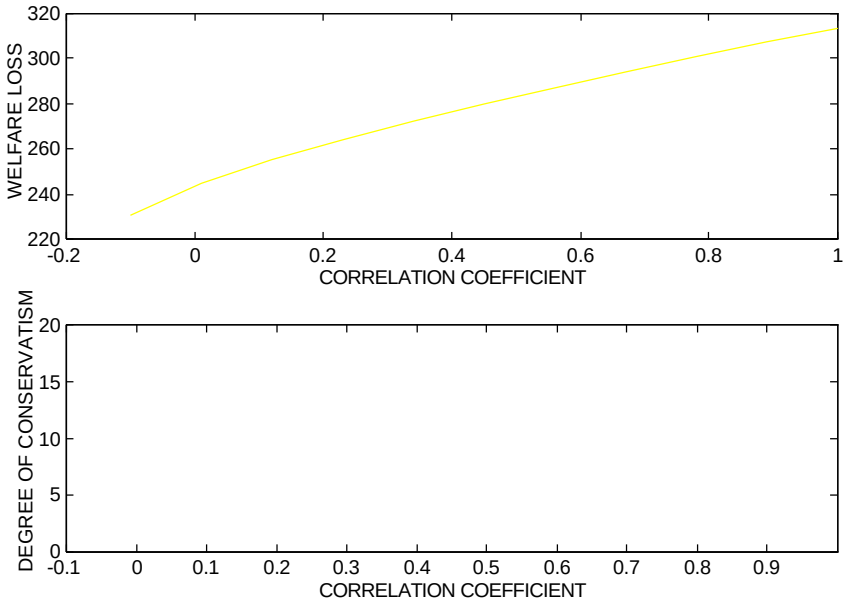


FIG. 3 FISCAL POLICY CO-ORDINATION

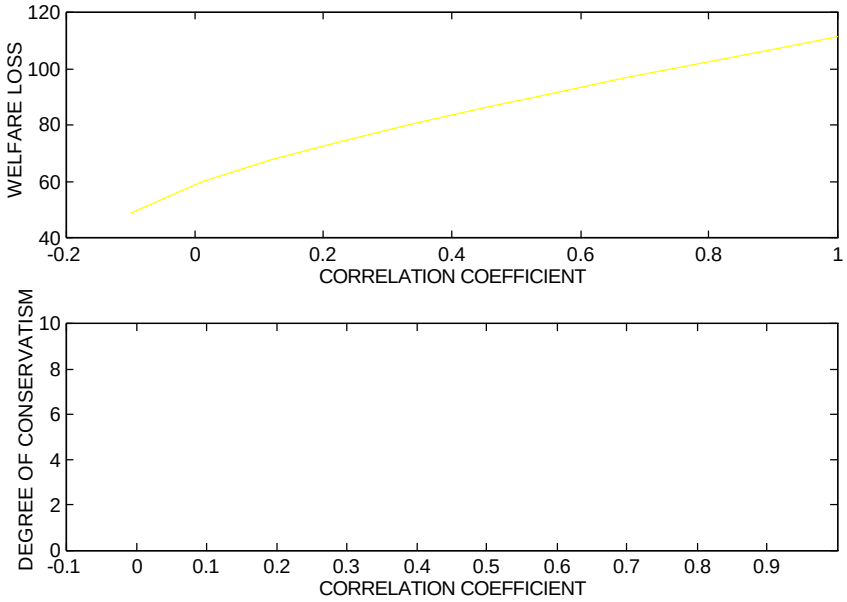


FIG. 4 FISCAL POLICY NON CO-ORDINATION

Case without distortionary tax