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TAX DISTORTIONS, UNEMPLOYMENT AND INTERNATIONAL POLICY COOPERATION

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Abstract:

In a symmetric two-country model, fiscal and monetary policies are endogenously determined as outcomes of a national as well as international policy game. Nash equilibrium policies are characterized by unemployment (due to tax distortions), inflation and too low public expenditures. Regimes of international monetary or fiscal policy cooperation are considered. In comparison with Nash equilibrium outcomes, employment is higher under either regime. Further, disadvantages of one regime form seem to be offset by the other's advantages. Hence, a regime of monetary *and* fiscal cooperation appears appropriate.

Keywords: International policy coordination, unemployment, tax distortions, inflation, policy games.

JEL Classification numbers: E52, E62, F42.

1. Introduction

In a world of increasing economic interdependence, the question of international policy cooperation is more topical than ever. In this paper the issue is addressed within the context of a world characterized by unemployment problems caused by distortionary taxes. Our main concern is therefore to examine employment consequences of various forms of international policy cooperation. As interdependence is synonymous with spill-over effects of unilateral policy measures, such analyses must necessarily involve strategic considerations. The applied methodology is therefore closely related to the game theoretic literature on policymaking; in particular that on monetary policy cooperation[1].

In contrast with this literature, however, we introduce fiscal authorities in addition to the monetary. Apart from added realism, this provides the endogenous determination of the natural rate of (un)employment as a function of tax distortions[2]. Furthermore, as internal policy interdependence makes fiscal authorities react to changes in monetary policies, we are able to examine real economic consequences of the transition to a regime of monetary cooperation. Also, by analogy, monetary authorities react to changed fiscal environments, and monetary consequences of fiscal cooperation can be assessed. These aspects are often neglected in the literature, where mostly just one form of policy is considered. In addition, the set-up opens the possibility of checking the merit of a system characterized by monetary *and* fiscal cooperation. This is appropriate, as one often is confronted with arguments promoting that one type of cooperation is necessary for the other type's success[3].

More specific, we consider a one period symmetric two-country game wherein monetary and fiscal policies are conducted by independent authorities in each country. Policies are conducted after nominal wage contracts are signed by forward looking wage setters. Policymakers care about full employment, consumer price stability, and a positive level of public expenditures. Although target values coincide, fiscal and monetary authorities may, however, disagree on these targets' relative

[1] This literature originated with Hamada (1976). Recent surveys and collections, theoretic as well as dealing with specific international institutional arrangements, include: Buiter and Marston (1985), Canzoneri and Henderson (1988, 1991), Giavazzi and Giovannini (1989), Giavazzi, Micossi and Miller (1988).

[2] Usually, tax distortions are only implicitly considered as an explanation for an, exogenously fixed, "too low" natural rate. The other common explanation for unemployment in these models, monopoly powers in the wage setting process, is not considered here (see Jensen (1991) on this).

[3] For example, the Delors Report (1989) advocates fiscal cooperation as a necessity for the success of monetary cooperation in the EC.

importance. In each country, fiscal authorities control a distortionary tax while monetary authorities control money creation. For the familiar reason of fewer instruments than targets, a policy dilemma exists, and first-best is unattainable. Policies of either kind have international spill-over effects which work through the real exchange rate, and thus the other country's consumer prices.

Within this set-up we consider the various types of policy regimes mentioned above. In none of these is there cooperation between fiscal authorities and central banks, and nor is there cooperation with the private sectors. The former assumption seems justified by the fact that in many countries, central banks enjoy a high degree of independence. The latter is appropriate in a one-shot setting as this, where the possibility for reputation building is ruled out. In other words, our concern is literally that of international policy cooperation, i.e., internalization of international, monetary and/or fiscal, externalities.

Our analysis compare the consequences of various cooperative schemes to the outcome under non-cooperation, characterized by unemployment, too low public expenditures, and a positive rate of consumer price inflation. Our central results demonstrate that any form of international policy cooperation has favourable implications for employment compared to non-cooperation. The main reasons are as follows. Under monetary cooperation inflation is higher, as the *ex ante* absence of real exchange rate alterations, reduce the perceived costs of money creation for the central banks[4]. As public expenditures are partly financed by money creation, these increase, and thereby weakens fiscal authorities' incentives to use distortionary taxes. In effect, employment increases. With respect to fiscal cooperation, first note that without it, the accompanying real exchange rate appreciation from unilateral tax increases, counteracts the domestic generated product price increase. This reduces the consumer price cost of tax policy, and equilibrium taxes are too high. Under fiscal cooperation, however, perceptions about real exchange rate movements are ruled out *ex ante*, and the consumer price cost of tax policy is therefore higher. Fiscal authorities then set lower taxes, thus fostering higher employment. A regime of both monetary and fiscal cooperation, loosely denoted "total cooperation", features both of these advantageous factors for employment, and employment will be higher than under either "partial" cooperative regime.

The implications for inflation and expenditures are ambiguous in some cases, but we find that

[4] This was first pointed out by Rogoff (1985), in a two country version of the Barro and Gordon (1983) monetary policy game.

the higher inflation under monetary cooperation most likely (that is, when fiscal authorities are more concerned with employment than inflation) will move expenditures closer to target than under non-cooperation. Under fiscal cooperation, the drop in taxes will dominate, and expenditures will unambiguously be lower. Inflation may fall given that central banks are not too concerned with expenditures.

This suggests that fiscal authorities, mostly concerned with expenditures, prefer that fiscal cooperation is accompanyed by monetary cooperation, as the loss of expenditures from fiscal cooperation is counteracted by the likely expenditure increase under monetary cooperation. Likewise, it suggests that monetary authorities, mostly concerned with inflation, prefer that monetary cooperation is supplemented by fiscal cooperation, as the increase in inflation from monetary cooperation is counteracted by the likely reduction in inflation associated with fiscal cooperation. A numerical example demonstrates the validity of this proposition, and thus it can be seen as an explanation for the above mentioned assertion that one form of cooperation is necessary for the other form's success.

The paper is organized as follows. In section 2 the model is presented, and section 3 computes the non-cooperative - Nash equilibrium - outcomes. Section 4 is divided into three subsections, each examining one policy regime: monetary, fiscal and total cooperation, respectively. Section 5 offer some concluding comments. An appendix contains a lengthy derivation.

2. The model

The model describes a symmetric two-country world with flexible prices and exchange rates. Each country, labelled "domestic" and "foreign", produce one physically distinct good. Consumers in both countries demand both domestic and foreign goods, while the public sector exclusively demand the good produced in its own country. Basically, the model is the one used by e.g. Canzoneri and Henderson (1988, 1991), Giavazzi and Giovannini (1989), Rogoff (1985), but it is augmented by the Alesina and Tabellini (1987) (closed economy) model, in order to address the issue of tax distortions explicitly (see also Bryson, Jensen and VanHoose (1992) and VanHoose (1992) for related two-country versions of the Alesina-Tabellini model).

The timing of decisions is as follows: In the beginning of the single period, nominal wage contracts in both countries are signed. These are valid for the remainder of the period. Subsequently, policymakers simultaneously conduct monetary and fiscal policies. In each country, a fiscal authority (FA) controls a tax rate on firms' revenues, whereas a central bank (CB) controls the money supply.

The prevailing policy regime is always known to the wage setters when they sign contracts.

We consider 4 different regimes. First, the bench-mark regime, where there is no policy cooperation. Thereafter, we consider 3 forms of international policy cooperation. One of monetary cooperation, one of fiscal cooperation, and one where both monetary and fiscal policy are coordinated across borders. In none of the regimes do we consider any internal cooperation; neither between local policymakers, nor between private sectors and policymakers. We return to the consequences of this later.

In the following, unstarred variables refer to domestic values while starred variables are the corresponding foreign. Due to symmetry, all arguments apply equivalently to domestic and foreign variables, and in the remainder we therefore make all conclusions from the domestic perspective.

At time t, log of output, y_t, is produced with labour, n_t, as only variable input. The following production relationships are assumed to apply:

$$y_t = \alpha n_t, \qquad y_t^* = \alpha n_t^*, \qquad 0 < \alpha < 1. \tag{2.1}$$

Perfectly competitive firms maximize profits, leading to the following labour demand schedules:

$$n_t = \frac{1}{1-\alpha}(p_t - w_t - \tau_t), \qquad n_t^* = \frac{1}{1-\alpha}(p_t^* - w_t^* - \tau_t^*), \tag{2.2}$$

where p_t, w_t, τ_t, are domestic product prices, nominal wages, and a tax levied on firms' revenues, respectively[5]. An increase in p_t increases the (net) marginal revenue product of labour, and therefore more labour is demanded. On the other hand, an increase in w_t increases labour's marginal cost, and less labour is demanded. Finally, an increase in the tax rate τ_t reduces net earnings, and less labour is demanded. This explains the nature of (2.2).

Money market equilibrium are characterized by simple quantity equations, i.e.,

$$m_t = p_t + y_t, \qquad m_t^* = p_t^* + y_t^*, \tag{2.3}$$

where m_t is the money supply.

[5] Omitting unimportant constants, and approximating $\ln(1-\tau_t)$ by $-\tau_t$, equation (2.2) results from $\max_{N_t} (1-\tau_t)P_tY_t - W_tN_t$ (where upper case letters are antilogs); cf. Alesina and Tabellini (1987).

Public expenditures are financed through tax earnings and money creation only (we then suppress the possibility of public debt[6]). Letting g_t denote the ratio of public expenditures to output, these are therefore residually determined as[7]:

$$g_t = \tau_t + m_t - m_{t-1}, \qquad g_t^* = \tau_t^* + m_t^* - m_{t-1}^*, \tag{2.4}$$

From the equilibrium conditions for the domestic goods market we find that demand shifts between domestic and foreign goods as given by

$$y_t - y_t^* = \frac{1}{\delta} z_t + \tau_t - \tau_t^*, \qquad \delta > 0, \tag{2.5}$$

where $z_t \equiv e_t + p_t^* - p_t$ is the real exchange rate, with e_t being the nominal exchange rate, i.e., domestic price of foreign currency (see the appendix for the derivation of (2.5)). A real exchange rate depreciation, i.e., an increase in z_t, thus increase the demand for domestic goods relatively to foreign. Further, higher domestic taxes, relatively to foreign, shifts demand in favour of domestic goods. This is because the increase in public demand of domestic goods more than outweighs the accompanying decrease in private consumption, as the private sector only spends a fraction on domestic goods.

The consumer price index (CPI), q_t, is a weighted average of domestic prices and domestic value of foreign prices, which, by use of the real exchange rate definition, can be written as:

$$q_t = p_t + \beta z_t, \qquad q_t^* = p_t^* - \beta z_t, \qquad 0 < \beta < 1. \tag{2.6}$$

The FAs are assumed to have the following preferences

$$V_t^{FA} = -\delta_1 n_t^2 - \delta_2 (g_t - \bar{g})^2 - \pi_t^2, \qquad V_t^{FA^*} = -\delta_1 n_t^{*2} - \delta_2 (g_t^* - \bar{g})^2 - \pi_t^{*2}, \tag{2.7}$$

$$\delta_1 > 0, \quad \delta_2 > 0, \quad \bar{g} > 0.$$

where $\pi_t \equiv q_t - q_{t-1}$ denotes CPI inflation. The CBs have the following preferences:

$$V_t^{CB} = -\mu_1 n_t^2 - \mu_2 (g_t - \bar{g})^2 - \pi_t^2, \qquad V_t^{CB^*} = -\mu_1 n_t^{*2} - \mu_2 (g_t^* - \bar{g})^2 - \pi_t^{*2}, \tag{2.8}$$

$$\mu_1 > 0, \quad \mu_2 > 0.$$

[6] On debt and seignorage in dynamic contexts, see e.g. Obstfeld (1991) and van der Ploeg (1991).

[7] At time t, nominal public spending, G_t, is given as $G_t = \tau_t P_t Y_t + M_t - M_{t-1}$. Dividing by $P_t Y_t$, using (2.3), then approximating $(M_t - M_{t-1})/M_t$ by $m_t - m_{t-1} = (M_t - M_{t-1})/M_{t-1}$, yields equation (2.4); see Alesina and Tabellini (1987).

Policymakers dislike deviations in employment from zero, the employment level absent any tax distortions. We refer to this level as "full" employment. Furthermore, policymakers dislike deviations in the public spending ratio from $\bar{g}$, as well as any changes in the CPI[8]. Note that although the FAs and CBs agree about the target values of the relevant variables, they do not necessarily agree on their relative importance. In the ensuing analyses, we will mostly consider the cases where CBs are more concerned with inflation than any other variable, and where FAs are more concerned with employment and expenditures than inflation. I.e., the cases where $\delta_i/\mu_i > 1$, $i = 1, 2$. These are plausible assumptions as CBs traditionally assign high weight to price stability, whereas FAs put relative high weight on employment and expenditures, e.g., due to political pressures (cf. Tabellini (1987a,b)).

The relevant reduced forms of the economies are now found to be (along with (2.4)):

$$n_t = m_t - w_t - \tau_t, \qquad n_t^* = m_t^* - w_t^* - \tau_t^*, \tag{2.9}$$

$$\begin{aligned} \pi_t &= (1-\alpha)m_t + \alpha(w_t + \tau_t) + \theta^M(m_t - m_t^* - w_t + w_t^*) - \theta^F(\tau_t - \tau_t^*) - q_{t-1}, \\ \pi_t^* &= (1-\alpha)m_t^* + \alpha(w_t^* + \tau_t^*) + \theta^M(m_t^* - m_t - w_t^* + w_t) - \theta^F(\tau_t^* - \tau_t) - q_{t-1}^*, \end{aligned} \tag{2.10}$$

where $\theta^M \equiv \alpha\beta\delta$ and $\theta^F \equiv (1+\alpha)\beta\delta$, respectively, denote CPI spill-over elasticities of country differences in monetary and fiscal variables. These channels are briefly described in the following.

First, consider a unilateral domestic monetary expansion. As domestic prices are pushed upwards, employment increases, and there will be excess supply of domestic goods. Hence, goods market equilibrium is restored by a real exchange rate depreciation. This accounts for an additional increase in the domestic CPI through the spill-over term θ^M. Conversely, the depreciation lowers the foreign CPI. Secondly, consider a unilateral domestic tax increase. As domestic employment decreases, domestic prices increase in order to secure equilibrium in the money market. On the goods market, disequilibrium caused by loss of domestic goods is enhanced by the increase of public expenditures on domestic goods, and the real exchange rate appreciates in order to restore equilibrium. This has deflationary implications for the domestic country, through the spill-over term θ^F, while the foreign country will experience inflation. Whether the composite impact on the domestic economy will be inflationary or deflationary depends on the relative magnitude of the domestically caused inflation, and the internationally caused deflation. Throughout we shall assume that the domestic price

[8] It should be stressed that the game situation arises due to $\bar{g} > 0$. If e.g., $\bar{g} = 0$, then no taxes were necessary, employment would be at the optimum, and the incentives to perform any policy would be absent.

effects on CPI always dominate the effects from real exchange rate movements. I.e, we assume $\alpha > \theta^F$.

The model is closed with the specification of wage setting behaviour. At the beginning of each period, workers sign nominal wage contracts in order to secure a target value of their real consumer wage. By convenient normalization this target value is chosen to be zero (in logs), which implies

$$w_t = q_t^e, \qquad w_t^* = q_t^{*e}, \tag{2.11}$$

where q_t^e is the rationally expected CPI at the contract date. Wage setters supply any labour that firms want to hire at the subsequent real product wage. We now turn to the analysis of policymaking in this world.

3. Non-cooperative policies

Now we consider policymaking in the bench-mark case of no international policy cooperation. Under such non-cooperative policymaking each policymaker maximizes its own utility, taking wages as well as all other policy parameters as given. This produces its best response function to any wages and any policies. From this and the other policymakers' best response functions, the one-shot subgame perfect Nash equilibrium outcomes of the policy game are subsequently derived.

The domestic FA and CB solve, respectively, the following problems:

$$\max_{\tau_t} \quad V_t^{FA} \qquad \text{s.t. (2.9), (2.10)}, \ \partial x_t/\partial \tau_t = 0, \quad x_t = m_t, \tau_t^*, m_t^*, \tag{3.1}$$

$$\max_{m_t} \quad V_t^{CB} \qquad \text{s.t. (2.9), (2.10)}, \ \partial x_t/\partial m_t = 0, \quad x_t = \tau_t, \tau_t^*, m_t^*. \tag{3.2}$$

From these problems, the following first order conditions are immediate (where superscript "*NC*" distinguishes the non-cooperative regime):

$$n_t^{NC} = \frac{\delta_2}{\delta_1}(g_t^{NC} - \bar{g}) + \frac{\alpha - \theta^F}{\delta_1}\pi_t^{NC}, \tag{3.3a}$$

$$\pi_t^{NC} = -\frac{\mu_1}{1 - \alpha + \theta^M} n_t^{NC} - \frac{\mu_2}{1 - \alpha + \theta^M}(g_t^{NC} - \bar{g}). \tag{3.3b}$$

From (3.3a) it is seen that when expenditures are too low, $g_t < \bar{g}$, the FA is ready to use distortionary taxes, and thus accept some unemployment, i.e., $n_t < 0$. This readiness is of course stronger the more expenditures are favoured relatively to employment, i.e., the higher δ_2/δ_1. However, tax policy has also price effects, in the sense that higher taxes increase consumer prices (cf. (2.10) and the assumption $\alpha > \theta^F$). Due to the FA's aversion against price movements, the presence of this channel

therefore restrains its willingness to reduce employment. It is captured by the last term of (3.3a), and, of course, the stronger CPI effect of taxes, relatively to the FA's employment concern (higher $(\alpha - \theta^F)/\delta_1$), the lower is the accepted employment reduction.

Equation (3.3b) reveals that the CB accepts inflation if employment and/or expenditures are too low. The more concerned with either variable, the more inflation is accepted. However, the stronger the inflation cost of money creation is, i.e., the higher $(1 - \alpha + \theta^M)$, the weaker is this acceptance.

In order to determine the explicit Nash equilibrium outcomes from these first order conditions, we make extensive use of the model's symmetry. First, symmetry implies that *ex post*, $\tau_t = \tau_t^*$, $m_t = m_t^*$, $w_t = w_t^*$, and, in effect, $z_t = 0$, will apply in equilibrium. That is, all policy variables as well as nominal wages are identical across countries, which ultimately leaves the real exchange rate unaffected. Hence, from the definition of the CPI, (2.6), it is immediate that consumer prices equal product prices, $q_t = p_t$. Using this in the employment relation (2.2), application of the wage setting rule (2.11), immediately generates the rational expectations employment level as

$$n_t = -\frac{1}{1-\alpha}\tau_t. \tag{3.4}$$

This demonstrates that unemployment problems is basically a consequence of tax distortions. Secondly, in a steady state the natural rate is constant over time, i.e, $y_t = y_{t-1}$ for all t, and application of the money market equilibrium condition (2.3), together with $q_t = p_t$, therefore quickly demonstrates that CPI-inflation is exclusively determined by money growth, i.e.,

$$\pi_t = m_t - m_{t-1}. \tag{3.5}$$

However, note that this applies *ex post*, not *ex ante*: in any period, fiscal incentives play a role for the price determination, cf. (3.3a), and therefore they influence *ex post* money growth in Nash equilibrium. Using (3.4) and (3.5) along with the budget identity (2.4) yields

$$g_t - \bar{g} = -(1-\alpha)n_t + \pi_t - \bar{g}. \tag{3.6}$$

Combining this with the first order conditions (3.3a) and (3.3b) then produces the Nash equilibrium outcomes under no policy cooperation as

$$\pi_t^{NC} = \frac{\mu_1\delta_2 + \mu_2\delta_1}{\Phi^{NC}}\bar{g}, \tag{3.7a}$$

$$(g_t^{NC} - \bar{g}) = -\frac{\delta_1(1-\alpha+\theta^M) + \mu_1(\alpha-\theta^F)}{\Phi^{NC}}\bar{g}, \tag{3.7b}$$

(3.7c) $$n_t^{NC} = -\frac{\delta_2(1-\alpha+\theta^M)-\mu_2(\alpha-\theta^F)}{\Phi^{NC}}\bar{g},$$

$$\Phi^{NC} \equiv (1-\alpha)\left[\delta_2(1-\alpha+\theta^M)-\mu_2(\alpha-\theta^F)\right]+\mu_1\delta_2+\mu_2\delta_1+\delta_1(1-\alpha+\theta^M)+\mu_1(\alpha-\theta^F).$$

We discuss this equilibrium in the following. The discussion is carried out without particular emphasis on the international aspects. The implications of the spill-over terms are instead relegated to the next section when various regimes are considered.

Given that $\Phi^{NC} > 0$ (and in a moment we will argue that it should be), inflation is positive. This has two explanations. Firstly, it arises due to the familiar time-consistency problem of the CB *vis-a-vis* the wage setters (cf. Kydland and Prescott (1977) and Barro and Gordon (1983)): as employment is considered too low when the FA uses distortionary taxes in order to finance expenditures, the CB has the incentive, *given* fixed nominal wages, to create surprise inflation in order to reduce the real wage, and thus increase employment. Expecting this, wage setters set wages sufficiently high so as to pre-empt this incentive, thus leaving the CB with no other option than giving wage setters what they want. The result is an inflation bias. Secondly, the CB cares for expenditures, and consequently it accepts some inflation in order to finance these[9].

If $\Phi^{NC} > 0$, expenditures are too low. Only in the case where none of the policymakers cared for employment, expenditures would be at their target value $\bar{g}$: the FA could simply set taxes equal to $\bar{g}$, and the CB could concentrate on maintaining price stability.

Employment may either be too low or high. However, in all that follows we assume that taxes are positive, and that there will be unemployment. I.e., we will assume that

(3.8) $$\frac{\delta_2}{\mu_2} > \frac{\alpha-\theta^F}{1-\alpha+\theta^M},$$

(which, by inspection of (3.7c) secures a negative n_t^{NC}). In words, this condition says that the ratio of the FA's and CB's expenditure concern must exceed the ratio of the price cost of fiscal policy relative to the price cost of monetary policy. As one would generally think that fiscal authorities assign more weight to expenditures than central banks, and that monetary policy has more effect on prices than fiscal policy, the assumption seems not unreasonable. In order to understand it technically within this

[9] If neither authority cared for expenditures, i.e., if $\delta_2 = \mu_2 = 0$, inflation would vanish. Hence, inflation can in this model be attributed to policymakers' expenditure concern, cf. Alesina and Tabellini (1987).

model, consider what could violate it. A low value of δ_2 means that the FA cares little about expenditures. Instead, it would try to alleviate any inflation by lowering taxes, cf. (3.3a). A high value of μ_2 implies that the CB are willing to accept a lot inflation in order to finance expenditures. The CPI cost of taxes thus increases, and the FA would lower taxes. If $(\alpha - \theta)$ is high, the price cost of taxes is high, and the same argument applies. Finally, a low value of $1 - \alpha + \theta^M$ makes money creation relatively cheap in terms of inflation, and the CB accepts more inflation. Again, this reduces the FA's incentives to use taxes.

In order to examine the implications of tax distortions, and thus unemployment, for the relative success of various international policy regimes, we assume (3.8) to hold. Note that it is also a sufficient condition for $\Phi^{NC} > 0$, thus validating the above stated arguments with respect to expenditures and inflation. We now turn to the question of international policy cooperation in order to assess whether such schemes may improve upon the outcomes associated with Nash equilibrium policies.

4. International policy cooperation

4.1. International monetary cooperation

Under international monetary cooperation, central banks form a coalition engaged in the bilateral determination of money supplies for their respective countries. Fiscal authorities, however, perform policies acting as Nash players against each other, as well as against the central bank coalition. That is, the domestic FA still solves (3.1). Cooperation is, for simplicity, defined as the joint maximization of the unweighted sum of the cooperating authorities' utility functions. Under international monetary cooperation, central banks therefore solve the following problem:

$$\max_{m_t, m_t^*} \quad V_t^{CB} + V_t^{*CB} \tag{4.1}$$

$$\text{s.t. (2.9), (2.10)}, \partial x_t / \partial m_t = 0, \partial x_t / \partial m_t^* = 0, \quad x_t = \tau_t, \tau_t^*.$$

Using one the first order conditions,

$$-\mu_1 n_t - \mu_2 (g_t - \bar{g}) - (1 - \alpha + \theta^M)\pi_t + \theta^M \pi_t^* = 0,$$

symmetry of the model, implying $\pi_t = \pi_t^*$, brings about the following outcome characterization (where superscript *"MC"* identifies variables under monetary cooperation):

(4.2a) $$n_t^{MC} = \frac{\delta_2}{\delta_1}(g_t^{MC} - \bar{g}) + \frac{\alpha - \theta^F}{\delta_1}\pi_t^{MC}.$$

(4.2b) $$\pi_t^{MC} = -\frac{\mu_1}{1-\alpha}n_t^{MC} - \frac{\mu_2}{1-\alpha}(g_t^{MC} - \bar{g}),$$

Note that (4.2a) is equivalent to (3.3a), as fiscal decision making is governed by the same optimization problem as under no policy cooperation. Hence, the FA's trade-offs are not changed by the monetary regime shift (but its equilibrium behaviour will be). Equation (4.2b), however, is novel as compared to the case of no policy cooperation. Under monetary cooperation, CBs internalize the international externalities of monetary policymaking. These externalities, measured by θ^M, represent the spill-over effect stemming from real exchange rate alterations in response to unilateral monetary changes. Under monetary cooperation such perceptions do not apply, as CBs *ex ante* takes into account that the real exchange rate *ex post* do not change in response to symmetric monetary policies. Therefore, the inflation cost of money creation is lower for each CB, and comparing (4.2b) with (3.3b), also reveals that the CB accepts higher inflation under monetary cooperation, given too low employment and/or expenditures.

In order to examine the outcomes under this policy regime, we need to determine expenditures. This is done by the exact same procedure as utilized in the previous section, i.e., expenditures are determined by (3.6). Combining this with (4.2a) and (4.2b) results in the following outcomes:

(4.3a) $$\pi_t^{MC} = \frac{\mu_1\delta_2 + \mu_2\delta_1}{\Phi^{MC}}\bar{g},$$

(4.3b) $$(g_t - \bar{g})^{MC} = -\frac{\delta_1(1-\alpha) + \mu_1(\alpha - \theta^F)}{\Phi^{MC}}\bar{g},$$

(4.3c) $$n_t^{MC} = -\frac{\delta_2(1-\alpha) - \mu_2(\alpha - \theta^F)}{\Phi^{MC}}\bar{g},$$

$$\Phi^{MC} \equiv (1-\alpha)\left[\delta_2(1-\alpha) - \mu_2(\alpha - \theta^F)\right] + \mu_1\delta_2 + \mu_2\delta_1 + \delta_1(1-\alpha) + \mu_1(\alpha - \theta^F).$$

These can immediately be compared with the outcomes under no international policy cooperation, equations (3.7a)-(3.7c). The qualitative results of this comparison are summarized by the following proposition (given without proof; tedious algebraic manipulations readily recover its contents):

Proposition 1:

$$\pi_t^{MC} > \pi_t^{NC},$$

$$(g_t^{MC} - \bar{g}) \gtrless (g_t^{NC} - \bar{g}) \qquad \Leftrightarrow \qquad \delta_1 \gtrless (1-\alpha)(\alpha - \theta^F),$$

$$n_t^{MC} > n_t^{NC}.$$

CPI-inflation is highest under monetary cooperation. As noted above, the perceived cost of monetary expansion is reduced by monetary cooperation. Hence, incentives to increase employment and expenditures by money creation are stronger, and as a consequence equilibrium inflation will be higher. Thus the part of inflation caused by lack of CB commitment *vis-a-vis* the wage setters is aggravated, but also the part of inflation attributable to public finance incentives is increased. The former effect is the one described by Rogoff (1985) in a model without fiscal policy (see also van der Ploeg (1988), Levine and Currie (1987)).

When fiscal policy is endogenous, changes in inflation, however, is not the only implication of monetary cooperation. As inflation has revenue generating properties, the FA will respond to the CB's looser monetary policy: for a higher inflation rate, the CPI cost of tax policy is higher, and the FA is therefore less willing to accept high taxes. Moreover, as higher inflation in itself allows for higher public expenditures, this also reduces the need for distortionary taxation. As a result, the FA will set taxes at a lower level, and, in immediate consequence, employment will be higher under monetary cooperation.

The effect of monetary cooperation on expenditures is ambiguous: inflation increases while taxes decline in comparison with no policy cooperation, thus leaving the net effect on expenditures indeterminable. However, we can pin down the factors determining which effect dominates as follows. If the CPI cost of tax policy is moderate (i.e., if $\alpha - \theta^F$ is small), the tax decline will be relatively small, and the inflation effect dominates, in effect making expenditures higher. Also tending towards a moderate tax reduction is a high employment concern of the FA (high δ_1), as that makes it value the price cost of tax policy as relatively unimportant. A sufficient condition for the FA to consider the price effect of tax policy as of secondary magnitude, is that the FA is more concerned with employment than inflation, i.e., if $\delta_1 > 1$. Under this rather mild assumption, expenditures are therefore always higher, i.e. closer to target, under monetary cooperation as compared to no policy cooperation.

The main conclusion from proposition 1 is that monetary cooperation without commitments

with private sectors may not be as bad as it is usually perceived. In models exclusively focusing on an employment-inflation trade-off and with exogenously given unemployment problems, only the effect of increased inflation described by Rogoff (1985) pertains. Employment is, via definition, neutral with respect to monetary policy regime. This has fostered the argument that "successful" monetary cooperation is only accomplished if it is accompanyed by commitments *vis-a-vis* the private sectors (see e.g., Currie, Levine and Pearlman (1992)). Proposition 1 indicates that this is too stark a conclusion. Inflation do indeed increase by a transition to a regime of monetary cooperation, but this has also beneficial effects in the sense that the FA's incentives are changed such that the natural rate of employment increases, and expenditures - most likely - also increases.

In the case where monetary cooperation in fact *is* imagined as a device for creating CB credibility *vis-a-vis* the private sector, Bryson, Jensen and VanHoose (1992) demonstrate that the obtained reduction in inflation, affects the FA's incentives in opposite direction as above. It set higher taxes, employment drops, and expenditures decline (see also Alesina and Tabellini (1987))[10].

4.2. International fiscal cooperation

Now we consider the case where fiscal authorities form a coalition devoted to the bilateral determination of fiscal policies. Monetary policy is performed non-cooperatively, between central banks, as well as *vis-a-vis* the coalition of fiscal authorities, i.e., the domestic CB solves (3.2). The coalition of FAs solves:

$$\max_{\tau_t,\tau_t^*} \quad V_t^{FA} + V_t^{FA^*} \tag{4.4}$$

$$\text{s.t. (2.8), (2.10)}, \partial x_t/\partial\tau_t = 0, \partial x_t/\partial\tau_t^* = 0, \quad x_t = m_t, m_t^*.$$

One of the first order conditions to (4.4),

$$\delta_1 n_t - \delta_2(g_t - \bar{g}) - (\alpha - \theta^F)\pi_t - \theta^F\pi_t^* = 0,$$

[10] Dornbusch (1988) and Giavazzi (1989), among others, use this as an argument against a "zero inflation" EMS policy, as countries in southern Europe depends, to a large extent, on seignorage as a means of finance.

will, due to symmetry, implying $\pi_t = \pi_t^*$, generate the following outcome characterization (where superscript *"FC"* indicates variables under fiscal cooperation):

(4.5a) $$n_t^{FC} = \frac{\delta_2}{\delta_1}(g_t^{FC} - \bar{g}) + \frac{\alpha}{\delta_1}\pi_t^{FC},$$

(4.5b) $$\pi_t^{FC} = -\frac{\mu_1}{1-\alpha+\theta^M} n_t^{FC} - \frac{\mu_2}{1-\alpha+\theta^M}(g_t^{FC} - \bar{g}).$$

Equation (4.5b) is the equivalent of (3.3b), as the policy problem governing monetary policy is the same as under no policy cooperation. Equation (4.5a), describing the trade-offs of the FA, is now different in comparison with (3.3a) due to the change in fiscal regime form. Under international fiscal cooperation, the FAs internalize the international externalities of tax policies. In effect, they take into account, *ex ante*, that taxes will be equal across countries, and therefore any real exchange rate alterations are ruled out. Thus, the term θ^F capturing these externalities is absent. This increases the CPI cost of tax policy: under unilateral tax determination a tax increase is perceived to generate a real exchange rate appreciation, accounting for a reduction in the CPI. This dampens the domestic product price increase. *Ex post*, perceptions are proved fallacious, as the real exchange rate remains unaltered. Thus, the fact that fiscal cooperation obliterates such perceptions, makes each FA less willing to give up employment in exchange for higher expenditures, as the CPI cost of tax policy is assessed correctly *ex ante*. This is immediate from a comparison of (4.5a) with (3.3a).

To derive the outcomes under fiscal cooperation, use of (3.6) together with (4.5a) and (4.5b), produces:

(4.6a) $$\pi_t^{FC} = \frac{\mu_1\delta_2 + \mu_2\delta_1}{\Phi^{FC}}\bar{g},$$

(4.6b) $$(g_t - \bar{g})^{FC} = -\frac{\delta_1(1-\alpha+\theta^M) + \mu_1\alpha}{\Phi^{FC}}\bar{g},$$

(4.6c) $$n_t^{FC} = -\frac{\delta_2(1-\alpha+\theta^M) - \mu_2\alpha}{\Phi^{FC}}\bar{g},$$

$$\Phi^{FC} \equiv (1-\alpha)[\delta_2(1-\alpha+\theta^M) - \mu_2\alpha] + \mu_1\delta_2 + \mu_2\delta_1 + \delta_1(1-\alpha+\theta^M) + \mu_1\alpha.$$

We now compare these with the outcomes under no policy cooperation, (3.7a)-(3.7c). The qualitative results of the comparison are contained in the following proposition (which, as was the case with proposition 1, is given without proof)

Proposition 2:

$$\pi_t^{FC} \gtreqless \pi_t^{NC} \qquad \Leftrightarrow \qquad \mu_2(1-\alpha) \gtreqless \mu_1,$$

$$(g_t^{FC} - \bar{g}) < (g_t^{NC} - \bar{g}),$$

$$n_t^{FC} > n_t^{NC}.$$

Taking the last result first, we see that employment is highest under fiscal cooperation as compared to no policy cooperation. As mentioned above, the CPI cost of taxes is higher under fiscal cooperation, and this make the FA select lower taxes. Without fiscal cooperation taxes are set inefficiently high, due to the above mentioned erroneous perceptions about real exchange rate movements[11]. Such assumptions are excluded under cooperation, and therefore taxes are lower, and, in turn, employment higher.

Ceteris paribus, lower tax returns make expenditures lower under fiscal cooperation. However, higher employment and lower expenditures have ambiguous effects on inflation, cf. (4.5b). Higher employment reduce the CB's incentive to perform expansive policies, whereas lower expenditures makes this incentive stronger. The net effect of fiscal cooperation on inflation therefore depends on the relative weights the CB assigns to employment and expenditure targets. A relatively high weight on employment, i.e., high μ_1, reduces the CB's incentive to perform expansive policies, and the part of inflation attributed to the CB's "credibility problem" *vis-a-vis* wage setters will be lower under fiscal cooperation. On the other hand, a relatively strong concern for expenditures, i.e., high μ_2, makes the incentive to perform expansive policies stronger, and hence inflation will be higher under fiscal cooperation[12].

In total, as was the case with monetary cooperation, international fiscal cooperation has pros and cons. But in contrast to models focusing exclusively on fiscal coordination, we are able to give some assessment as to how monetary policy, and thus inflation, will be altered. Again it is notable, that the results of proposition 2 are in disagreement with the previously mentioned notion about the

[11] Devereux (1991) and Turnovsky (1988) also find, in other types of models, that taxes are inefficiently high when fiscal policies are uncoordinated as policymakers *ex ante* attempts to affect the terms of trade.

[12] If inflation is higher, expenditures will never increase, however. This is because higher inflation makes the CPI cost of taxes even higher, thus lowering taxes even further, thereby offsetting the beneficial expenditure effects of potential higher inflation under fiscal cooperation.

necessity of monetary policy being characterized by credibility *vis-a-vis* the private sector. Such credibility is immediately characterized as if CBs performed policy without employment concern, i.e., $\mu_1 = 0$. Examination of the proposition reveals that under that assumption inflation is definitely going to increase if fiscal policies are coordinated.

4.3. Total cooperation

In a regime of total cooperation, both monetary and fiscal policies are conducted by coalitions of CBs and FAs, respectively. Hence, the CBs jointly solve problem (4.1) and the FAs solve problem (4.4). The relevant first order conditions are therefore (4.2a) and (4.5a), which together with (3.6) generate the following outcomes (where superscript "*TC*" indicates total cooperation):

(4.7a) $$\pi_t^{TC} = \frac{\mu_1\delta_2 + \mu_2\delta_1}{\Phi^{TC}}\bar{g},$$

(4.7b) $$(g_t^{TC} - \bar{g}) = -\frac{\delta_1(1-\alpha) + \mu_1\alpha}{\Phi^{TC}}\bar{g},$$

(4.7c) $$n_t^{TC} = -\frac{\delta_2(1-\alpha) - \mu_2\alpha}{\Phi^{TC}}\bar{g},$$

$$\Phi^{TC} \equiv (1-\alpha)\left[\delta_2(1-\alpha) - \mu_2\alpha\right] + \mu_1\delta_2 + \mu_2\delta_1 + \delta_1(1-\alpha) + \mu_1\alpha.$$

We are now in a position to compare the outcomes of this regime with either of the three previously analyzed regimes. As the two regimes of "partial cooperation" yielded qualitatively different results when compared to the non-cooperative, it should come as no surprise that a comparison of the present regime with the non-cooperative will be ambiguous. The following proposition therefore focuses on those unambiguous results which shed most light on the benefits associated with total cooperation (again, the proof is merely algebraic and therefore omitted):

Proposition 3:

$$\pi_t^{FC} < \pi_t^{NC} \quad \Rightarrow \quad \pi_t^{TC} < \pi_t^{MC}$$

$$(g_t^{MC} - \bar{g}) > (g_t^{NC} - \bar{g}) \quad \Rightarrow \quad (g_t^{TC} - \bar{g}) > (g_t^{FC} - \bar{g})$$

$$n_t^{TC} > n_t^{FC}, \qquad n_t^{TC} > n_t^{MC}$$

Employment is unambiguously higher under total cooperation than under any other regime form. This should come as no surprise given the results of the past propositions: alleviation of international monetary externalities increases employment as the increase in inflation moderates the FA's incentives to use distortionary taxation. Internalization of fiscal externalities raise the CPI cost of tax policy which also moderates these incentives. Under total cooperation the best of both worlds is attained, and employment is at the highest level.

We demonstrated before that monetary cooperation generated higher inflation, whereas fiscal cooperation could create lower inflation, in comparison with non-cooperation. Therefore, inflation under total cooperation may be determined by counteracting forces. However, we are able to made the point that *if* inflation is lower under fiscal cooperation, then inflation under total cooperation will be lower than under monetary cooperation. This suggests that CBs, caring relatively much about inflation, would only want to coordinate monetary policies, if also fiscal policies are coordinated.

As far as expenditures are concerned, we previously indicated that these were lower under fiscal cooperation, and could be higher under monetary cooperation, as compared to non-cooperation. Hence, when comparing total cooperation with non-cooperation, two opposing forces are present. However, given that expenditures are higher under monetary cooperation, then expenditures are always higher under total cooperation than under fiscal cooperation. This suggest that FAs, caring relatively much about expenditures, are more willing to coordinate their policies if also monetary policies are coordinated.

TABLE 1	*NC*	*MC*	*FC*	*TC*
π_t	0.1589	0.1816	0.1484	0.1680
$g_t - \overline{g}$	-0.0669	-0.0518	-0.0808	-0.0687
n_t	-0.0808	-0.0553	-0.0693	-0.0443
V_t^{FA}	-0.0517	-0.0471	-0.0512	-0.0463
V_t^{CB}	-0.0312	-0.0359	-0.0273	-0.0309
$\alpha = 0.7, \beta = 0.4, \delta = 0.67, \overline{g} = 0.3, \delta_1 = 2, \delta_2 = 3, \mu_1 = 0.75, \mu_2 = 0.25.$				

We conclude from the above that the employment benefits from total cooperation are obvious. Further, disadvantages of monetary cooperation seem to be offset by advantages of fiscal cooperation, and *vice versa*. This tentative conclusion is best illustrated by a simple numerical example, which allows us to evaluate the outcomes in terms of the respective authorities' pay-offs. In table 1, such an

example is given. It is constructed so as to yield falling inflation when going from non-cooperation to fiscal cooperation, and increasing expenditures when going from non-cooperation to monetary co-operation. Hence, the conditions stated in proposition 3 with respect to these variables are satisfied. In terms of the authorities' pay-offs, the conclusion holds: cooperating FAs are indeed better off if the CBs also cooperate, and cooperating CBs are better off if the FAs also cooperate. Incidentally, total cooperation is favoured over non-cooperation by both.

5. Concluding comments

This paper has analyzed some consequences of international cooperation of monetary and/or fiscal policies. In a world where unemployment problems are attributable to tax distortions we have shown that such problems may be dampened by cooperative policymaking either form. Moreover, disadvantages of one regime form (in terms of inflation of expenditures) seem to be offset by the other's advantages. Hence, a regime of monetary *and* fiscal cooperation appears appropriate.

Special attention has been drawn to the interdependence of monetary and fiscal policies. It is demonstrated that a monetary regime shift has real effects through its impact on fiscal incentives, and that a change in fiscal regime form has nominal effects through altered monetary incentives. Such aspects have previously been neglected in the literature, where analyses of international monetary and fiscal cooperation usually are conducted independently. As our analysis exemplifies that monetary cooperation can have positive derivative effects for fiscal policy, and *vice versa*, it suggests that the interrelationship of monetary and fiscal regime forms should receive more attention in the future if we should widen our understanding of international policy cooperation.

Finally, we emphasise that our analysis has treated international policy cooperation as the internalization of international externalities. We do not consider international policy cooperation as a means to, e.g., establish "credibility" with the private sectors. This naturally leads to the question of which "commitment technology" (in the sense of Canzoneri and Henderson (1991)) actually sustains a given policy regime. What technology can support cooperation among policymakers, but not among policymakers and private sectors? There is no easy answer to this question, as it would require the incorporation of regime choice into the players' strategy space. Since good prototype theories of such endogenous regime formation are yet lacking, we feel, though, that the "comparative static" nature of the analysis provided here can offer important insight into the advantages and disadvantages of international policy cooperation.

Appendix

Derivation of equation (2.5)

The following arguments are similar to the ones of Canzoneri and Henderson (1988) and Bryson, Jensen and VanHoose (1992). The domestic nominal income equilibrium condition reads (upper case letters denote antilogs):

(A.1) $$P_t Y_t = f((1-\tau_t)P_t Y_t, P_t, E_t P_t^*, E_t(1-\tau_t^*)P_t^* Y_t^*) + G_t,$$

where $f(\bullet)$ is private (domestic as well as foreign) nominal spending, and G_t is public nominal expenditures. Assuming the following functional form of f,

$$f = ((1-\tau_t)P_t Y_t)^{(1-\beta)} P_t^{-(1+\gamma)} (E_t P_t^*)^{\gamma} ((E_t(1-\tau_t^*)P_t^* Y_t^*)^{\beta}, \qquad \gamma > 0, \qquad 0 < \beta < 1,$$

then log linearizing (A.1) around the natural rate yields approximately equation (2.5) with $\delta \equiv \beta/(\gamma+\beta)$.

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