ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

DEPARTMENT OF ECONOMICS

ECONOMIC COOPERATION AND INTERDEPENDENCE

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Contents

Introduction

The issue of policy coordination between authorities of different countries has extensively emerged among economists, especially over the last decades. This economic interdependence may take many forms. Thus, among some countries there may be structural interdependence -that is economic events in one country strongly influence the economic events in other countries- or high degree correlation of exogenous disturbances. In addition, there may exist direct relation among the objectives of authorities of different countries or variables that affect simultaneously the social welfare of these countries.

The "openness" or the exposure to global economy for the majority of countries worldwide has respectively increased this interdependence and has caused a controversy about the need of the cooperation of both monetary and fiscal policies in a clearly highly integrated world. The outcome of this controversy is the huge literature about these issues especially about the effect of positive or negative externalities (or spillovers) that a country produces and direcly affects other counries. One could say that there is a strategic interdependence among countries, as the strategy of a country over its fiscal or monetary policies affects this country's payoffs but other countries' strategies and therefore payoffs. In other words, the matter of policy cooperation may be viewed as a game in which countries are the players and the social welfare of their citizens are the payoffs in the end of the game.

In this essay we try to investigate the coordination and the interdependence of economic policies in a theoretical framework illustrating some of the basic related models. In these particular models we use microfoundation and basic elements from game theory. More specifically, we demonstrate the main ways of policy coordination pertaining to fiscal, monetary and fiscal and monetary policies using two-country and n-countries models.

In part A, we begin our analysis illustrating a basic model of coordinated fiscal policies by Persson and Tabellini (1995), in which we show the effect of tax competition as a kind of an externality. Firstly, we present the model and its basic assumptions and then we solve for the cooperative and the noncooperative equilibria. Then, we make a comparison of these two regimes and show that when noncooperative behaviors take place then the world welfare decrease.Finally, we make an extension of the basic theoretical framework, inserting credibility issues over the fiscal authorities.

In part B, we use a simple monetary model by Persson and Tabellini (1995). In this case, we examine two kinds of international externalities that arises from two sources of conflict: conflict over stabilization and conflict over real income. In each case, we examine the cooperative and the noncooperative regime and show that whether there would be an expansionary or contractionary bias between these two regimes depend on the sign of the exogenous shock. Finally, we make an extension of the basic model using again the credibility issue concluding that in this case cooperation may not be effective.

In part C, we illustrate a model of fiscal and monetary interaction in a monetary union. More specifically, we use a model by Dixit and Lambertini (2001) in which there is interaction between a common central bank that applies its monetary policy, and n fiscal authorities-one for each country within the monetary union. Firstly, we present our main model of this interaction. Secondly, we demonstrate what happens when discretionary policies take place and show that in the case that the authorities act unilaterally the ideal goal for each authority and the existing outcome do not coincide. Finally, we illustrate that when the ideal values of inflation and output for each authority coincide, then the monetary union achieves actually these ideal values.

Part A: Coordination of fiscal policies

International coordination of fiscal policies has attracted much attention over the last decades. Cooper and John's pioneer work (1988) investigates the effect of spillovers and strategic complementaries. In their paper, the former refers to the interaction between agents at the level of payoffs; that is if a strategy of one player's strategy affects the payoffs of the other player, while the latter refers to interactions at the level of strategies; that is a change in one player's strategy which generates change of the other player's optimal strategy. These spillovers and strategic complementarities can arise at the levels of preferences and technology or in the manner in which agents organize their transactions.

Cooper and John (1988) use a game theory framework displaying Keynesian features, in which players' optimal strategies depend upon the strategies of other agents. They analyze the welfare properties of Nash equilibria concluding that spillovers and strategic complementarities lead both to coordination failures.The inefficiencies are driven by the presence of externalities in payoff functions, while the multiplicity of equilibria derives explicitly from positive interaction at the level of strategic choices.

In this part we base our analysis examining the issue of coordination of fiscal authorities using a model of fiscal policy by Persson and Tabellini (1995). This model illustrates the effect of tax competition in fiscal cooperation. In this case, tax bases are international mobile and the corresponding logic is that with an internationally mobile capital, governments have the incentive to keep tax rates sufficiently low in able to attract capital from abroad. The outcome of this competition is ineffictively low –in Pareto optimal terms- taxes rates in both countries. Cooperation calls for raising taxes on capital in both countries.

A.1 The basic model

The model of Persson and Tabellini (1995) is made up of two countries-the home and the foreign country,each inhibited by a representative consumer. There are two periods (period 1 and 2) and one (traded) commodity. An * denotes a foreign variable.

Public consumption, g, is exogenous and only takes place in ther second period.Consumer preferences are defined over private consumption, c (occured in periods 1 and 2) and public consumption.Consumer preferences[1] in the home country are represented by:

$$u = U(c_1) + c_2 + H(g)$$

In the first period the consumer in the home country receives an exogenous endowment e, that can can be consumed or invest at home or abroad. Furthermore, it is assumed that the production fuction is identical in the two countries: One unit invested today yields one unit today tomorrow, gross of taxes. However, “mobility costs” do occur when the consumer chooses to invest abroad: transaction and information costs are higly associated with foreign investment. For simplicity, these costs are borne in the second period, when the investment brings out some return. We assume that the only tax base is capital, which when invested at home is taxed at the domestic rate θ, whereas capital invested abroad is taxed at the foreign rate θ*.

Under these assumptions we can write the consumer budget constraints for first and second period respectively as :

$$e \geq c_1 + k + f \equiv c_1 + s$$

$$c_2 \leq (1 - \theta)k + (1 - \theta^*)f - M(f)$$

$$\equiv (1 - \theta)s + (\theta - \theta^*)f - M(f)$$

where k and f denote domestic and foreign investment of the home country respectively, $s = k + f$ denotes savings, and M(f) is a function that captures the mobility costs of foreign investment.We further assume that $M(0) = 0$, $M_f > 0$, $M_{ff} > 0$.

Finally, the government budget constraint in the second period in the second period is:

$$g \leq \theta k + \theta f^* \equiv \theta(s - f + f^*)$$

[1] Or equivalently consumer’s utility function.

In addition it is assumed that capital is taxed according to the source principle and not the residence principle, and that the same rate applies irrespective who owns the capital.

By the consumer's optimality conditions, savings are a function of the domestic tax rate,

$$s = S(\theta) = 1 - U_c^{-1} (1 - \theta), \text{ with } S_\theta < 0.$$

Moreover, investment abroad is a function $f = F(\theta,\theta^*)$, with $F_\theta = - F_{\theta^*}$. In this framework, an externality is obvious: a unilaterally higher capital tax rate at home encourages capital flight, and vice versa if the foreign tax rate rises.Finally, domestic investment at home can be written as:

$$k = K(\theta,\theta^*) = S(\theta) - F(\theta,\theta^*)$$

Thus, a higher capital tax rate in the home country discourages home investment in two ways: it reduces savings and induces capital flight by home citizens. The foreign country is identical in all respects. In particular, $F^*_{\theta^*}= F_\theta$ and $F^*_\theta = F_{\theta^*}$.

A.2 Equilibrium policies with and without cooperation

Persson and Tabellini (1995) in their model assume that there is a specific mode of cooperation of the two countries: it is assumed that in the case of cooperation a social planner through the pair of policies maximizes world wide welfare[2].The timing of the events is as follows: 1) In period 1 governments choose tax policy, (2) Having observed the policy, consumers choose how much to save and where to invest, (3) In period 2 no new decision is made, and the budget constraints dictate how much private and public consumption is feasible, given the period 1 choices.

[2] For this section, we assume that there is not any credibility problem.

To compute the optimal tax rates, we write the home consumer indirect consumer indirect utility function as:

$$u = U(c_1) + c_2 + H(g) =$$
$$= u\,(\theta,\theta^*) \equiv U(1 - s(\theta)) + (\,1 - \theta\,)s(\theta) + (\,\theta - \theta^*)F(\theta,\theta^*) - M(F(\theta,\theta^*)$$
$$+ H[\theta(s(\theta) - F(\theta,\theta^*) + F(\theta,\theta^*)]$$

The foreign consumer indirect utility function, $u^*(\theta,\theta^*)$, is analogously defined.Optimal tax rates maximize the world wide welfare $[u(\theta,\theta^*) + u^*(\theta,\theta^*)]$.

Using the envelope theorem, one can get the equilibrium tax rate in the home country by the following optimality condition:

$$H_g = \frac{1}{1 - n^C} \qquad (1.1)$$

where n^C denotes the elasticity of the relevant tax bases (k and f*) for the home government with respect to the domestic tax rate, in a cooperative equilibrium.In equation (1.1) the right hand side is the marginal cost of higher taxes, which also reflects the tax distortion on investment decisions. The higher is the elasticity n^c , the greater is the distortion and hence the lower is the optimal tax rate (because H(.) is concave and the left hand side is decreasing in g and hence in θ).

The key determinant of the equilibrium tax is thus the elasticity n^C . In a cooperative equilibrium, this equilibrium can be written as:

$$n^C = - \frac{S_\theta \theta}{s} \qquad (1.2)$$

The crucial result is that in the case of cooperation the two governments refrain from exploiting international capital mobility for their own benefit: σ only reflects the savings elasticity and it neglects the investment elasticity due to the international movements of capital.

This does not happen in the case of non-cooperative policy making.In this case, there exists a non-cooperative Nash equilibrium: each government maximizes the welfare of its own citizens, taking the tax rate in the other country as given. Thus, the home government maximizes its objective function u(θ,θ*) defined above, taking the tae tax rate in the other country as given. Its reaction function is defined by a condition similar to (1.1), except that the elasticity on the right hand side is now:

$$n^N = - \frac{(S_\theta + 2F_\theta *)\theta}{s} \quad (1.3)$$

That is the elasticity computed in the Nash equilibrium.

A.3 Comparison of the two regimes

Using the fact that $F_\theta * < 0$, it follows that $n^N > n^C$. Using the equation (1.1) we have that the equilibrium tax rate is lower in noncooperative regime.That is

$$\theta^N < \theta^C$$

The intuition beyond our results is obvious: in the absence of cooperation both governments unilaterally have the incentive to reduce taxes, so that it becomes possible to attract foreign capital and to keep domestic capital within their borders.Moreover, this incentive is larger the greater is international capital mobility (i.e.the more negative is F*).

The conclusion is that lack of international cooperation in Persson and Tabellini's model (1995) leads to an inferior result: world wide welfare falls.Thus, the world economy in the case of Nash equilibrium is driven in a second best environment. In the Nash equilibrium, there is no capital mobility from either country. Tax competition does not pay: it simply distorts governments' incentives. In both countries, Nash equilibrium public consumption is too low and private savings too high compared with the (second-best) optimal taxation rule. This distortion is greater (and so is the benefit from cooperation) the larger is international capital mobility

A.4 Extension of the basic model

In the previous section, we made the crucial assumption that there is no credibility problem in government policies. If this assumption is withdrawn, there is another domestic incentive constraint that can make cooperation counterproductive.

Kehoe (1989) shows that even when governments are benevolent, cooperation is undesirable-that is because time inconsistency problem arises[3]. This model is a two country version of Fiscer's (1980) optimal tax model. In it, private agents are competitive (that is each agents takes both prices and government policies as exogenous and therefore, uninflunced by his actions) and as above, each government maximizes the welfare of its country's residents.

Note that Van der Ploeg (1987) explored the possibility of undesirable cooperation in a two-country version of Calvo's (1978) inflation tax model using a somewhat different notion of equilibrium that the one used by Kehoe (1989).

The timing of events in Kehoe's model is the following: Consumers have consumer,savings-investment decision in the first period and consumption and labour in the second period and government of each country sets proportional tax rates on capital income and on labour income , in order to finance second-period per capita government government spending g-which is exogenously given.

In Kehoe's paper, the two different regimes -cooperative and noncooperative-correspond to alternative institutional arrangements. Neither regime has a mechanism for committing in a specific set of policy rules at the beginning of the game. Each institutional arrangements define an extensive form game.The subgame perfect equilibria of these two games are used to compare welfare across regimes.The conclusion is that social welfare is maximized under the noncooperation regime[4].

[3] Using a simple monetary union,in a seminal work Rogoff (1985) is the first that challenges the view that cooperation is undesirable.

[4] Kehoe(1989) uses a microfounded model of maximizing agents, quite similar to the basic model of Persson and Tabellini (1995).

Persson and Tabellini (1995) extend the model that we demostrated above and show that if the government lacks credibility, then it matters whether cooperation makes government policy more or less credible. In this framework cooperation can be actually undesirable for society as a whole, as well as for the government that engages in cooperation. The whole analysis involves an aspect of time inconsistency problem. In this case a government has the incentive not to follow a policy that they announced before an investment by an individual takes place, since an investment when it incurrs, it cannot be recovered fully. Individuals realize government's incentive and have a motive to invest less.

To illustrate this point, suppose that we change the timing of events in the model of the previous section as follows: i) In period 1 individuals save, ii) In period 2 the governments of both countries choose economic policy iii) Finally, individuals choose the location of their investment. Thus, savings and investment are temporally separated or, equivalently, capital can be moved across countries after policy choices have been made.

In this case, tax policy suffers from a credibility problem. Governments cannot convince individuals that taxes will be low as they have the ex post incentive to tax savings a lot. Through cooperation, international mobility is removed and that makes credibility problem even worse.

To show this, we remove the term S_θ from the relations (1.2) and (1.3). In the precence of cooperation, the elasticity of the tax base becomes zero:

$$n^C = -S_\theta \theta/s \quad \text{or} \quad \eta^{cext} = 0$$

$$n^N = -(S_\theta + 2F_\theta^*)\theta/S \quad \text{or} \quad \eta^{next} = -2F_\theta^*\theta/S$$

In the Nash equilibrium the elasticity η^n remains remains positive in absolute value, but it is a smaller number than in the previous subsection (since in (1.3) S_θ and $F^*_\theta < 0$). By

(1.1), it then follows that the equilibrium tax rate is higher, both in the non-cooperative and the cooperative regime:

$$n^{cext} < n^{next}$$

and

$$\theta^{cext} > \theta^{next}$$

Thus, according to Persson and Tabellini (1995), in this case, equilibrium tax rates are still lower in the case of noncooperation. But the intuition under the lack of credibility is quite different: in the case of cooperation tax rates are too high to be Pareto optima and moreover, tax rates under the noncooperative regime are not too low (comparing of course to the basic model).

There are two different directions for tax rates caused by tax competition and lack of credibility.Tax competition pulls the tax rate below the Ramsey optimum, but lack of credibility pulls it above. Without cooperation, the tax competition effect is still operative so that taxes remain lower than with cooperation, even though they are higher than in the Nash equilibrium of the previous section. Tax competition can therefore be socially desirable, by giving credibility to a policy of low capital taxes.

Part B: Coordination of monetary policies

Below we examine the case of the coordination of monetary policies in an environment where fiscal policy is assumed to be exogenous. In this framework, our selective survey may highlight Cooper and John (1988) as a pioneer work in this area also, using the concept of spillover to describe potential interaction between the payoff functions of two central banks.

Hamada (1976) examines the interdependent nature of monetary policies applying the monetary approach to the balance of payments. A standard conclusion of his work is that increasing policy cooperation among countries is desirable. Rogoff (1985) has challenged this view. Using a simple monetary model, Rogoff shows that cooperation among policy makers can lead to a lower level of welfare than noncooperation does. One problem pointed out by Rogoff (1985) is that monetary policy coordination may be counterproductive if government lack credibility.

Frankel (1988) investigates the matter of uncertainy about initial conditions or objective functions. He also pointed out that cooperation may be difficult to be applied as there is the incentive for the central banks to deviate. Related literature in game theory has showed that this incentive is actually lessened when the authorities play the game for many periods.

In our analysis about monetary coordination, we will use a model of monetary interaction by Persson and Tabellini (1995) that relies on social welfare functions defined directly over macroeconomic outcomes and on reduced-form relations between macroeconomic and policy instruments.

B.1 A simple model

We present a simple model of monetary policy by Persson and Tabellini (1995) which is similar but reduced forms of the static models in Canzoneri and Henderson (1988, 1991) . It also encompasses other models, like those in Canzoneri and Gray (1985) and Rogoff (1985), among others.

As in previous section, there are two countries: the home and the foreign country. The single policy instrument in this framework is m, pertaining to money growth. The policymaker targets to maximize the following welfare function defined over macroeconomic variables:

$$\mathbf{W(p, x, z ; \theta, \varepsilon)} \qquad (2.1)$$

where p is the deviation from the natural rate x, and the rate of change of the real exchange rate, z, defined as the relative price of foreign goods in terms of home goods.As for θ and ε, they are symmetrically distributed shocks that may affect macroeconomic outcomes. In addition, we assume that W(.) function is quadratic and separable in the macroeconomic outcomes: the partials in p, x and z, when non-zero, are linear in these variables and the cross-partials W_{ij} for i, j= p, x, z are zero.

Moreover, the model follows the literature in assuming that private agents sign nominal contracts for wages (or prices). The policymaker knows the realization of both θ and ε when setting m, but private agents have information only for θ-shocks. As in Fischer (1977), this superiority of information over the shock ε provides a role for stabilization policies. In this framework, we study actually a "discretionary" policy environment, just because of this information advantage by the policymakers.

Following much of the literature, the real exchange rate, z, is the only source of spillover across countries. Defined as the rate of change in the relative price of foreign goods, we can write z as:

$$z = s + q^* - q \qquad (2.2)$$

where s is the change in the nominal exchange rate and q(q*) is the own-currency change in the price of home (foreign) country goods.Thus a positive z reflects a real depreciation. We use the following semi-reduced forms:

$p = P(m, z ; \theta, \varepsilon)$ (2.3) and P as a positive function of m and z,

$x = X(m - m^e, z; \theta, \varepsilon)$ [5] (2.4) and X as a positive function of $m - m^e$,

$z = Z(m - m^e, m^* - m^{*e}; \theta, \varepsilon, \theta^*, \varepsilon^*)$ [6] (2.5) and Z as a positive function of $m - m^e$ and $m^* - m^{*e}$.

where the e superscript denotes private expectations, conditions on θ, and where "*" denotes a foreign variable.

We normalize the model by assuming :

$p = 0$ when $m = m^e = z = \varepsilon = \theta = 0$

$x = 0$ when $m = m^e$, and $z = \theta = \varepsilon = 0$,

$z = 0$ when $m = m^e$, $m^* = m^{*e}$, and $\theta = \varepsilon = \theta^* = \varepsilon^* = 0$

Moreover, we assume the following timing of events :

i) The values of θ and θ* are observed by anyone, ii) private agents form expectations: m^e and m^{*e}, iii) the policymakers observe the values of ε and ε* and iv) they choose money growth rates m and m* simultaneously and finaly v) macroeconomic outcomes are realized.

5 The CPI-inflation rate p in (2.3) increases with money growth and with real depreciation.This reduced form follows from the definition of CPI-inflation $p = P(q, z)$ where P(.) is increasing in both variables, and the assumption that the rise in homs-goods prices depends on θ-shocks and ε-shocks and is an increasing function of domestic money growth: $q = Q(m, \theta, \varepsilon)$

6 The Z(.) function can be thought of as the inverse of a relative demand function, where the relative demand for home goods, $d - d^*$, is a decreasing function of the relative price of foreign goods: $D(z; \theta, \theta^*, \varepsilon, \varepsilon^*)$ with $D_z(.) > 0$.If so, we can write the equilibrium condition $(d - d^*) = (x - x^*)$ as $z = D^{-1}((x-x^*); \theta, \theta^*, \varepsilon, \varepsilon^*)$, which together with (2.4) defines (2.5).

B.2 International externatilies

We now proceed to the examination of two kinds of externalities that rise from two respective kinds of conflicts; that is the conflict over stabilization and conflict over real income. Persson and Tabellini (1995) expand in this way their model mainly using the one one suggested by Canzoneri and Henderson (1998).

B.2.1 *Conflict over stabilization*

In this version the countries are completely symmetric.The objective function and the output levels are not directly affected by the real exchange rate.However, real exchange rate directly affects CPI-inflation through import prices.Thus, we assume :

$W_z = W_z{*} = X_z = X_z{*} = 0$ (2.6)

In addition, policy makers evaluate output evaluations according to:

$W_x, W_x{*} > 0$ as $x, x^* < 0$ and $W_x, W_x{*} < 0$ as $x, x^* < 0$.

Thus, there are no shocks of the common information type giving rise to domestic incentive problems:

$\theta = \theta^* = 0$.

On the contrary, shock ε is present and common to both countries:

$\varepsilon = \varepsilon^*$,

This shock has the character of a supply shock, in that:

$X_\varepsilon = X_\varepsilon{*} < 0$, $P_\varepsilon = P_\varepsilon{*} > 0$, and $Z_\varepsilon = 0$.

We then demonstrate the case of cooperative and noncooperative policies and make a comparison.

Cooperative policy

In this regime, a natural assumption to be made is that the two countries choose monetary policies so as to maximize the sum of their objective functions. For any ε, the optimal value for home money growth must satisfy the first-order condition:

$$W_pP_m + W_xX_m + (W_pP_z - W^*_{p^*})Z_m = W_pP_m + W_xX_m = 0 \quad [7] \qquad (2.7)$$

Taking expectationsof (2.7) over ε, we can solve for equilibrium expectations, m^e. Plugging m^e back to (2.7), we obtain the cooperative equilibrium of m, conditional on ε, that is labeled as $m^c = M^c(\varepsilon,\varepsilon^*)$.By the assumed symmetry of structure and shocks, we have $m^c = m^{*c} = M^c(\varepsilon,\varepsilon^*)$. Some observations are needed to be made about this outcome:

- First, if ε = 0 [8], each country reaches its first-best macroeconomic outcome at $m^c = m^{*c} = M^c(0,0)$ [9].
- Second, at non-zero values of ε, higher output has to be optimally traded off against higher inflation[10] [11].
- Third, due to symmetry, the implied equilibrium real exchange rate chnage is independent of ε : $z = Z^c(\varepsilon,\varepsilon^*) = 0$ for all ε.

[7] Where the first equality follows from the symmetry of the model (which makes $P_z = - P_z^*$).
[8] That is there is no supply shock.
[9] This follows by Pm and Xm both being positive and by $W_p = W_x = p = x = z = 0$ at $m = m^e = m^* = m^{*e} = 0$.
[10] By (2.2) and (2.7), sgn[x] = sgn[p] at $m = m^e = 0$ for ε other than zero; it follows that sgn[W_p] = - sgn [W_x] at $M^c(\varepsilon,\varepsilon^*)$.
[11] Whether the home policymaker in fact chooses to expand or contract money growth depends on the relative weight he imposes on inflation relative to output and on the properties of the P(.) and X(.) functions.Hence, $M^c(\varepsilon,\varepsilon^*)$ can be positive or negative.

Non-cooperative policy.

Suppose now that the two policymakers make independent and unilateral monetary policy decision.The home country's policymaker thus sets m to maximize his objective, taking m*, as well as m^e and m^{*e}, as given[12].

This yields the first-order condition:

$$W_pP_m + W_xX_m = - W_pP_zZ_m \quad . \qquad (2.8)$$

Taking expectations of (2.8) over ε defines equilibrium expectations, m^e .Plugging them back into (2.8) yields the non-cooperative equilibrium policy, $m^N = M^N(\varepsilon,\varepsilon^*)$.

Comparison

The comparison of the two regimes mentioned above, involves necessarily the role of shock ε. Obviously, there are three potential values of ε :

- First, if $\varepsilon = 0$ (if there is no supply shock), m^N and m^c both implement first best at $m=m^e = 0$ [13].
- Second, if e > 0, the home policymaker (who is optimally trading off high CPI-inflation against low output, has an additional incentive to contract money growth: to generate a negative value of z real appreciation, so as to lower CPI inflation via lower prices of imported prices.Hence, m^N is lower than m^c . But the because the foreign policymaker has an analogous incentive, and because of symmetry, the effect on the real exchange rate is nullified in equilibrium.That is, $Z^N(\varepsilon,\varepsilon^*) = Z^C(\varepsilon,\varepsilon^*) = 0$. If both countries jointly expanded their money growth rates from m^N , their payoffs would improve; by (2.8) the increase in m would have a zero effect on W, but the accompanying increase in m* would raise W by preventing a real depreciation and thereby limit the increase in home inflation. In this case we would say that there is a contractionary bias in both countries in the case of non-cooperative regime compared to the cooperation regime.

[12] We study the Nash equilibrium associated with such non-cooperative behavior.

[13] The P,Z,X – partials are all non zero and $W_p = W_x = p = x = 0$ at this point.

- Finally, with a favorable supply shock ($\varepsilon < 0$), the non-cooperative equilibrium instead has an expansionary bias.

B.2.2 *Conflict over real income*

The international conflict in the previous section is only temporary. In a dynamic model the conflict would still only be temporary, even if the ε-shock was permanent.Suppose that we amend the model in section 2.2.1 with real income objectives for policymakers.That is actually the same model except that the home policymakes values an improvement in its terms of trade, a decrease in z

$$W_z = - W_z^* < 0 \qquad (2.10)$$

That adds a permanent source of conflict between the countries.We then examine the cases of cooperative and noncooperative policy like previously in section 2.2.1.

Cooperative policy

The first-order condition for home money growth now becomes:

$$W_p P_m + W_x X_m + [(W_p - W^*_{p^*})P_z + (W_z + W^*_z)]Z_m = W_p P_m + W_x X_m = 0 \text{ [14]} \qquad (2.11)$$

Comparing (2.7) and (2.11) the optimal cooperative policy is exactly the same. That happens because removing the international real income conflict is identical to internalizing the spill-over effects on the foreign country in a symmetric model.

Non-cooperative policy

With non-cooperative monetary policy-making, the corresponding firs-order condition is

$$W_p P_m + W_x X_m = - (W_p P_z + W_z) Z_m \qquad (2.12)$$

[14] Where we have used (2.10) to get the second equality.

The term $-W_z Z_m$ [15] captures the incentive that the home country policymaker has to improve the terms of trade via contractionary monetary policy once once wage contracts have been written. But this incentive will be frustrated in equilibrium; by a symmetric contractionary incentive in the foreign country, we have $Z^N(\varepsilon,\varepsilon^*)$.

Comparison

We proceed our analysis making some observations.

- If $\varepsilon > 0$ (that is an adverse supply shock), $W_p P_z$ and W_z have the same sign.That means that the stabilization and real income incentives pull in the same direction, namely towards a more contractionary policy than in the cooperative regime
- If $\varepsilon < 0$ (that is a positive supply shock) the stabilization and real income incentives pull in different directions[16].

Thus, the conflict over real income may either reinforce or weaken the conflict over stabilization.In addition, as we mentioned there exists a permanent conflict over the terms of trade.Unlike the stabilization example, non-cooperative policy no longer corroborates the cooperative optimum in the absence of supply shocks.

B.3 Extension of the basic model

In section 1.4 we illustrated an extension of the basic model of fiscal cooperation on the basis of credibility problem. In this section, we do the same for the case of monetary cooperation. In the two kinds of conflict above the only source of inefficiency is the lack of cooperation.In this case, the cooperative regime is ex poste Pareto optimal outcome. Rogoff (1985) pointed out that lack of commitment in monetary policy may render international cooperation undesirable. We demonstrate his argument using again Persson and Tabellini's model (1995) as a specialized version of Rogoff's model (1985).

[15] This term is always positive independently of ε, which adds a permanent contractionary bias to monetary policy.

[16] Indeed, by continuity of P_ε and W_p, there must be a negative value of ε such that the cooperative and non-cooperative policies coincide.For this value, W_p is precisely equal to $-P_z/W_z$, at the point $M^c(\varepsilon,\varepsilon)$.

In the following analysis we make the initial assumption that there are θ-shocks[17], which is common ($\theta = \theta^*$), but not ε-shocks ($\varepsilon = \varepsilon^* = 0$). Let θ be the measure of the fluctuation of the home policymaker's preferred level of output and the natural rate.Furthermore,we make the following assumptions:

$$W_z = W_z^* = X_z = X_z^* = 0 ,$$

$$W_x, W_x^* > 0 \text{ as } x, x^* < \theta \quad \text{and} \quad W_x, W_x^* < 0 \text{ as } x, x^* > \theta \quad ,$$

$$Wx\theta > 0 ,$$

$$\varepsilon = \varepsilon^* = 0.$$

We now proceed again in the analysis of cooperative and non-cooperative policies and the comparison between them.In addition, we continue to assume that the two countries are symmetric in every possible aspect.

Cooperative policy

As before, the home and the foreign policy maker agree to set their money growth rates so as to maximize the sum of their welfare functions, given the realization of θ and the expectations. The optimum condition for m becomes:

$$W_pP_m + W_xX_m + (W_pP_z – W^*_{p*}P_z)Z_m = W_pP_m + W_xX_m = 0$$

This condition is identical to condition (2.6)[18] but it does not produce the same solution.Let the solution be $m = m^e$,which would produce $p = x = 0$. The marginal zero of inflation is zero at this point (that is $W_p = 0$) , while W_x is positive.Given that X_m is positive, there is an incentive to expand monetary policy.This incentive stays active until W_p has become sufficiently negative to deter further expansion.Because θ is public information, this policy is anticipated, so that $m^e(\theta,\theta) = M^c(\theta,\theta)$.

[17] All realizations of θ-shocks are assumed to be positive.
[18] Both conditions share the property that the real exchange rate effect of domestic monetary expansion is effectively ignored in the coopertaive optimum.

The policymaker would like to announce the policy $m = 0$ but in the absence of a commitment technology such a commitment is not credible.Thus, we end up with positive inflation $p > 0$ but with output at the natural rate, $x = 0$[19]. Moreover,since monetary policies are perfectly anticipated, the real exchange rate is equal to its natural level $Z(\theta,\theta)= 0$ for all θ.

Non-cooperative policy

In the absence of cooperation, policymakers no longer ignore the real exchange rate effects of monetary policy. We rewrite the condition presented in condition (2.8) :

$$W_p(P_m + P_z Z_m) + W_x X_m = 0$$

The policymaker now perceives the existence of additional marginal cost when considering an expansion of m. This expansion generates a real depreciation, whereby higher prices of imported goods add further to CPI-inflation. Again, policy is perfectly anticipated such that $m^e(\theta,\theta) = M^N(\theta,\theta)$ and $x = 0$, for all θ.These lead to $M^N(\theta,\theta) < M^c(\theta,\theta)$.Clearly then p is always higher in the cooperative regime, which makes the outcome strictly worse in the noncooperative regime.And again, by a symmetric outcome in the foreign country we have that $z = 0$.

Thus, perceived exchanged rate effects provide a disincentive to inflate, which by itself creates a contractionary bias in monetary policy. Clearly, a tradeoff rises: cooperation is helpful in promoting more efficient stabilization, but unhelpful in not putting a check on the domestic incentive problem.Whether the benefits outweight the cost depends on whether the coordination problem is more serious than the credibility problem.

Rogoff (1985) implies that gains from cooperation can be insured only when appropriate domestic institutions are in place. Canzoneri and Henderson (1988) intepret this oucome in terms of coalitions :cooperation between a subset of the players in a game does not necessarily produce better outcome for these players, though cooperation by the grand coalition of all players would.

[19] This is nothing but the well-known Barro-Gordon inflation bias.

Part C: Coordination of fiscal and monetary policies in a monetary union

In this part we examine the case of fiscal interactions in a monetary union. A full monetary union, in which a single money is managed by a common central bank, can actually be perceived as the complete form of monetary policy cooperation. In this case, there is an interaction between this single monetary authority and the decentralized fiscal policies.

There have been several studies of monetary-fiscal interaction in a monetary union. Most of them consider the purpose of public goods to be the provision of public goods; for example Sibert (1992), Levine and Brociner (1994) and Beetsma and Bovenberg (1998). Other works have studied the desirability of fiscal constraints within a monetary union.On the one hand, Chari and Kehoe (1998) and Dornbusch (1997) argue that fiscal constraints are not necessary, and possibly harmful, when the monetary authority can commit its policies. On the other hand, Beetsma and Bovenberg (1995) and Beetsma and Uhlig (1999) argue that fiscal constraints improve welfare because they correct the debt bias stemming from government myopia.

In addition, the existing studies on the welfare effects of fiscal coordination within a monetary union generate conflicting results. Fiscal coordination is beneficial when there is a free-rider problem that results in too much debt being issued, as in Chari and Kehoe (1998) and Huber (1998). In the model of Beetsma and Bovenberg (1998), however, fiscal cooperation harms welfare when it is set before monetary policy because it enhances the strategic position of fiscal policies vis-a-vis the monetary authority.With monetary commitment, debt is too high from a social welfare perspective but not the government's perspective, give its myopia.

We will demonstrate a model of fiscal coordination within a monetary union. More specifically the one stated by Dixit and Lambertini (2001) , focusing on the countercyclical role of fiscal policy. Dixit and Lambertini (2001) consider a central bank and a government with possibly conflicting goals over output and inflation, and study the equilibria with and without monetary commitment ,including Nash and leadership equilibria. Dixit and Lambertini (2000a) study in detail the case where fiscal and monetary authorities agree about the ideal levels of output and inflation.

Cooper and Kempf (2000) analyze monetary and fiscal policy with and without monetary union in a two-country setting where the monetary and fiscal authorities agree on the policy goals.In this model the two authorities share a budget constraint. When the monetary authority has leadership, a monetary union is Pareto-improving.However, if the fiscal authorities have leadership or monetary transfers to the fiscal authorities are constrained, a monetary union is welfare improving only if the aggregate shocks are highly correlated.

C.1. The model

Dixit and Lambertini (2001) use a Barro and Gordon (1983) type model with n countries belonging to a monetary union. There is a common central bank, which applies monetary policy, and n fiscal authorities, one in each member country. The policy variable that the central bank chooses is the money supply or a nomial interest rate, denoted as π_0 [20].The fiscal authority in country i chooses a poliy variable x_i[21], which can be government spending on goods and services or a cut in taxation.

The output level in country i are given by:

$$y_i = \bar{Y}_i + \sum_j \alpha_{ij} x_j + b_i(\pi - \pi^e) \qquad , i = 1,...,n \qquad (3.1)$$

where $\bar{Y}_i$ is the natural level of output of country

or in vector-matrix form:

$$y = \bar{Y} + Ax + (\pi - \pi^e)b. \qquad (3.1^*)$$

[20] Higher π_0 means a more expansionary monetary policy.
[21] A higher x_i means a more expanisonary fiscal policy.

where π^e is the inflation expected by the private sector

The common inflation level is given by

$$\pi = \pi_0 + \sum_i c_i x_i = \pi_{0} + c'x. \qquad (3.2)$$

The variable a_{ii} shows the effect on output if that country's own fiscal policy, and the a_{ij} the spillovers of that country's fiscal policy on others. These spillovers are a kind of externality in our model and can be positive for Keynesian demand effects and negative for crowding out effects. The matrix A summarizes the fiscal policy own and cross effects, the vector b for the supply effects of suprise inflation and the vector c captures the effects of fiscal policies on inflation. We denote the whole vector of these variables as

$$z = [\bar{Y}, A, b, c]$$

In addition we make the assumption that the private sector's expectations are rational and formed before any of these shocks is realized and before the policy variables are chosen.Thus,

$$\pi^e = E_z[\pi(z)] = \int \pi(z) \qquad (3.3)$$

Each fiscal authority wants to minimize its loss function defined by:

$$L_i^F = \frac{1}{2}\theta_i^F (y_i - y_i^F)^2 + \frac{1}{2}(\pi - \pi_i^F)^2, \qquad (3.4)$$

where y_i^F and π_i^F are the ideal levels of output and inflation respective for the fiscal authorities of country i. It may be actually $y_i^F > \bar{Y}_i$, so extra output is desirable.

The common central bank minimizes a similar loss function

$$L^M = \frac{1}{2} \sum_i \theta_i^M (y_i - y_i^M)^2 + \frac{1}{2}(\pi - \pi^M)^2 \qquad (3.5)$$

where y_i^M and π^M are the output and inflation goal for monetary authority, or according to matrix notation,

$$L^M = \frac{1}{2}(y(z) - y^M)'\Theta^M(y(z) - y^M) + \frac{1}{2}(\pi(z) - \pi^M)^2 \quad (3.5^*)$$

where y^M is the vector of output goals and Θ^M is the diagonal matrix with entries θ_i^M .

In addition, we assume that that the central bank is at least as conservative as all fiscal authorities in all respects.That is:

$$y_i^M < y_i^F, \quad \pi^M < \pi_i^F, \quad \theta_i^M \leq \frac{\theta_i^F}{n} \qquad \text{for all i.} \quad (3.6)$$

We also assume that fiscal policy is by definition discretionary while monetary policy can be commited or discretionary.The assumed timing of events is the following:

1) If monetary policy is discretionary, nothing happens. But if it is under commitment , the common central bank chooses its policy rule $\pi_0(z)$.
2) The private agents form expectations about the inflation; that is π^e .
3) The stohastic shocks are realized.
4) If monetary policy is discretionary, the central bank chooses π_0 .On the other hand if the monetary policy functions under commitment implements policy rule $\pi_0(z)$ chosen at step 1.
5) The fiscal authority in each country chooses x_i [22].

We now proceed now to the investigation for equilibria corresponding to the different regimes of discretion and commitment for the central bank and the fiscal authorities.

[22] When both policies are discretionary, they may be chosen simultaneously or sequentially, cooresponding to Nash and Stackelberg equilibria.

C.2 Discretionary policies

In the case that both fiscal and monetary authorities function discretionary, we can identify two possible games. In the first game the authorities choose their policy simultaneously while in the second we assume that the monetary authority has the leadership advantage[23]. We examine these two cases more closely.

C.2.1 *Nash equilibrium*

As we mentioned, in this case the fiscal and monetary authorities act simultaneously, or as we stated in section C.1 steps (4) and (5) occur simultaneously.
The first order condition of (3.4), after we substitute (3.3), with respect to x_i gives:

$$\theta_i^F (y_i - y_i^F)(a_{ii} + b_i c_i) + (\pi - \pi_i^F) c_i = 0 \qquad (3.6)$$

The first order condition of (3.5), with respect to π_0 is :

$$\sum_i \theta_i^M (y_i - y_i^M) b_i + (\pi - \pi^M) = 0 \qquad (3.7)$$

Substituting for y_i from (3.6) into (3.7) and solving for π, we get:

$$\pi = \frac{\pi^M - \sum_i k_i \pi_i^F - \theta_i^M b_i \left(y_i^F - y_i^M\right)}{1 - \sum_i k_i} \qquad (3.8),$$

where $k_i = \dfrac{\theta_i^M}{\theta_i^F} \quad \dfrac{b_i}{b_i + a_{ii} / c_i}$.

[23] Or in other words, the monetary authority acts as a Stackelberg leader.

Since all a_{ii} and c_i are positive, all k_i are also positive. Using assumption (3.6) about the relative conservatism of the monetary authority, we have that $k_i < \frac{1}{n}$ and $\sum_i k_i < 1$.

Therefore,

$$\pi < \frac{\pi^M - \sum_i k_i \pi_i^F}{1 - \sum_i k_i} = \pi^M < \pi_i^F \quad \text{for all i.} \qquad (3.9)$$

and,

$$y_i = y_i^F - \frac{c_i}{\theta_i^F (b_i c_i + a_{ii})} (\pi - \pi_i^F) > y_i^F > y_i^M \qquad \text{for all i.} \quad (3.10)$$

The result, as it is obvious, is beyond what monetary and fiscal desire. More specifically, the outcome is too high output and too low inflation and is more extreme than the ideal goals for each policy maker.The intuition is that the policy makers act simultaneously and in a non-cooperative framework.

C.2.2 *Monetary leadership* [24]

We now assume that the common central bank acts first as a Stackelberg leader and fiscal authorities act after they observe this action. In other words, monetary policy is chosen at step (4) and fiscal policies at step (5). Dixit and Lambertini (2001) use a matrix notation to produce their results.

First, we define as $h_i \equiv \theta_i^F \left(\frac{a_{ii}}{c_i} + b_i \right)$ and H the diagonal matrix with entries h_i .

In this case, we can write (3.6) in matrix notation[25] as:

[24] The same apply when there is fiscal leadership.

[25] (3.6) was divided with c_i and then it is trasformated into matrices.

$$H\,[\,y(z) - y^F\,] + \pi(z)\,e - \pi^F = 0 \qquad (3.11)$$

where e is a a unit vector of dimension n x 1. Substituting for output and inflation, fiscal policy is given by

$$x(z) = J^{-1}\,[\,-(Hb + e)\,\pi_0\,(z) - H(\bar{Y} - b\pi^e - y^F) - \pi^F\,], \qquad (3.12)$$

where $J \equiv H\,(A + bc') + ec'$.

Inflation and output, taking into account the action of fiscal authority at step (5) are respectively:

$$\pi(z) = [\,1 - c'\,J^{-1}\,(Hb + e)]\,\pi_0(z) - c'\,J^{-1}\,[H(\bar{Y} - b\pi^e - y^F) - \pi^F\,] \qquad (3.13)$$

and

$$y(z) = y^F - H^{-1}\,\{[1 - c'\,J^{-1}\,(Hb + e)]\,\pi_0(z) - c'\,J^{-1}\,[H\,(\bar{Y} - b\pi^e - \pi^F\,]\}e + H^{-1}\pi^F \quad (3.14)$$

Under discretionary monetary leadership, the common central bank minimizes her loss function (3.5*) subject to (3.13) and (3.14). The first order condition for the monetary authority in this case is[26]:

$$[\,-(y(z) - y^M)'\Theta^M\,H^{-1}\,e + \pi(z) - \pi^M\,]\,[\,1 - c'\,J^{-1}\,(Hb + e)\,] = 0 \quad \text{or equivalently,}$$

$$-(y(z) - y^M)'\Theta^M\,H^{-1}\,e + \pi(z) - \pi^M = 0\;^{27} \qquad (3.15)$$

Solving (3.13) for π(z) and substituting to (3.15), we solve for π and get:

$$\pi = \frac{\pi^M + \left(\pi^F\right)' H^{-1}\Theta^M H^{-1} e + (y^F - y^M)\Theta^M H^{-1} e}{1 + e' H^{-1}\Theta^M H^{-1} e}$$

[26] We substituted (3.13) and (3.14) in (3.5*).

[27] Since $[\,1 - c'\,J^{-1}\,(Hb + e)\,]$ for all states z.

which is larger than a weighted average of the ideal inflation rates of all authorities since, under Dixit and Lambertini's (2001) assumptions H and Θ^M have all positive entries and $(y^F - y^M)$ is a vector with positive components.

It is obvious that the previous amount depends on the differences in ideal outputs between monetary and fiscal authorities.This outcome is not necessarily as extreme as the Nash equilibrium in the previous section.For instance, if $y^F = y^M$, π is a weighted average of all the ideal inflation rates.

C.2.3 *Monetary commitment*

Finally, we examine the regime where the monetary authority can commit itself to a monetary rule. The common central bank now minimizes its loss function subject to (3.3).The Lagrangean for this problem is:

$$L = \int \{ \frac{1}{2} (y(z) - y^M)' \Theta^M (y(z) - y^M) + \frac{1}{2} (\pi(z) - \pi^M)^2 - \lambda\pi(z)\} + \lambda\pi^e \qquad (3.16)$$

where λ is the Langrangean multiplier fot the constraint (3.3), and y(z) and $\pi(z)$ are given as function of $\pi_0(z)$ by (3.13) and (3.14). The first-order condition with respect to $\pi_0(z)$ gives

$$[- (y(z) - y^M)' \Theta^M H^{-1} + \pi(z) - \pi^M - \lambda] \ [1 - c'J^{-1} (Hb + e)] = 0$$

Since $1 - c'J^{-1} (Hb + e) \neq 0$ with probability 1, we get:

$$- (y(z) - y^M)' \Theta^M H^{-1} + \pi(z) - \pi^M - \lambda = 0 \qquad (3.17)$$

The first-order condition with respect to π^e gives:

$$\lambda + \int [- (y(z) - y^M)' \Theta^M H^{-1} + \pi(z) - \pi^M - \lambda] [c'J^{-1} Hb] = 0 \qquad (3.18)$$

Combining (3.17) and (3.18) we get that:

$$\lambda = 0$$

Inserting $\lambda = 0$ to (3.17) simplifies to

$$-(y(z) - y^M)' \, \Theta^M H^{-1} + \pi(z) - \pi^M = 0$$

which is exactly the same with (3.15)-that is the first-order condition for dicretionary monetary leadership.Using (3.13) and (3.15) we get solutions for $\pi(z)$ and $y(z)$. This outcome shows that the existence of fiscal discretion totally negates any value of monetary commitment by the common central bank.

C.3 Discussion

The non-cooperative interaction of monetary and fiscal authorities leads to a race between contractionay monetary policy that aims to reduce inflation and expanionary fiscal policy that aims to raise output. As it was illustrated, the resulting Nash equilibrium is characterized by both inflation and output more extreme than the ideal levels of all authorities in a monetary union. Dixit and Lambertini (2001) suggest that this outcome may be avoided if the ideal points of the monetary authority coincide with those of all fiscal authorities ex ante. That is

$y_i^F = y_i^M = y_i^*$, $\pi_i^F = \pi^M$ for all countries i.

In this case all of the above equilibria collapse to

$y_i(z) = y_i^*$, $\pi(z) = \pi^*$ for all i,z.

Thus, if the authorities' preferences can be made to coincide, the ideal goals for inflation and output can be attained. In any case that that monetary and fiscal authority are in disagreement then giving either authority a leadership role produces less extreme and more desirable outcomes.

Conclusion

In this essay we tried to investigate the theoretical framework of policy coordination. More specifically, the models that were used involve the main types of policy cooperation and interdependence; coordination of fiscal policies, coordination of monetary policies and fiscal and monetary interactions in a monetary union. Our findings showed that when frictions are present –in our model the externalities- cooperation between authorities of different countries increases the total -or global- welfare. But if there are some additional frictions then cooperation may be undesirable.In our models we showed that in the case of a noncooperative regime, the quantities are inefficiently low because of the 'race' between the authorities of different countries.

In addition, we introduced the credibility or time-inconsitency problem and showed that in this case, it is not efficient for policies to be coordinated. In the case of the monetary union, we showed that fiscal and monetary authorities can achieve Pareto Optimal when they both share the same preferences about inflation and output.

The matter of economic cooperation and interdependence becomes more and more crucial among economists and policymakers and that is why huge research has been conducted in this field. This research includes additionally a dynamic approach and a multi-country framework. In any case, as we illustrated in our model above the questionwhether or not it is efficient for countries to cooperate may not have a clear theoretical answer and must certainly be associated with empirical evidence.

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