DOCUMENTOS DE ECONOMIA Y FINANZAS INTERNACIONALES

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December 2000

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Coordination of fiscal policies in a monetary union

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April 2000

[1]This paper is a revised version of the third chapter of my Ph. D. Dissertation. I wish to thank the Thesis committee, in particular Juan F. Jimeno, and my adviser Oscar Bajo-Rubio, for their helpful suggestions. Previous versions were presented at the International Symposium on Economic Modelling (Maribor, July 1999), and the Research Seminar of the Laboratoire de Macroéconomie at CREST (Paris, December 1999). Financial support from the Spanish Ministry of Education through the Project PB98-0546-C02-01, as well as from the Spanish Institute for Fiscal Studies and Fundación de las Cajas de Ahorros Confederadas, is also gratefully acknowledged. Of course, all the remaining errors are my own.

Abstract

This paper examines how the member countries of a monetary union react to country-specific shocks and to shocks from the rest of the world, when the budget deficit is the only policy instrument available. We develop a three-country model in which countries show different preferences regarding objectives, and face asymmetric disturbances. Two of the countries form a monetary union where an independent central bank controls monetary policy, and fiscal policy is determined by fiscal authorities at the national level. In this framework, we analyse in strategic terms how authorities can deal with monetary, real and supply shocks using fiscal policy with stabilizing purposes. Finally, we discuss the welfare aspects of the optimal solution and the extent to which a coordinated fiscal policy may influence the performance and evolution of the monetary union.

Key words: Monetary union, fiscal policy, policy coordination.
JEL Classification: E61, E62, F42.

1 Introduction

One of the main implications of a monetary union is the loss of the exchange rate and monetary policy as instruments of macroeconomic stabilization. In the absence of fully flexible prices and wages, as well as labour mobility, as adjustment mechanisms, governments have to deal with shocks using mainly fiscal policy. The implications of a monetary union regarding fiscal policy will depend on the asymmetry of the shocks, since country-specific shocks could difficult the working of the union. Bayoumi and Eichengreen (1993) stress that the costs of the European monetary union will be larger if the countries have to deal with asymmetric shocks, which require country-specific adjustment policies. On the other hand, Erkel-Rousse and Mélitz (1995) conclude that fiscal policy is an important adjustment instrument when facing asymmetric shocks. More recently, Driver and Wren-Lewis (1999) find that the potential costs of a European monetary union following an asymmetric shock are significant, in particular if fiscal policy is not used as a stabilization tool (similar results can be found in Díaz-Roldán (2000a)). Because of that, we will analyse in this paper how fiscal policy could deal with asymmetric shocks in a monetary union.

Unlike the wide range of studies on monetary policy coordination, the available literature has hardly discussed the possibility of fiscal policy coordination. We could mention, among others, Kehoe (1987), Turnovsky (1988), Tabellini (1990), Boscá and Orts (1991), Frenkel and Razin (1992), Razin and Sadka (1994), van Aarle and Huart (1997) and Dixon and Santoni (1997); however, all of them analyse two-country models, although Kehoe extends the results to a multi-country model. In general, the results obtained do not support fiscal policy coordination. On the other hand, none of these studies present models explicitly designed for a monetary union; an exception is De Bonis (1994), who develops a model for a monetary union (formed by two countries), and analyses monetary and fiscal policy coordination between the monetary union and the rest of the world.

Given the interdependence that a monetary union implies, the question is whether fiscal policy coordination may be preferable to non-cooperative solutions. A recent line of research has discussed the advantages of fiscal policy coordination in the European monetary union. The institutional framework provided by the Maastricht Treaty, regarding excessive deficits, can be interpreted as a rule of cooperation. But imposing limits on deficits do not reduce risk. As noticed by Boscá and Orts (1991), the Maastricht criteria do not assure an efficient fiscal policy, unless the limits are the result of acting cooperatively. Buiter *et al.* (1993) conclude that in the European monetary union, uncoordinated fiscal policies may be inefficient but it is not possible to determine if they lead to an excessive deficit. More recent studies discuss the implications of the fiscal discipline enforced by the Pact for Stability and Growth (see e.g. Eichengreen and Wyplosz (1998) and Obstfeld and Peri (1998)). It has been argued that the Stability Pact represents a more complex rule of cooperation, since its constraints are more restrictive than the limits of the Maastricht Treaty, reducing fiscal policy flexibility and the extent of automatic stabilization. But the need of fiscal policy coordination in a monetary union is still an open issue.

The aim of this paper is to try to offer a response to that question, by showing different hypothesis on the scenario and evolution of a monetary union. This will let us know under which conditions fiscal policy coordination might be useful.

As mentioned earlier, most studies on fiscal policy coordination do not develop a model for a monetary union and they do not always include the supply side either. The only exception, to our knowledge, is De Bonis (1994), who develops a three-country model (two of them forming the monetary union, and the rest of the world) but, when analysing the possibilities of coordination, she studies the interaction between the monetary union and the rest of the world, which is equivalent to analyse a two-country model.

In this paper, we will develop an aggregate demand-aggregate supply three-country model in which countries show different preferences regarding objectives, and face asymmetric disturbances. Two of the countries form a monetary union where an independent central bank controls monetary policy, and fiscal policy is determined by fiscal authorities at the national level. The budget deficit is the only instrument used to reach the economic policy targets, and fiscal authorities have to choose the optimal budget deficit in each country in order to deal with monetary, real and supply shocks. The authorities can act individually or cooperatively and, in the rest of the paper, we identify authorities' cooperation with policy coordination.

As an original contribution of this paper, the supply side is embodied into the model, and a model explicitly designed for a monetary union is developed. Moreover, when analysing the role of fiscal policy to face shocks from both a member country of the union and the rest of the world, we treat variables from the rest of the world as endogenous; in other words, we develop a model for a "big" monetary union. An important result derived from our analysis is that the desirability of fiscal policy coordination is not only related to the characteristics of the shocks, but is also related to how their effects are transmitted across countries. In particular, the role played by the channels of transmission of the shocks (the aggregate demand, and the interest rate and the exchange rate) will prove to be crucial for the results.

The main results of the paper are, first, that fiscal policy coordination between the member countries of the union would be counterproductive when aggregate demand is the channel of transmission of the shocks, independently of the nature (demand-side or supply-side) and the origin of the shocks (a country of the union or the rest of the world). Second, when the interest rate and the exchange rate act as the channel of transmission of the shocks, cooperation would be counterproductive only against real shocks from the monetary union. However, cooperation would result useful for the rest of the cases; that is, when dealing with real shocks from the rest of the world, and with monetary and supply shocks independently of their origin.

The rest of the paper is structured as follows. In section 2 a theoretical model for a monetary union is developed, which will allow us to study the effects of shocks on the union's member countries. Next, in section 3 we analyse in strategic terms how the authorities can deal with shocks using fiscal policy with stabilizing purposes. We also show how fiscal policy coordination may internalize the spillover effects of an individual decision, and how the superiority of the cooperative solution would depend on the nature of the disturbances, the channel of transmission, and the asymmetry of the preferences. In section 4, we discuss the welfare aspects of the optimal solution and the extent to which a common fiscal policy may influence the performance and evolution of the monetary union. Finally, in section 5 we present the main conclusions.

2 The model

We have two symmetric economies: a monetary union and the rest of the world, with flexible exchange rates and perfect capital mobility between them. All the variables are defined as rates of change and those from the rest of the world are denoted with an asterisk.

The monetary union is described by the following set of equations, where all parameters, denoted by Greek letters, are nonnegative:

$$y = -\alpha r_{\mathrm{W}} + \gamma g + \beta(e_{\mathrm{W}} + p^{*} - p) + \delta y^{*} + f \tag{1}$$

$$m - p = \theta y - \psi r_{\mathrm{W}} \tag{2}$$

$$p_c = (1 - \mu)p + \mu(p^{*} + e_{\mathrm{W}}) \tag{3}$$

$$w - \varepsilon p_c = \phi prod - \eta u + z - v \tag{4}$$

$$p - w = -\phi prod - \varphi u \tag{5}$$

$$y = n + prod \tag{6}$$

Equation (1) represents the goods market equilibrium condition. Output, y, depends on the world interest rate r_{W}, the budget deficit g, the real exchange rate between the union and the rest of the world $(e_{\mathrm{W}} + p^{*} - p)$, the rest of the world's output y^{*}, and a positive real shock f. Notice that the assumption of perfect capital mobility implies that $r = r^{*} = r_{\mathrm{W}}$. We also assume that the Marsall-Lerner condition holds, so that a real exchange rate depreciation leads to a positive effect on the balance of trade and output of the monetary union, which implies β to be positive.

Equation (2) shows the money market equilibrium condition, where m denotes the union's money supply, and the demand for money depends on the union's output and the world interest rate.

Equations (3) to (6) represent the aggregate supply of the economy, built along the lines of Layard, Nickell and Jackman's (1991) model (see also Nickell (1990) for a survey). Equation (3) is the definition of the consumer price index, p_c, as a weighted average of the union goods' and the imported goods' prices in terms of the common currency.

Equation (4) shows that nominal wages, w, are determined by the degree of indexation with respect to the consumer price index, depending on ε; labour productivity, *prod*; the unemployment rate, u; wage pressure factors, z; and the way in which agents form their expectations, captured by the variable v.

The parameter ε denotes the degree of wage rigidity, with $0 \leqq \varepsilon \leqq 1$. The value $\varepsilon = 1$ implies real wage rigidity, so that nominal wages are fully indexed to changes in the consumer price index p_c; whereas if $\varepsilon = 0$ we have nominal wage rigidity. In our model, we will assume the intermediate case so that $0 < \varepsilon < 1$.

On the other hand, the effects of expectations on the consumer price index is captured by the variable v. In a "*New Classical Macroeconomics*" framework, assuming rational expectations, the discrepancies between the actual change in the consumer price index and its expected change is due to random agents' mistakes, i.e.: $p_c - p_c^e = error$, so that $v = \varepsilon\ error$, and if *error* is equal to zero (i.e. the agents do not make mistakes), the unemployment rate obtained from equations (4) and (5) will be the *natural rate of unemployment.* Alternatively, in a "*New Keynesian Macroeconomics*" framework, if the agents form their expectations assuming that the expected change of the consumer price index is equal to its change in the previous period, $p_c^e = p_{c,-1}$, then $p_c - p_c^e = p_c - p_{c,-1} = \Delta\ p_c$, and $v = \varepsilon \Delta\ p_c$ would capture changes in the inflation rate for the consumer price index. Then, if when $\Delta\ p_c = 0$, the unemployment rate obtained from equations (4) and (5) will be the *NAIRU.* Therefore, this general formulation allows us to include both models (*New Classical* and *New Keynesian*) as particular cases.

In equation (5), prices, p, are formed by adding a margin to wages, which depends on productivity, *prod*, and the unemployment rate, u. We also assume that the parameter ϕ is the same that in the wage equation (4). This assumption, which simplifies the analysis without altering the basic results, is commonly used in the literature, and is justified since in the long term productivity changes do not affect the unemployment rate (see e.g. Layard, Nickell and Jackman (1991)).

Finally, equation (6) defines changes in output as the sum of changes in employment, n , and productivity, *prod* .

The second economy analysed is the rest of the world. As mentioned earlier, we develop a model for two symmetric economies; consequently, equations describing the rest of the world are equivalent to the monetary union's equations. We also assume asymmetric shocks in origin leading to different effects on the union and the rest of the world:

$$y^* = -\alpha r_{\mathrm{W}} - \beta(e_{\mathrm{W}} + p^* - p) + \delta y + f^* \tag{7}$$

$$m^* - p^* = \theta y^* - \psi r_{\mathrm{W}} \tag{8}$$

$$p_c^* = (1-\mu)p^* + \mu(p - e_{\mathrm{W}}) \tag{9}$$

$$w^* - \varepsilon p_c^* = \phi prod^* - \eta u^* + z^* - v^* \tag{10}$$

$$p^* - w^* = -\phi prod^* - \varphi u^* \tag{11}$$

$$y^* = n^* + prod^* \tag{12}$$

Notice that in the goods market equilibrium condition, we neglect the fiscal variable g^*, which is implicitly included in the real shock f^*, since our aim is to study the role of the member countries' fiscal policies when dealing with exogenous shocks.

The countries of the union

In order to study the interaction between the member countries of the monetary union and the extent to which fiscal authorities can deal with shocks, we need to know the economic framework of the member countries 1 and 2.

The set of equations for country 1 is the following:

$$y_1 = -\alpha r_{\mathrm{W}} + \gamma g_1 + \beta(e_{\mathrm{W}} + p^* - p_1) + \beta(p_2 - p_1) + \delta y^* + \delta(y_2 - y_1) + f_1 \tag{13}$$

$$p_{c1} = \frac{(1-\mu)}{2}p_1 + \frac{(1-\mu)}{2}p_2 + \mu(p^* + e_{\mathrm{W}}) \tag{14}$$

$$w_1 - \varepsilon p_{c_1} = \phi prod_1 - \eta u_1 + z_1 - v_1 \tag{15}$$

$$p_1 - w_1 = -\phi prod_1 - \varphi u_1 \tag{16}$$

$$y_1 = n_1 + prod_1 \tag{17}$$

We assume that coefficient β is the same for both the price differential between the union's countries (notice that nominal exchange rate disappears in this case), and the real exchange rate between the union and the rest of the world. In a similar way, coefficient δ is the same for the output of country 2 and the output of the rest of the world. Different assumptions would not change the basic results.

The set of equations for country 2 would be similar.

Finally, the money market equilibrium condition -equation (2)- is common to the two countries. We can rewrite it as follows:

$$m - \frac{1}{2}p_1 - \frac{1}{2}p_2 = \frac{\theta}{2}y_1 + \frac{\theta}{2}y_2 - \psi r_{\mathrm{W}} \tag{18}$$

Notice that, since all the variables are in rates of change, the variables of the monetary union are equal to the weighted sum of the member countries' variables, and we can assume that their relative weights reflect the bargaining power of each country inside the union. That is, for any variable x:

$$x = \frac{Y_1}{Y}x_1 + \frac{Y_2}{Y}x_2$$

where x, x_1, x_2 are the rates of change of each variable for the union, country 1, and country 2 respectively; Y, Y_1, Y_2 are their levels of output, and $Y_1 + Y_2 = Y$. For convenience, we have assumed $\frac{Y_1}{Y} = \frac{Y_2}{Y} = \frac{1}{2}$. So, from the weighted sum of equations (13) to (17) and the corresponding equations for country 2, we can obtain equations (1), and (3) to (6).

The transmission of the shocks

From equations (1) to (6) and (7) to (12), replacing $u = l - n$ (where l denotes active population), and assuming equilibrium in the goods market, we can obtain the reduced forms for the monetary union and the rest of the world[1].

$$y = a_y m \pm b_y m^* + c_y g + d_y f \pm h_y f^* - i_y s - j_y s^* \tag{19}$$

$$y^* = a_y m^* \pm b_y m \pm k_y g + d_y f^* \pm h_y f - i_y s^* - j_y s \tag{20}$$

[1]The detailed derivation of all the equations in the paper, together with the definition of the coefficients, can be seen in Díaz-Roldán (2000b).

$$p = a_p m \pm b_p m^* + c_p g + d_p f + h_p f^* + i_p s + j_p s^* \quad (21)$$

$$p^* = a_p m^* \pm b_p m + k_p g + d_p f^* + h_p f + i_p s^* + j_p s \quad (22)$$

where, to simplify, all the exogenous supply shocks have been grouped in a contractionary disturbance s:

$$s = z - v - \tfrac{1}{\lambda} l - \tfrac{1}{\lambda} prod$$

so that s embodies the negative effect on output of an increase in the degree of wage pressure, z, as well as the positive effects of increases in expectations errors, v, active population, l, and productivity, $prod$; and, in a similar way, for the foreign country:

$$s^* = z^* - v^* - \tfrac{1}{\lambda} l^* - \tfrac{1}{\lambda} prod^*$$

where $\lambda = \frac{1}{\eta + \varphi}$.

Equations (19) to (22) show the interdependence between the two economies, given by the interaction of the variables. On the other hand, if the variables of the monetary union are equal to the weighted sum of the member countries' variables, and the interaction taking place between them is equivalent to the interaction between the union and the rest of the world, we could rewrite the preceding equations as follows[2]:

$$y_1 = a_y m \pm b_y^{'} m^* + c_y^{'} g_1 \pm c_y^{''} g_2 + d_y^{'} f_1 \pm d_y^{''} f_2 \pm h_y^{'} f^* - i_y^{'} s_1 - i_y^{''} s_2 - j_y^{'} s^* \quad (23)$$

$$y_2 = a_y m \pm b_y^{''} m^* + c_y^{'} g_2 \pm c_y^{''} g_1 + d_y^{'} f_2 \pm d_y^{''} f_1 \pm h_y^{''} f^* - i_y^{'} s_2 - i_y^{''} s_1 - j_y^{''} s^* \quad (24)$$

$$y^* = a_y m^* \pm b_y m \pm k_y^{'} g_1 \pm k_y^{''} g_2 + d_y f^* \pm h_y^{'} f_1 \pm h_y^{''} f_2 - i_y s^* - j_y^{'} s_1 - j_y^{''} s_2 \quad (25)$$

[2] See footnote 1.

$$p_1 = a_p m \pm b_p^{'} m^* + c_p^{'} g_1 + c_p^{''} g_2 + d_p^{'} f_1 + d_p^{''} f_2 + h_p^{'} f^* + i_p^{'} s_1 + i_p^{''} s_2 + j_p^{'} s^* \quad (26)$$

$$p_2 = a_p m \pm b_p^{''} m^* + c_p^{'} g_2 + c_p^{''} g_1 + d_p^{'} f_2 + d_p^{''} f_1 + h_p^{''} f^* + i_p^{'} s_2 + i_p^{''} s_1 + j_p^{''} s^* \quad (27)$$

$$p^* = a_p m^* \pm b_p m + k_p^{'} g_1 + k_p^{''} g_2 + d_p f^* + h_p^{'} f_1 + h_p^{''} f_2 + i_p s^* + j_p^{'} s_1 + j_p^{''} s_2 \quad (28)$$

The reduced form given by equations (19) to (22) shows the interaction among the two countries of the union and the rest of the world.

Notice that we have two kinds of monetary shocks: the monetary policy instrument of the union's monetary authority (m) and monetary shocks from the rest of the world (m^*). On the other hand, regarding real and supply shocks, we can observe shocks from both the union's countries (f_1,f_2,s_1,s_2), and the rest of the world (f^*, s^*).

If we look at the equations (23) to (28) we find that a negative supply shock affecting one of the countries of the union (s_1, $s_2 > 0$) or the rest of the world ($s^* > 0$), leads to an output fall and a rise in prices both in the union and in the rest of the world, being this effect independent of the channel of transmission and the origin of the shock.

On the contrary, as can be seen from equations (23) to (28), positive demand shocks, lead to positive effects on the output and prices of the country of origin of the shock. But when the shock is transmitted across the countries of the union, and between every member country and the rest of the world, the sign of the coefficients depends on which channel of transmission prevails. In our model, the channels of transmission of the demand shocks are the aggregate demand, the interest rate, the real exchange rate between the union and the rest of the world, and the monetary union's relative prices.

An increase in the money supply $(m, m^* > 0)$ -positive monetary shocks, in general- , an increase in the budget deficit of the member countries of the monetary union (g_1, $g_2 > 0$), and positive real shocks (f_1, f_2, $f^* > 0$) lead to an increase in output. When aggregate demand prevails, the result is the *"locomotive effect"*: the effects on the output and prices of the country of origin of the shock are transmitted to the rest of the economies with the same sign. We find an aggregate demand expansion with an output expansion and a rise in prices in all the involved economies.

But when changes in the interest rate and real exchange rate prevail, the result is the "*beggar-thy-neighbour effect*": the effects on the output and prices of the country of origin of the shock are transmitted to the rest of the economies with the opposite sign. The reason is that a real exchange rate depreciation (appreciation) in an economy leads to an aggregate demand expansion (contraction) in that economy, and to a contraction (expansion) in the other, given that which means a depreciation (appreciation) for an economy, means an appreciation (depreciation) for the other. An increase in the money supply of the monetary union ($m > 0$), increases output and leads to an exchange rate depreciation between the monetary union and the rest of the world; consequently, the monetary union's output and prices rise, but output and prices fall in the rest of the world. The case of a positive money supply shock from the rest of the world ($m^* > 0$) to the monetary union, would be symmetric.

Regarding real disturbances, both an increase in the budget deficit of the member countries (g_1, $g_2 > 0$) and positive shocks to the monetary union (f_1, $f_2 > 0$) lead to an expansion in aggregate demand that is partially offset by a real exchange rate appreciation. This appreciation reduces aggregate supply in the rest of the world, which translates to the union's member countries. The result is that the output of the country suffering the shock rises, and the output of the other country and the rest of the world fall, with prices always rising. The case of a positive real shock from the rest of the world ($f^* > 0$) would be symmetric.

We have just shown the transmission of macroeconomic shocks affecting interdependent economies, and the extent to which the fiscal policy adopted by the member countries' governments in a monetary union, generates externalities in the rest of the economies. The purpose of the next section is to show how international policy coordination may internalize these spillover effects.

3 Fiscal policy coordination in a monetary union

The theoretical arguments supporting policy coordination are based on the idea that cooperation internalizes the effects of economic interdependence. In this way we need to take into account the strategic behaviour of the authorities, so we will use the Game Theory approach in order to study how the authorities can deal with shocks.

We assume that countries 1 and 2 are represented by their fiscal authorities, which face the problem of minimizing their loss functions:

$$L_1 = y_1^2 + \sigma_1 g_1^2 \tag{29}$$

$$L_2 = y_2^2 + \sigma_2 g_2^2 \tag{30}$$

where the target variables are the rates of change in output, (y_1, y_2), and the rates of change in the budget deficit, (g_1, g_2). The parameters $\sigma_1, \sigma_2 > 0$ are the inverse of the marginal substitution rates, i.e., the cost of reaching an objective relative to the cost of reaching the other. We assume $\sigma_1 \neq \sigma_2$, so we consider asymmetric preferences. On the other hand, the quadratic form of the loss functions implies that any change, positive or negative, in the variables will represent a loss of utility. So, each country will minimize its loss function when all the objectives are equal to zero, $y_1 = y_2 = 0$ and $g_1 = g_2 = 0$.

We are modelling a monetary union where the monetary authority (a common central bank) controls the price target, so the latter has not been included in the loss function of the fiscal authorities. However, the fact that the disciplining effects of a monetary union imply some restrictions on the budget deficit, leads us to include this as an objective of the fiscal authorities. An example of this situation is the European monetary union, where each member country will have to consider the requirements imposed by the Pact for Stability and Growth.

Alternatively, if we would have assumed that fiscal authorities do not delegate completely prices control to the common central bank, their loss function would be:

$$L_i = y_i^2 + \sigma_i g_i^2 + \pi_i p_i^2 \qquad i = 1, 2$$

It can be proved[3] that the results only differ from the case analysed in this paper (fiscal restrictions and full delegation) in the size of the coefficients. In particular, the desirability of delegating the control of prices will depend on the effects of the shock on the economy, the use of the deficit as instrument, and the degree of aversion to changes in the instrument.

In an attempt to describe more accurately the European monetary union, in the rest of the paper we will make use of the loss functions represented by equations (29) and (30). Notice that we have assumed that the loss function is the fiscal authority's loss function, as well as a fiscal policy is used with stabilization purposes but is constrained by the monetary union's restrictions. For that reason, we can also assume that fiscal authorities will be more averse to changes in the budget deficit than in output (in terms of the loss function, $\sigma_1, \sigma_2 > 1$). So, the best solution will be that leading to the lowest deviation of the budget deficit from zero. Therefore, the solutions leading to a lower change in the budget deficit would guarantee the fulfilment of the fiscal restrictions, but would question the stabilization function of fiscal policy.

Now we will show the effects of fiscal authorities' decisions when they cope with shocks. For this reason, we will analyse how they will react when facing shocks that affect both the money market (m, m^*) and the goods market (f_1, f_2, f^*), shifting the aggregate demand curve; and when facing supply shocks (s_1, s_2, s^*), which shift the aggregate supply curve.

Each fiscal authority of the monetary union has to minimize its loss function by choosing the optimal rate of change of the budget deficit, subject to the restrictions imposed by the international economic framework. According to the Game Theory literature, we will focus our analysis in the comparison between the competitive solution and the cooperative solution. In any case, the solutions will depend on the prevailing channel of transmission: the aggregate demand, or the interest rate and the real exchange rate. So, we will solve the problem for these two alternative cases.

The "locomotive effect"

When aggregate demand is the prevailing channel of transmission, the restrictions that fiscal authorities have to consider when solving their optimization problem are as follows[4]:

[3]See footnote 1.

[4]These restrictions come from equations (23) and (24), when demand shocks are

$$y_1 = a_y m + b_y^{'} m^* + c_y^{'} g_1 + c_y^{''} g_2 + d_y^{'} f_1 + d_y^{''} f_2$$

$$+h_y^{'} f^* - i_y^{'} s_1 - i_y^{''} s_2 - j_y^{'} s^* \quad (31)$$

$$y_2 = a_y m + b_y^{''} m^* + c_y^{'} g_2 + c_y^{''} g_1 + d_y^{'} f_2 + d_y^{''} f_1$$

$$+h_y^{''} f^* - i_y^{'} s_2 - i_y^{''} s_1 - j_y^{''} s^* \quad (32)$$

a) Non-cooperative solution: The competitive solution

When each country solves the problem individually, ignoring interdependence and taking as given the other country's policy, the solution is the Nash-Cournot equilibrium. The optimization problem of country 1 is as follows:

$$\min_{g_1} L_1 = y_1^2 + \sigma_1 g_1^2$$
$$s.t.(31) \quad (33)$$

From the first-order condition we obtain the reaction function of country 1, which shows the response to shocks and to changes in country 2's policy:

$$g_{R,1} = -R_{1,1} g_2 - R_{1,2} f_1 - R_{1,3} f_2 - R_{1,4} f^* - R_{1,5} m - R_{1,6} m^*$$

$$+R_{1,7} s_1 + R_{1,8} s_2 + R_{1,9} s^* \quad (34)$$

where $R_{1,i} > 0, i = 1, ..., 9$.

The problem for country 2 is similar:

$$\min_{g_2} L_2 = y_2^2 + \sigma_2 g_2^2 \quad (35)$$
$$s.t.(32)$$

from which we obtain:

transmitted with the same sign.

$$g_{R,2} = -R_{2,1}g_1 - R_{2,2}f_1 - R_{2,3}f_2 - R_{2,4}f^* - R_{2,5}m - R_{2,6}m^*$$

$$+R_{2,7}s_1 + R_{2,8}s_2 + R_{2,9}s^* \tag{36}$$

where $R_{2,i} > 0, i = 1, ..., 9$.

The absolute value of each coefficient indicates the size of the response to shocks. None of them is totally offset, because $|R| < 1$. Both reaction functions have negative slopes. The country 1's reaction function has a slope greater than one in absolute value: $\left.\frac{dg_2}{dg_1}\right|_{g_1=R(g_2)} = -\frac{1}{R_{1,1}}$, with $\left|-\frac{1}{R_{1,1}}\right| > 1$. This means that any movement along the country 1's reaction function, requires a lower change in the budget deficit in country 1 than in country 2. Solving their problems individually, and ignoring interdependence, if a country minimizes changes in its budget deficit this requires a greater variation in the other country's deficit.

The Nash-Cournot equilibrium is the point where the reaction functions of each country intersect, given by:

$$g_{N,1} = -N_{1,1}f_1 - N_{1,2}f_2 - N_{1,3}f^* - N_{1,4}m - N_{1,5}m^*$$

$$+N_{1,6}s_1 + N_{1,7}s_2 + N_{1,8}s^* \tag{37}$$

$$g_{N,2} = -N_{2,1}f_1 - N_{2,2}f_2 - N_{2,3}f^* - N_{2,4}m - N_{2,5}m^*$$

$$+N_{2,6}s_1 + N_{2,7}s_2 + N_{2,8}s^* \tag{38}$$

where $N_{1,i}$; $N_{2,i} > 0, i = 1, ..., 8$.

It can be proved[5] that the coefficients of the Nash solution are lower, in absolute value, than the coefficients of the reaction function. That is, when solving the problem individually each country acts in a "myopic" way and, since interdependence is ignored, the effects of fiscal policy are transmitted abroad.

b) Cooperative solution: The social planner problem

[5] See footnote 1.

If the countries coordinate their policies, they will minimize the weighted sum of their loss functions. Given the assumption of symmetry, and with the weights of each country equal to $\frac{1}{2}$, the social planner problem would be:

$$\min_{g_1,g_2} \mathfrak{L} = \left[\frac{1}{2}(y_1^2 + \sigma_1 g_1^2) + \frac{1}{2}(y_2^2 + \sigma_2 g_2^2)\right] \quad s.t.(31) \text{ and } (32) \tag{39}$$

From the first-order conditions we obtain:

$$g_{C,1} = -C_{1,1}f_1 - C_{1,2}f_2 - C_{1,3}f^* - C_{1,4}m - C_{1,5}m^* + C_{1,6}s_1 + C_{1,7}s_2 + C_{1,8}s^* \tag{40}$$

$$g_{C,2} = -C_{2,1}f_1 - C_{2,2}f_2 - C_{2,3}f^* - C_{2,4}m - C_{2,5}m^* + C_{2,6}s_1 + C_{2,7}s_2 + C_{2,8}s^* \tag{41}$$

where $C_{1,i}$; $C_{2,i} > 0, i = 1, ..., 8$.

The "beggar-thy-neighbour effect"

When the interest rate and the exchange act as the prevailing channels of transmission, the restrictions that fiscal authorities have to take into account to solve their optimization problem are as follows[6]:

$$y_1 = a_y m - b_y^{'} m^* + c_y^{'} g_1 - c_y^{''} g_2 + d_y^{'} f_1 - d_y^{''} f_2 - h_y^{'} f^* - i_y^{'} s_1 - i_y^{''} s_2 - j_y^{'} s^* \tag{42}$$

$$y_2 = a_y m - b_y^{''} m^* + c_y^{'} g_2 - c_y^{''} g_1 + d_y^{'} f_2 - d_y^{''} f_1 - h_y^{''} f^* - i_y^{'} s_2 - i_y^{''} s_1 - j_y^{''} s^* \tag{43}$$

[6] These restrictions come from equations (23) and (24), when demand shocks are transmitted with the opposite sign.

a) Non-cooperative solution: The competitive solution

The Nash-Cournot Equilibrium of country 1 is given by:

$$\begin{aligned} \min_{g_1} L_1 &= y_1^2 + \sigma_1 g_1^2 \\ & s.t.(42) \end{aligned} \tag{44}$$

and from the first-order condition we obtain the reaction function:

$$g_{R,1} = R'_{1,1}g_2 - R'_{1,2}f_1 + R'_{1,3}f_2 + R'_{1,4}f^* - R'_{1,5}m + R'_{1,6}m^*$$

$$+R'_{1,7}s_1 + R'_{1,8}s_2 + R'_{1,9}s^* \tag{45}$$

where $R'_{1,i} > 0, i = 1, ..., 9$.

The problem is similar for country 2:

$$\begin{aligned} \min_{g_2} L_2 &= y_2^2 + \sigma_2 g_2^2 \\ & s.t.(43) \end{aligned} \tag{46}$$

from which we obtain:

$$g_{R,2} = R'_{2,1}g_1 + R'_{2,2}f_1 - R'_{2,3}f_2 + R'_{2,4}f^* - R'_{2,5}m + R'_{2,6}m^*$$

$$+R'_{2,7}s_1 + R'_{2,8}s_2 + R'_{2,9}s^* \tag{47}$$

where $R'_{2,i} > 0, i = 1, ..., 9$.

In this case, the reaction functions have positive slopes, being the slope of the reaction function of country 1 greater than one. The Nash solution is given by the following equations:

$$g_{N,1} = -N'_{1,1}f_1 + N'_{1,2}f_2 + N'_{1,3}f^* - N'_{1,4}m + N'_{1,5}m^*$$

$$+N'_{1,6}s_1 + N'_{1,7}s_2 + N'_{1,8}s^* \tag{48}$$

$$g_{N,2} = N'_{2,1}f_1 - N'_{2,2}f_2 + N'_{2,3}f^* - N'_{2,4}m + N'_{2,5}m^*$$

$$+N'_{2,6}s_1 + N'_{2,7}s_2 + N'_{2,8}s^* \tag{49}$$

where $N'_{1,i}$; $N'_{2,i} > 0, i = 1, ..., 8$.

b) Cooperative solution: The social planner problem
Choosing again weights equal to $\frac{1}{2}$, the problem would be:

$$\min_{g_1,g_2} \mathfrak{L} = \left[\frac{1}{2}(y_1^2 + \sigma_1 g_1^2) + \frac{1}{2}(y_2^2 + \sigma_2 g_2^2)\right]$$
$$s.t.(42) \text{ and } (43) \tag{50}$$

From the first-order conditions we obtain:

$$g_{C,1} = -C'_{1,1}f_1 + C'_{1,2}f_2 + C'_{1,3}f^* - C'_{1,4}m + C'_{1,5}m^*$$

$$+C'_{1,6}s_1 + C'_{1,7}s_2 + C'_{1,8}s^* \tag{51}$$

$$g_{C,2} = C'_{2,1}f_1 - C'_{2,2}f_2 + C'_{2,3}f^* - C'_{2,4}m + C'_{2,5}m^*$$

$$+C'_{2,6}s_1 + C'_{2,7}s_2 + C'_{2,8}s^* \tag{52}$$

where $C'_{1,i}$; $C'_{2,i} > 0, i = 1, ..., 8$.

4 Welfare aspects of the optimal solution

From a theoretical point of view, the cooperative solution is Pareto superior since it internalizes the spillover effects arising from economic interdependence. These externalities, $\frac{\partial L_1}{\partial g_2}$ and $\frac{\partial L_2}{\partial g_1}$, show how the loss function of a country changes in response to changes in the other country's instrument. For that reason cooperation is Pareto superior, since the competitive solution neglects the externalities produced by changes in the policy instrument.

On the one hand, the first-order conditions from which we have obtained the Nash equilibrium are $\frac{dL_1}{dg_1} = 0$ and $\frac{dL_2}{dg_2} = 0$. But for these points $\frac{\partial L_1}{\partial g_2} \neq 0$ and $\frac{\partial L_2}{\partial g_1} \neq 0$.

On the other hand, the first-order conditions of the social planner problem are:

$$\frac{\partial \mathfrak{L}}{\partial g_1} = \frac{1}{2}\left(\frac{\partial L_1}{\partial g_1} + \frac{\partial L_2}{\partial g_1}\right) = 0 \tag{53}$$

$$\frac{\partial \mathfrak{L}}{\partial g_2} = \frac{1}{2}\left(\frac{\partial L_1}{\partial g_2} + \frac{\partial L_2}{\partial g_2}\right) = 0 \tag{54}$$

and from these conditions it is clear that $\frac{\partial L_1}{\partial g_1} = -\frac{\partial L_2}{\partial g_1}$ and $\frac{\partial L_2}{\partial g_2} = -\frac{\partial L_1}{\partial g_2}$, which shows how the cooperative solution internalizes externalities. But the desirability of the cooperative solution will depend on the nature of the externality since, if this externality has the same sign than the shock, the cooperative solution does not offset the adverse effects. Subsequently, we can conclude that cooperation may be counterproductive when it internalizes spillover effects which reinforce the effects of the shock.

In order to avoid the spillover effects of their policies, countries' authorities will try to minimize the use of the budget deficit. In this sense, they identify stabilization with avoiding changes in the policy instrument. In particular, we have modelled a loss function in which any change in the variables implies a loss of utility. Since the target variables are linear in the policy instruments, the solution that requires a lower change in the budget deficit would be the optimal solution. So, in a first step, authorities will minimize their loss function, and, in a second step, they will choose the solution (competitive or cooperative) with the lowest absolute value for the instrument:

$$g = \min\left\{\left|g_{N,i}\right|, \left|g_{C,i}\right|\right\} \;\; \forall i = 1, 2$$

It is difficult to know the size of the coefficients of the solutions, since they depend on the coefficients of the reduced form -equations (23) to (28). For that reason, in order to compare the Nash solution with the cooperative solution we will make use of graphical analysis. We will take into account both the slope of the reaction functions (negative for the "*locomotive effect*", and positive for the"*beggar-thy-neighbour effect*"), and the sign of the solutions.

The "locomotive effect"

From the reduced form -equations (31) and (32)- we can see that the objective variables (y_1, y_2) are linear in the policy instruments (g_1, g_2). Because of that, we can plot both the reaction functions and the indifference curves in the same $g_1 - g_2$ plane. For simplicity, we will not show the indifference curves.

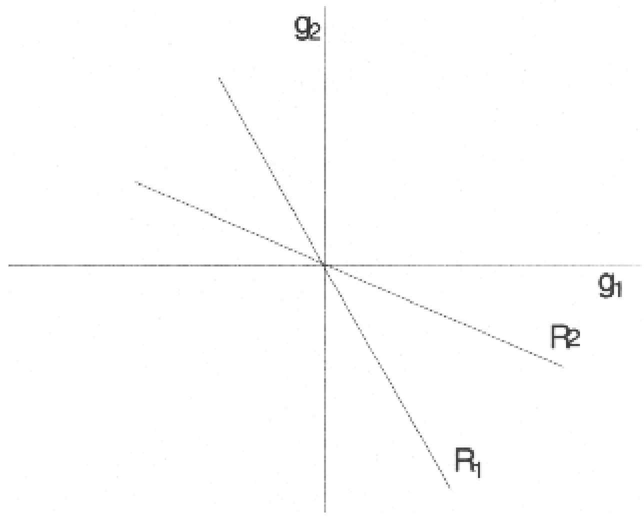

Figure 1: "Locomotive effect". Reaction functions in absence of shocks.

For the *"locomotive effect"*, the reaction functions have negative slopes. Figure 1 shows that the reaction functions intersect at the origin: none of the countries has to change its budget deficit in that point, since there are no shocks. If any disturbance takes place, the reaction functions would shift to the left or to the right according to the particular type of shock.

Figure 2 shows the reaction functions after a shock leading to an expansion in both countries. In these cases, fiscal authorities find optimal a contractive policy to offset the effects of the shock, so the reaction functions shift to the left. Equations (31) and (32) show that output expands following expansionary demand shocks $(m, m^*, f_1, f_2, f^* > 0)$ or expansionary supply shocks $(s_1, s_2, s^* < 0)$, so that the *bliss points* for countries 1 and 2 are at points $B_1 = (0, g_2 < 0)$ and $B_2 = (g_1 < 0, 0)$ respectively.

The Nash solution is at point N in Figure 2, where the reaction functions intersect. Cooperative solutions will be on the contract curve, which, by linking B_1 and $B_{2,}$ captures Pareto efficient combinations along the tangencies between the indifference curves. There are infinite cooperative solutions, but we can focus on the case in which both countries react in the same way, $g_1 = g_2$. In a symmetric model, with the same bargaining weights for each country, it is reasonable to assume that the gains and losses from cooperation would be divided equally. In that case, the solution -which is the most symmetric possible- is given by point C in Figure 2. But, in any case, cooperative solutions require a greater change in budget deficit than the Nash solution, so that cooperation would be counterproductive.

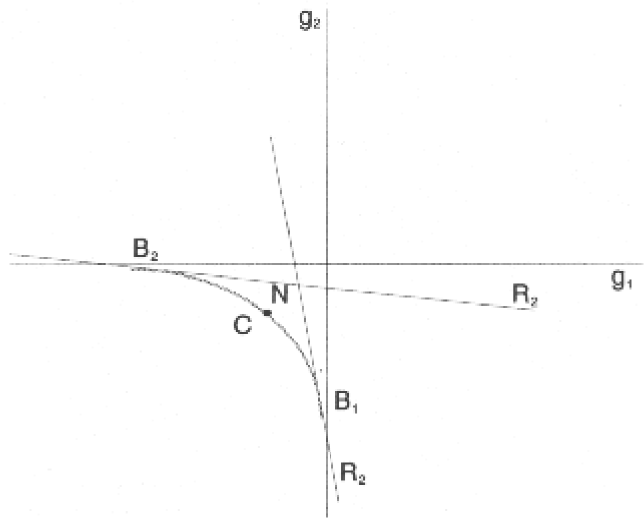

Figure 2: "Locomotive effect". Expansion in both countries. Cooperation counterproductive.

If we depict the case of a shock leading to a recession in both countries, the reaction functions shift to the right (see Figure 3). The Nash solution is at point N in Figure 3, where the reaction functions intersect, and the symmetric cooperative case, point C, requires a greater change in budget deficit than the Nash solution; so that cooperation would be again counterproductive.

We have just shown that, when aggregate demand is the channel of transmission of the shocks, fiscal policy coordination between the member countries of the union would be counterproductive. This is so because cooperation requires a greater change in budget deficit than in the competitive solution, independently of the nature and the origin of the shocks.

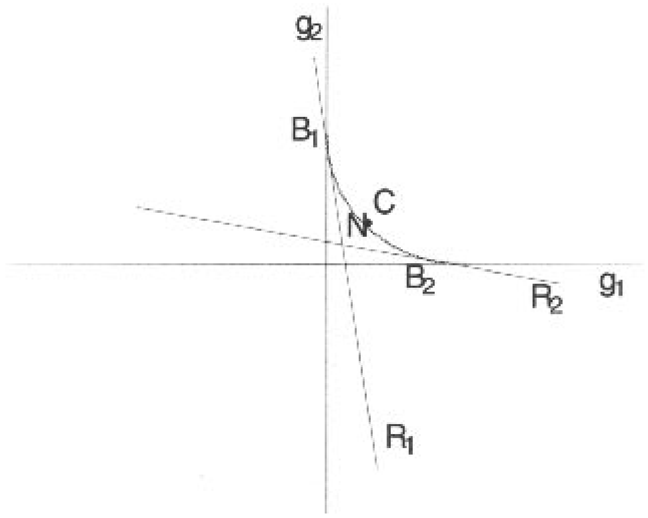

Figure 3: "Locomotive effect". Contraction in both countries. Cooperation counterproductive.

In the previous section it was shown that the cooperative solution internalizes externalities that are different from zero. When the externality has the same sign than the shock, the cooperative solution reinforces the adverse effects of the shock. It can be proved that, for the "*locomotive effect*" case[7], for positive shocks externalities are also positive, and for negative shocks externalities are negative. For that reason cooperation is counterproductive, since it internalizes externalities that reinforce the effect of the shock and so requires a greater change in the budget deficit. Then, in order to avoid some of these adverse effects, it would be preferable not to coordinate.

The "beggar-thy-neighbour effect"

For the "*beggar-thy-neighbour effect*", the reaction functions have positive slopes. Figure 4 shows that the reaction functions intersect at the origin, where none of the countries has to change its budget deficit.

When changes in the interest rate and in the exchange rate are the prevailing channel of transmission, expansionary (contractionary) real shocks in a country translate into contractions (expansions) for the other country ($f_1 > 0, f_2 < 0$ or $f_1 < 0, f_2 > 0$). When the output of a country expands, the

[7]See footnote 1.

output of the other falls (see equations (42) and (43)). Figure 5 and Figure 6 show the alternative possibilities, where the symmetric cooperative solution is given by point C . In both cases, cooperation would result counterproductive since the cooperative solution requires a greater change in the budget deficit as compared to the Nash solution.

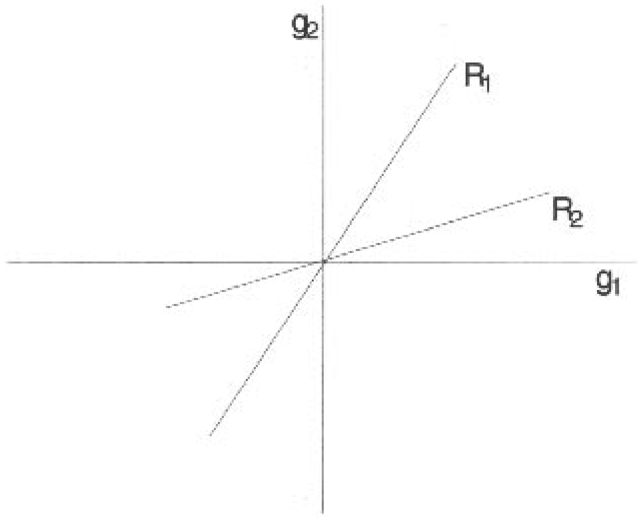

Figure 4: "Beggar-thy-neighbour". Reaction functions in absence of shocks.

On the other hand, we should also consider shocks that expand output in both countries: expansionary monetary and supply shocks from the union ($m > 0$, $s_{1,} s_2 < 0$), or contractionary demand shocks and expansionary supply shocks from the rest of the world ($m^*, f^*, s^* < 0$). Figure 7 shows that the reaction functions of countries 1 and 2 shift to the left and to the right respectively, and cooperation - represented in the figure by the symmetric case at point C - would result useful since it requires a lower change in budget deficit in both countries.

Similarly, contractionary monetary and supply shocks from the union ($m < 0$, $s_{1,} s_2 > 0$), or expansionary demand shocks and contractionary supply shocks from the rest of the world ($m^*, f^*, s^* > 0$), lead to an output fall in both countries. Figure 8 shows that the reaction function of countries 1 and 2 shift to the right and to the left respectively, and cooperation - given by the symmetric solution at point C- would result useful again since it requires a lower change in budget deficit in both countries.

It can be proved that for the *"beggar-thy-neighbour effect"*, in the case of real shocks from the union (f_1, f_2) externalities have the same sign than the shock (see equations (42) and (43)). Because of that, cooperation is counterproductive since it reinforces the effects of the shock and requires a greater change in the budget deficit. But for the rest of shocks (i.e., monetary and supply shocks from the union (m, s_1, s_2) and any shock from the rest of the world (m^*, f^*, s^*)), externalities have the opposite sign. In those cases, the cooperative solution offsets the adverse effects, so cooperation proves to be useful.

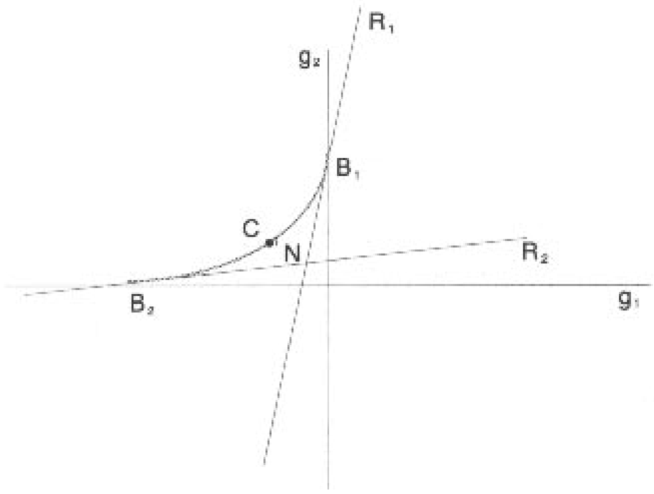

Figure 5: "Beggar-thy-neighbour". Expansion in country 1 and contraction in country 2. Cooperation counterproductive.

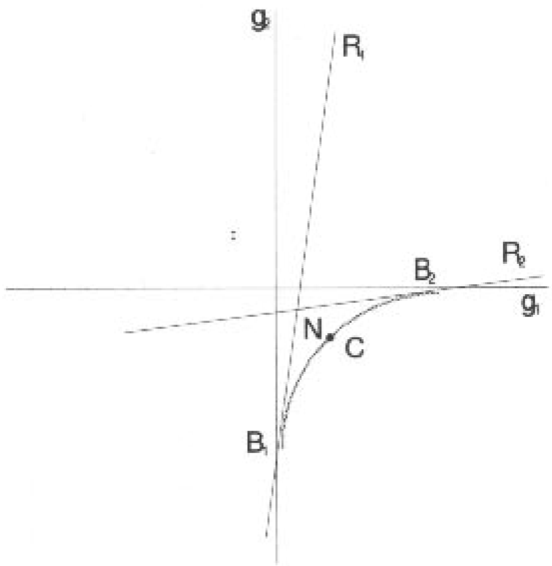

Figure 6: "Beggar-thy-neighbour". Contraction in country 1 and expansion in country 2. Cooperation counterproductive.

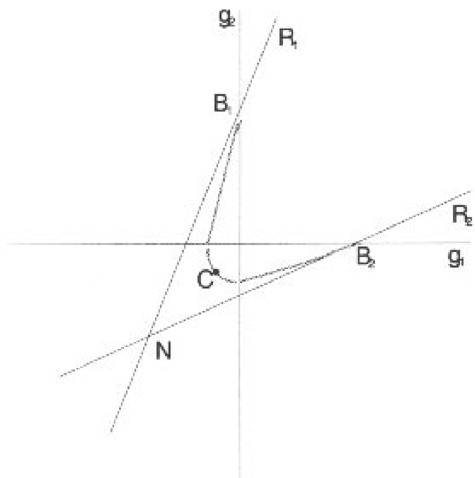

Figure 7: "Beggar-thy-neighbour". Expansion in both countries. Cooperation useful.

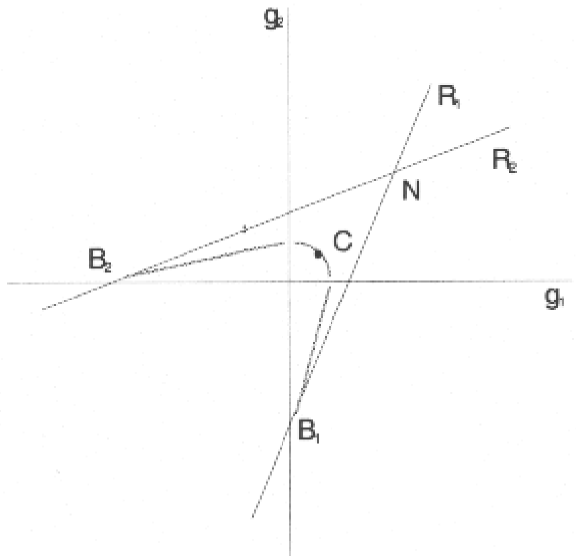

Figure 8: "Beggar-thy-neighbour". Contraction in both countries. Cooperation useful.

Summarising the results obtained, we could derive the conditions under which coordination of fiscal policies might be useful. These conditions are presented in Table 4.1, and we can conclude that the results are determined not only by the asymmetry of the shock, but also by its nature (monetary, real or supply-side). When the "*locomotive effect*" case holds, cooperation always would result counterproductive; but for the "*beggar-thy-neighbour*" case, cooperation would be counterproductive only for real shocks originated within the monetary union.

TABLE 4.1

DESIRABILITY OF FISCAL POLICY COORDINATION

SHOCK	COOPERATION
Monetary (m, m^*)	• "Locomotive effect": **counterproductive**. • "Beggar-thy-neigbour effect": **useful**
Real (f_1, f_2, f^*)	• "Locomotive effect": **counterproductive**. • "Beggar-thy-neigbour effect": **counterproductive** when the shock is originated within the monetary union, and **useful** for the rest of cases.
Supply (s_1, s_2, s^*)	• "Locomotive effect": **counterproductive**. • "Beggar-thy-neigbour effect": **useful**

5 Conclusions

In this paper we have tried to examine one of the main implications of a monetary union. In absence of monetary policy, the authorities have to deal with shocks using fiscal policy with stabilization purposes, but the disciplining effects of a monetary union may require some limitations on the public debt and the budget deficit of its member countries. For that reason, we have focused on the analysis of how the member countries of a monetary union react to country-specific shocks and to shocks from the rest of the world. It is also assumed that the budget deficit is the only instrument used to face shocks, and that some restrictions exist on the use of fiscal policy instruments.

In order to examine these questions, we have developed a three-country model in which countries show different preferences regarding objectives, and face asymmetric shocks. Two of the countries form a monetary union where an independent central bank controls monetary policy, and fiscal policy is determined by fiscal authorities at the national level. Unlike other studies on the subject, the model has been explicitly designed for a monetary union, where the channel of transmission of the shocks is determinant for the results.

In our model, supply shocks have unambiguous effects on endogenous variables. On the contrary, the effects of demand shocks will depend on the channel of transmission: when aggregate demand prevails, the result is the "*locomotive effect*", whereas if changes in the interest rate and real exchange rate prevail, the result is the "*beggar-thy-neighbour effect*".

After analysing the solutions for the two alternatives, we can conclude that:

a) For the "*locomotive effect*" case, if the authorities act individually, the solution requires a lower change in budget deficit than if they coordinate; a result that holds for any kind of disturbance. The reason is that the use of the budget deficit as a policy instrument, leads to externalities with the same sign than the shock. In these cases, cooperation would be counterproductive since it reinforces the effects of the disturbance when internalizing externalities.

This result would be in line with that obtained by Dixon and Santoni (1997), who conclude that, when government expenditures are strategic complements (which would be equivalent to our "*locomotive effect*" case) and there is a positive demand externality, the coordinated solution involves higher government expenditure than the uncoordinated solution.

b) For the "*beggar-thy-neighbour*" case, cooperation would be counterproductive only for real shocks originated within the monetary union. This is so because, when using the budget deficit as instrument, externalities have the same sign than shocks. As a result, cooperation would be counterproductive since it reinforces the effects of the shock when internalizing externalities.

On the contrary, for all the shocks from the rest of the world, as well as for monetary and supply shocks originated within the union, externalities have the opposite sign. In those cases, the cooperative solution requires a lower change in the budget deficit than in the competitive solution; then, cooperation would be useful.

To summarize, if fiscal authorities include the budget deficit as an objective in their loss function, fiscal policy coordination would be useful only provided that changes in the interest rate and the real exchange rate prevail as the channel of transmission; and, at the same time, if the probability of suffering from monetary and supply shocks originated within the union, and any kind of shock from the rest of the world, is higher. Therefore, it would be crucial to know which would be the channel of transmission and the kind of disturbances actually prevailing in a monetary union.

On the other hand, we should stress the importance of our assumption that identifies the society's loss function with the fiscal authorities' loss function. This assumption is in line with most of the available literature (surveyed in Daniels and VanHoose (1998)) which tends to identify the objective function of the policymakers with the social objective function; in addition, some of these studies suggest (e.g. Bryant (1995)) that cooperation may be counterproductive when its aim is to deviate attention from national priorities, and also when it is used to reach the particular interest of policymakers. This latter assumption has allowed us to use the criterion that the best solution is that requiring the lowest change in the budget deficit. When including the deficit as an objective, the authorities try to minimize simultaneously both changes in a macroeconomic variable (output) and changes in the fiscal policy instrument. But if they minimize the use of the instrument (budget deficit), they are giving more importance to the deficit target than to the aim of reducing the effects of the shocks. This situation may be an example of the possible reasons to be reluctant when establishing limits on the use of budget deficits in a monetary union (see, e.g., Buiter *et. al.* (1993)).

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