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Macroeconomic Policy Coordination of Interdependent Economies: the Game-Theory Approach in a Static Framework

di Juan Carlos Martinez Oliva

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Summary

The present paper aims at setting out the basic elements of the game-theory approach in a static framework. For this purpose a "beggar-thy-neighbour" world, corresponding to the case of symmetric-negative spillover, is compared with a "locomotive" world, corresponding to the case of symmetric-positive spillover. In both cases the utility outcomes from Cournot-Nash, Pareto and Stackelberg regimes are analyzed. A fixed exchange rate regime, modelled as a non-cooperative game, is also considered. The conclusions develop a number of considerations that underscore the need for some empirical implementation of the game-theory approach.

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I. Introduction (*)

Macroeconomic analysis has long dealt with the issue of policy coordination in a context of interdependent nations.

A conventional approach to the problem of evaluating the gains to be derived from the coordination of economic policies is to analyze the dynamic convergence of economic structures towards the national goals 1/. The dynamic behaviour of the economic system is examined by considering the relationship between one set of policy variables and another set of variables under the control of policy-makers in a multi-country context. An important outcome of this approach is that there is a strong case for international coordination to assure a speedy return of target variables to their target values 2/.

A crucial assumption of the approach just described, which may be considered an extension of the well-known assignment approach, is that all targets can be reached. In recent years the analysis of policy coordination has applied a set of familiar concepts from the standard duopoly theory to the standard macroeconomic modeling of open economies in order to remove this restrictive assumption. The distinctive feature of this "game-theory" or "optimizing" approach is to allow for i) the possibility of a scarcity of policy instruments, which influ-

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ences the achievement of targets; ii) the conflicts arising from the externalities represented by the impact of the policy actions of each government on their partners' economies. The view that in an interdependent world rational policy-making has game-theoretic aspects and that uncoordinated macroeconomic policies leading to Pareto-suboptimal strategies has been the ground for the pioneering contributions by Niehans (1968) and Hamada (1974, 1976). Recent contributions on this subject have been published among others by Canzoneri and Gray (1983, 1985), Hughes Hallett (1985), McKibbin and Sachs (1986), Oudiz (1985), and Oudiz and Sachs (1984) 3/.

The purpose of this paper is to set out the basic elements of the game-theory approach in a static framework, with the help of a simple two-country symmetrical model with flexible exchange rates. This model, which is developed in the Section II, represents a variant, suggested by J. Sachs, of an analysis found in Canzoneri and Gray (1983) 4/. It has been extended by Oudiz and Sachs (1984) to allow for wage indexation and imperfect capital mobility.

Different structural characteristics of national economies give rise to different cases of spillover. For this reason, in Sections III and IV we sum up the game-theoretic implications of two relevant cases, following a taxonomy proposed by Canzoneri and Gray (1985). A "beggar-thy-neighbour" world, corresponding to the case of symmetric-negative spillover, is compared with a "locomotive" world, corresponding to the case of symmetric-positive spillover. In both cases the utility outcomes from Cournot-Nash, Pareto and Stackelberg regimes are analyzed. A fixed exchange rate regime, modelled as a non-cooperative game is also considered. Finally, in the conclusions, we develop a number of considerations that underscore the need for some empirical implementation of the game-theory approach.

II. Policy Transmission under Flexible Exchange Rates

In order to avoid unnecessary complications and to give the essential outline of the analysis, we will use a highly simplified model in which two countries under flexible exchange rates are concerned with two targets, output and consumer prices, and a single policy instrument, money supply.

(1) $p = \bar{w}$

(2) $p_c = \alpha p + (1 - \alpha)(e + p^*)$

(3) $p^* = \bar{w}^*$

(4) $p_c^* = \alpha p^* + (1 - \alpha)(p - e)$

(5) $q = \delta(p^* + e - p) - \sigma i + \gamma q^*$

(6) $q^* = \delta(p - e - p^*) - \sigma i^* + \gamma q$

(7) $m - p = \varphi q - \beta i$

(8) $m^* - p^* = \varphi q^* - \beta i^*$

(9) $i = i^*$

where p represents domestic prices, w nominal wages, p_c consumer prices, e the exchange rate (domestic currency price of a unit of foreign currency), q domestic output, i the nominal interest rate, m the money stock; an asterisk denotes foreign country variables. Except for nominal interest rate, all the variables are logarithms. Greek letters are positive constant coefficients.

In Equations (1) and (3) domestic prices are assumed to be a fixed mark-up over (constant) domestic wages, Equations (2) and (4) represent consumption prices as a weighted average of domestic and foreign prices, Equations (5) and (6) give the demand for home output as an increasing function of the real exchange rate $(p^* + e - p)$, Equations (7) and (8) represent the demand for real money balances as a function of output and of the interest rate. In the last equation (9), capital is supposed to be perfectly mobile, which implies that the expected yield differential between home and foreign assets is equal to zero.

We now want to analyze the short run effects of m and m* on q, q*, e, p_c, p_c^* . Differentiating and solving Equations (5) - (8) and using (9) we get the following reduced forms:

$$(10) \qquad dq = \frac{1 - \gamma + 2\sigma\varphi/\beta}{2\varphi\Delta} dm - \frac{1 - \gamma}{2\varphi\Delta} dm^*$$

$$(11) \qquad dq^* = - \frac{1 - \gamma}{2\varphi\Delta} dm + \frac{1 - \gamma + 2\sigma\varphi/\beta}{2\varphi\Delta} dm^*$$

$$(12) \qquad de = - \frac{1 + \gamma}{2\delta\varphi} (dm^* - dm)$$

where $\Delta = 1 - \gamma + \sigma\varphi/\beta$

and, using (2) and (4): 5/

$$(13) \qquad p_c = + (1 - \alpha) e$$

$$(14) \qquad p_c^* = - (1 - \alpha) e.$$

In this symmetrical model monetary policy is negatively transmitted across countries: in accordance with the traditional "beggar-thy-neighbour" interpretation of flexible exchange rates, a domestic money expansion has a negative spillover effect by causing the exchange rate to depreciate and thus shifting demand from the foreign country to home market.

It is necessary to stress that the sign of policy multipliers depends on the particular assumpions, fixed prices and perfect capital mobility, underlying the model 5/.

For purposes of illustration we drop the assumption that w and w* are constant, adding two equations to the system (1) - (9):

(15) $w = \theta p_c$

(16) $w^* = \theta p_c^*$

and defining:

(17) $R = e + p^* - p.$

After some substitutions we get:

(18) $p = \frac{\theta (1 - \alpha) R}{1 - \theta}$

(19) $p^* = - \frac{\theta (1 - \alpha) R}{1 - \theta}$

and, using (9), Equations (5) - (8) can be rewritten as:

(5a) $q = \delta R - \sigma i + \gamma q^*$

(6a) $q^* = - \delta R - \sigma i + \gamma q$

(7a) $m - \frac{\theta (1 - \alpha) R}{1 - \theta} = \varphi q - \beta i$

(8a) $m^* - \frac{\theta (1 - \alpha) R}{1 - \theta} = \varphi q^* - \beta i$

It can be shown that for appropriate values of θ allowing for wage indexation abroad will reverse the sign of the spillover effect of domestic monetary policy and vice-versa 6/. In such a case the rise in the nominal exchange rate following a domestic monetary expansion causes p^* to fall as a consequence of the reduction in w^*, and the foreign country's competitive loss (as measured by the rise in R, the real exchange rate) is diminished in comparison with the fixed price model. At the same time foreign country output is positively influenced by the reduction of the world interest rate.

III. A "Beggar-thy-Neighbour" World

According to conventional usage, a "beggar-thy-neighbour" world is one in which an expansionary monetary policy in one country causes a contraction in economic activity abroad 7/. To analyze the algebra of policy conflicts in such a world we write the following reduced forms, which describe, in a two-country world, the influence on output and inflation of monetary policies in both countries:

$$(20) \qquad q = b\,m - c\,m^*$$

$$(21) \qquad q^* = -\,c\,m + b\,m^* \qquad\qquad a,\ b,\ c > 0$$

$$(22) \qquad p_c = \bar{p} - a\,(m^* - m)$$

$$(23) \qquad p_c^* = \bar{p} - a\,(m - m^*)$$

where all the variables are percentage changes.

Equations (20) - (23) are a simplified representation of (10) -(14). The additional term $\bar{p}$ has been included in (22) - (23), in order to represent an exogenous disturbance on consumer prices in both countries 8/. As will be seen below, this term plays a crucial role in the subsequent analysis.

Given the reduced forms (20) - (23) we can now derive the reaction functions of the authorities in both countries assuming that each authority desires to maximize its quadratic utility function:

$$(24) \qquad \max_{m}\ U = -\frac{1}{2}\ (\bar{q}^2 + w\ \bar{p}_c^2)$$

$$(25) \qquad \max_{m^*}\ U = -\frac{1}{2}\ (\bar{q}^{*2} + w\ \bar{p}_c^{*2})$$

where $\bar{q}$, $\bar{q}^*$, $\bar{p}_c$ and $\bar{p}_c^*$ must be interpreted as deviations from the target values, which are assumed to be zero.

The first-order condition to maximize each utility function, subject to its policy instrument, is:

$$\frac{\partial U}{\partial m} = \frac{\partial U}{\partial q}\frac{\partial q}{\partial m} + \frac{\partial U}{\partial p_c}\frac{\partial p_c}{\partial m} = 0 \qquad (26)$$

By substitution of (20) - (23) into (24) and (25), using (26) and collecting m and m* on the opposite sides of the equations we get:

$$m\,(b^2 + a^2\,w) = m^*\,(b\,c + a^2\,w) - w\,a\,\bar{p} \qquad (27)$$

$$m^*\,(b^2 + a^2\,w) = m\,(b\,c + a^2\,w) - w\,a\,\bar{p} \qquad (28)$$

Both reaction functions (R and R*) have positive slopes in (m*, m) space and R* is the mirror image of R (see Figure 1). It can be easily seen that since b is greater than c (home monetary policy has a stronger effect on home demand than foreign monetary policy) as results from Equations (10) and (11), we get:

$$b^2 + a^2\,w > b\,c + a^2\,w \qquad (29)$$

This means that in (m*, m) space the slope of the home reaction function is greater than one and, correspondingly, the slope of the foreign reaction function is less than one.

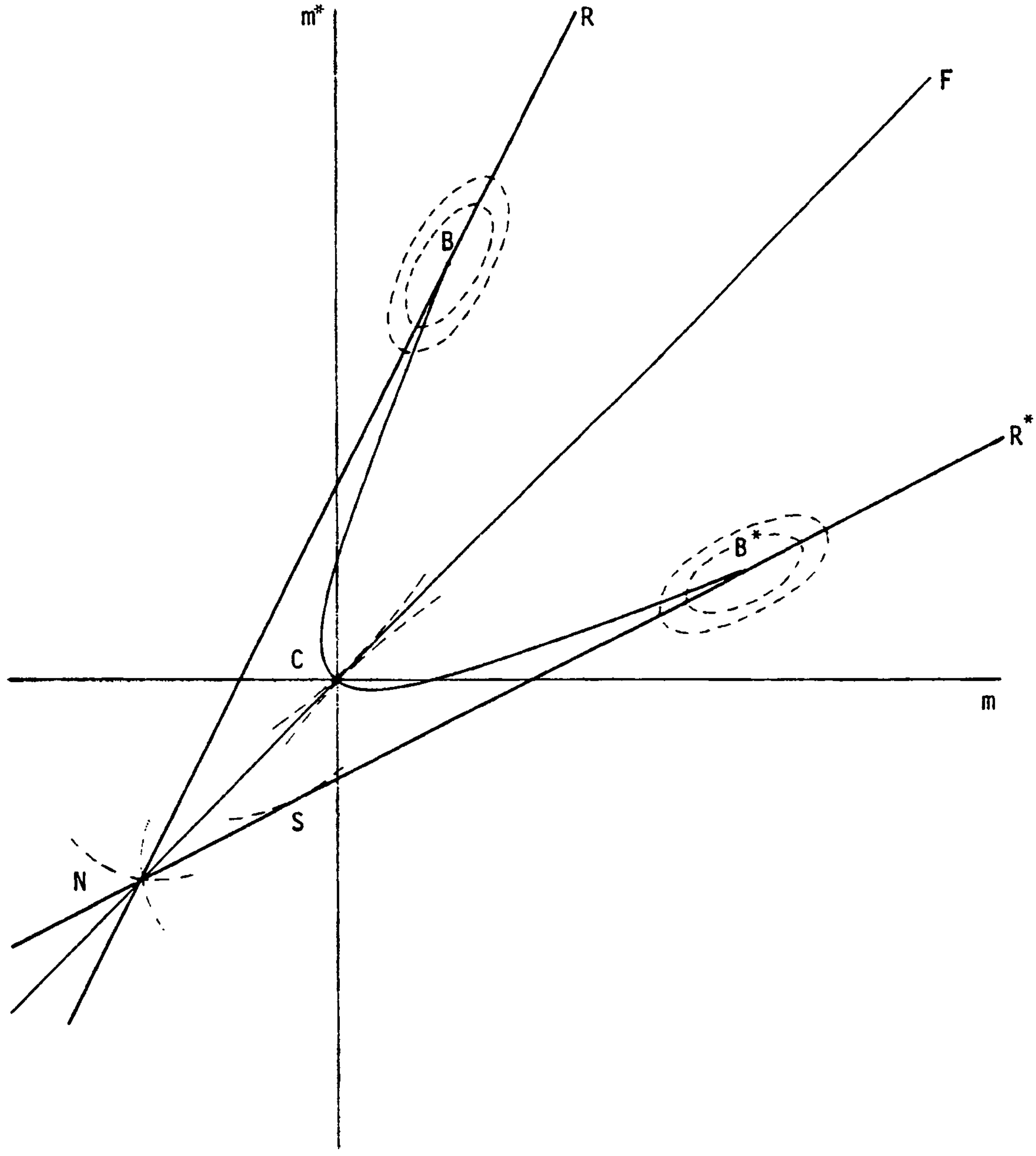
The combination of m and m* that maximizes the utility function for each country can be obtained from (20)-(23), setting the rates of change of output and consumer prices in both countries equal to their target values:

$$B = (m^*, m) = \left[\frac{\bar{p}\,b}{a(b-c)}, \frac{\bar{p}\,c}{a(b-c)}\right] \qquad (30)$$

$$B^* = (m^*, m) = \left[\frac{\bar{p}\,c}{a(b-c)}, \frac{\bar{p}\,b}{a(b-c)}\right] \qquad (31)$$

B and B* are the centers of two families of indifference curves (ellipses), respectively for the home and the foreign country,

Figure 1



each curve corresponding to a different level of utility. The two points B and B* (bliss points) represent the maximum utility. The points B and B*, lying in the first quadrant, are symmetrical and show that each country desires a more expansionary stance abroad.

It is easy to see that B and B* are incompatible. This is implied by the assumption that $\bar{p} \neq 0$. It is important to point out that for $\bar{p} = 0$, R and R* intersect at the point where $m = m^* = 0$, which is the common bliss point of both countries (see Figure 2). In this case there is no scope for coordination. We can interpret $\bar{p}$ as the effect of a disturbance affecting consumer prices in both countries. If each authority aims at reducing p_c to the initial level, as before the disturbance, there will be a conflict between their objectives.

1. Non-Cooperative and Cooperative Games

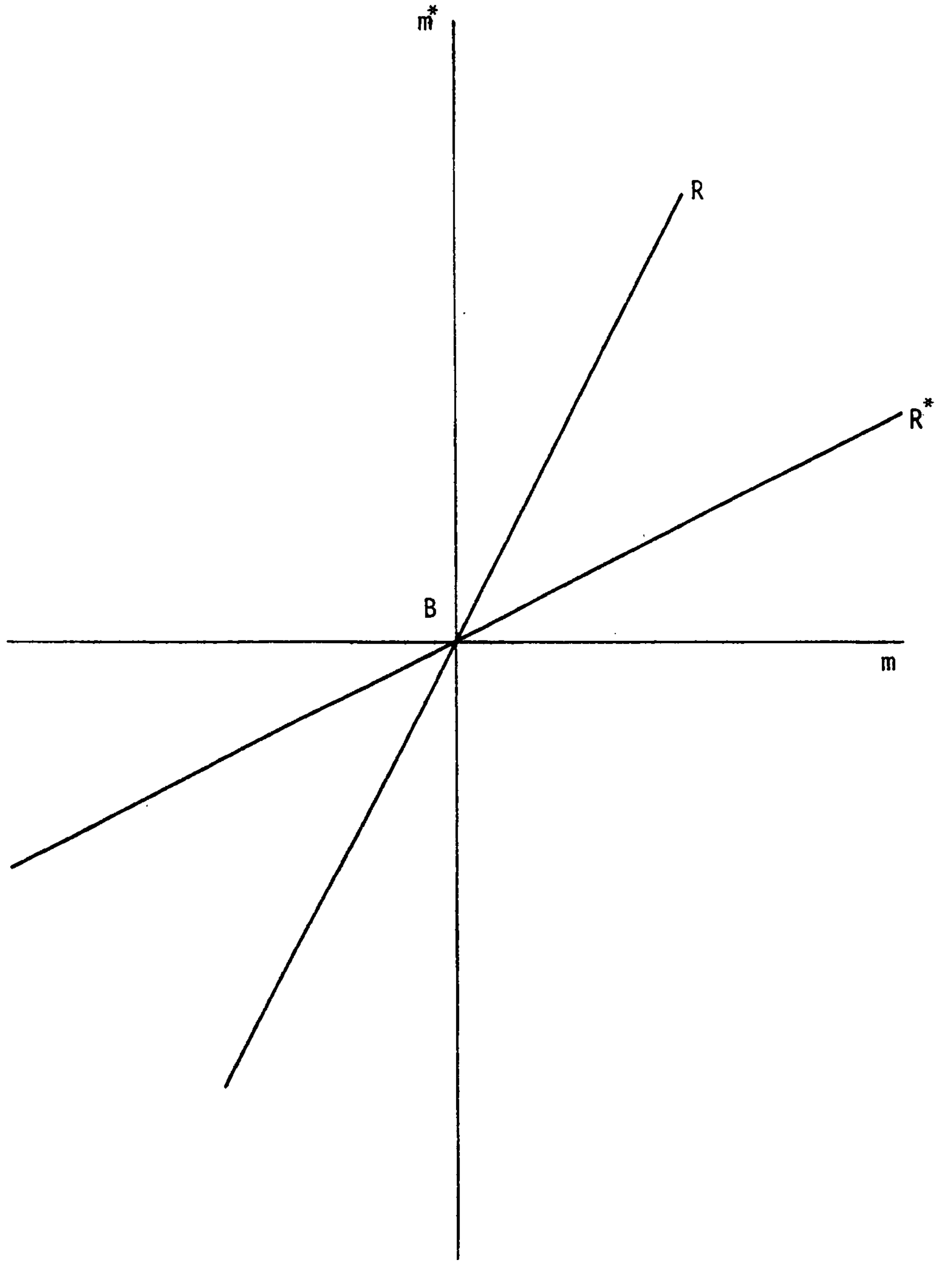
Let us suppose that the home country aims at reducing p_c by appreciating the exchange rate, i.e. by reducing m, for m* unchanged 9/. If the foreign country acts symmetrically, with each country moving along its reaction function, the final outcome is point N (threat point), which is the intersection of R and R*, at which neither country has an incentive to move away 10/. Following game theory terminology, as well as duopoly theory, this equilibrium is called the Cournot-Nash or "non-cooperative" equilibrium. Point N can be derived algebraically from (27) and (28):

$$(32) \qquad N = \left[\frac{wa\bar{p}}{b(c-b)}, \frac{wa\bar{p}}{b(c-b)}\right]$$

It lies in the third quadrant, implying a more restrictive monetary policy in both countries than in B or B*.

Let us now assume that combinations of m and m* are chosen along the "contract curve" BB*, defined as the locus of tangencies between the two utility maps drawn by the

Figure 2



indifference curves. All possible combinations of policies along the contract curves are Pareto-efficient and correspond to the so-called "cooperative solution".

It can be shown that there exists a set of cooperative solutions to which a non-cooperative solution is always inferior because it reduces the level of utility for both countries. The cooperative equilibrium can be found by optimizing a weighted sum of the two countries' utility functions subject to m and m*:

$$(33) \qquad \underset{m,m*}{\text{Max}}\, U^C = -\alpha \frac{1}{2} (q^2 + w\, p_c^2) - (1-\alpha) \frac{1}{2} (q^{*2} + w\, p_c^{*2})$$

where, in a symmetrical world α is set equal to 0.5 11/. Setting the two partial derivatives of U^C with respect to m and m* equal to zero and using (20) - (23) we get:

$$(34) \qquad C = (0,\ 0)$$

This (symmetrical) cooperative equilibrium requires a less restrictive monetary stance at home and abroad than does the Cournot-Nash equilibrium. It can be easily shown that the utility outcome from cooperation is larger than from the Cournot-Nash regime. Using (32) by inserting it in (20) - (23) and (24) - (25) we get the expression for utility in the Cournot-Nash regime:

$$(35) \qquad U^N = -\frac{1}{2} w\, \bar{p}^2 \left(\frac{w\, a^2}{b^2} + 1\right)$$

And using (34) instead of (32) as before, we get the utility in the cooperative regime:

$$(36) \qquad U^C = -\frac{1}{2} w\, \bar{p}^2$$

From (35) and (36), finally we get:

$$(37) \qquad U^C - U^N = \frac{1}{2} \frac{w^2 a^2 \bar{p}^2}{b^2} > 0$$

2. Leader-Follower Games

2.1 Stackelberg Regime

A third case can be analyzed assuming that home authorities act as leaders, maximizing their utility subject to the reaction function of the foreign authorities. The equilibrium in such a case is given by the condition that the slope of utility function U be equal to the slope of reaction function R :

$$(38) \qquad \left(\frac{d\,m^*}{d\,m}\right)_U = \left(\frac{d\,m^*}{d\,m}\right)_{R^*}$$

Using (24), by the implicit-function derivation rule we get:

$$(39) \qquad \left(\frac{d\,m^*}{d\,m}\right)_U = \frac{(b^2 + w\,a^2)\,m - (b\,c + w\,a^2)\,m^* + w\,\bar{p}\,a}{(b\,c + w\,a^2)\,m - (c^2 + w\,a^2)\,m^* + w\,\bar{p}\,a}$$

and from (28):

$$(40) \qquad \left(\frac{d\,m^*}{d\,m}\right)_{R^*} = \frac{b\,c + a^2\,w}{b^2 + a^2\,w}$$

Solving (39), (40) (using (38) and (28)) for m and m* we arrive at the following:

$$(41) \qquad m = \frac{w\,a\,\bar{p}\,(b-c)[b(b^2 + w\,a^2) + (b\,c + w\,a^2)\,(b+c)]}{\Delta} < 0$$

$$(42) \qquad m^* = \frac{w\,a\,\bar{p}\,b(b-c)[(b^2 + w\,a^2) + 2\,(b\,c + w\,a^2)]}{\Delta} < 0$$

where:

$$\Delta = -(b^2 + wa^2)\left[(b + wa^2) - (bc + wa^2)^2\right] + $$
$$+ (bc + wa^2)^2 (b^2 - c^2) < 0$$

This solution (the so-called Stackelberg equilibrium, once again from duopoly theory) is represented in Figure 1 by Point S. There it can be seen that gains from the Stackelberg equilibrium are greater than in the Cournot-Nash equilibrium. Since the slopes of home country indifference curves are zero along the intersection with the home country reaction function 12/ and increase to the right, S must be closer to B than N. Self-evidently, S is closer to B* than N.

2.2 Fixed Exchange Rate Regime

Last but not least, we suppose that the foreign authorities decide to act as fixed exchange rate followers: they choose to fix the nominal exchange rate instead of responding in accordance with their own reaction function. Schedule F in Figure 1 is the locus of all possible combinations of m and m* consistent with fixed exchange rates 13/. This schedule has a slope equal to one and passes through the point (0, 0). Since foreign authorities act as fixed rate followers, F is their new reaction function. In this situation the home country maximizes its utility function U subject to F. From condition (38) we have:

(43) $$\left(\frac{d\,m^*}{d\,m}\right)_U = \left(\frac{d\,m^*}{d\,m}\right)_F = 1.$$

Solving (43) and the equation:

(44) $$m^* = m,$$

we get $m = m^* = 0$, which is the same result we got assuming policy coordination. This result, which was first obtained by Canzoneri and Gray (1983) 14/ shows that there is a form of "non-cooperative" behaviour, i.e. fixed exchange rate leadership by the home authorities, which leads to a Pareto-optimal outcome. The loss for the home authorities is lower in the fixed rate equilibrium than in the Stackelberg equilibrium. At the same time the foreign authorities are better off as fixed exchange rate followers than as Stackelberg followers.

IV. A "Locomotive" World

In this section we will depict a case with symmetric-positive spillover, the so-called "locomotive" world. As was shown in Section II this situation is likely to occur in a world with indexed wages. The formal representation of such a situation, with a monetary expansion positively affecting economic activity abroad is:

(20a) $q = b\ m + c\ m^*$

(21a) $q^* = c\ m + b\ m^*$

(22a) $p_c = \bar{p} - a\ (m^* - m)$

(23a) $p_c^* = \bar{p} - a\ (m - m^*).$

where all the variables are percentage changes and $\bar{p}$ represents an external disturbance of consumer prices, as before.

By following the procedure already used for the symmetric-negative spillover case, using (20a) - (23a) and (24) and (25) we get:

(27a) $m\ (b^2 + w\ a^2) = -\ m^*\ (b\ c - w\ a^2) - w\ a\ \bar{p}$

(28a) $m^*\ (b^2 + w\ a^2) = -\ m\ (b\ c - w\ a^2) - w\ a\ \bar{p}.$

These are the new reaction functions for home and foreign country. Considering again that $b > c$ and assuming the condition that $b\ c > w\ a^2$, both reaction functions have a negative slope in (m*, m) space (see Figure 3). Using (20a) - (23a) we can obtain the bliss points:

$$(30a)\quad B = \left[\frac{\bar{p}\ b}{a(b+c)}\ ,\ -\ \frac{\bar{p}\ c}{a(b+c)}\right]$$

$$(31a)\quad B^* = \left[-\ \frac{\bar{p}\ c}{a(b+c)}\ ,\ \frac{\bar{p}\ c}{a(b+c)}\right]$$

In order to maximize its utility, each country requires a monetary contraction at home and a monetary expansion abroad. Figure 4 compares this result to that of Section III. Considering, as an illustration, the case of the home country, Q^- schedule is the locus of all combinations of m and m* that keep q at its target value in presence of a negative policy transmission, Q^+ is the locus of all combinations of m and m* that keep q at its target value in presence of a positive policy transmission. P_c is the locus of combinations of m and m* that keep p_c at its target value in both regimes. B^- and B^+ are the optimal combinations of m and m* in the two regimes. It should be noted that in the absence of disturbances ($\bar{p}$ = 0) B^- and B^+ coincide.

1. Non-Cooperative and Cooperative Games

Solving (27a) and (28a) for m* and m we get the Cournot-Nash solution:

$$(32a)\quad N = \left[-\ \frac{w\ a\ \bar{p}}{b(b+c)}\ ,\ -\ \frac{w\ a\ \bar{p}}{b(b+c)}\right]$$

and, following the same procedure as in Section III.1, the cooperative solution is:

$$(34a)\quad C = (0,\ 0).$$

It can be easily seen that, as in the former case, the cooperative solution has a greater utility result than the Cournot-Nash solution.

2. Leader-Follower Games

2.1. Stackelberg Regime

We now want to show that in the presence of positive spillover the Stackelberg regime does not offer a Pareto-improving outcome when compared to the Cournot-Nash solution. Once again we impose the condition (38) that the slope of the utility function U be equal to the slope of the reaction function R*:

$$(39a)\quad \frac{(b^2 + w\,a^2)m - (b\,c - w\,a^2)m^* + w\,\bar{p}\,a}{(b\,c - w\,a^2)m + (c^2 + w\,a^2)m^* - w\,\bar{p}\,a} = \frac{b\,c - w\,a^2}{b^2 + w\,a^2}.$$

Solving (39a) and (28a) for m* and m we get:

$$(41a)\quad m = - \frac{w\,a\,\bar{p}\,(b+c)\quad b(b^2 + w\,a^2) - (b\,c - w\,a^2)(b - c)}{\Delta} < 0$$

$$(42a)\quad m^* = - \frac{w\,a\,\bar{p}\,b(b + c)\,(b^2 + w\,a^2) - 2(b\,c - w\,a^2)}{\Delta} \gtrless 0$$

where :

$$(43a)\quad \Delta = (b^2 + w\,a^2)\left[(b^2 + w\,a^2)^2 - (b\,c - w\,a^2)^2\right] + \\ - (b\,c - w\,a^2)^2\,(b^2 - c^2) > 0.$$

The numerator of (41a) is unambiguosly less than zero. The sign of the numerator of (42b) may be positive or negative implying that S lies in the second quadrant for m* > 0 and in the third quadrant for m* < 0. In addition S must lie to the left of N. 15/. We will assume for the sake of illustration that m* is less than zero. It is easily seen that the Stackelberg regime does not offer a Pareto-improving outcome to both players, when compared to the Cournot-Nash solution. As Canzoneri and Gray

Figure 3

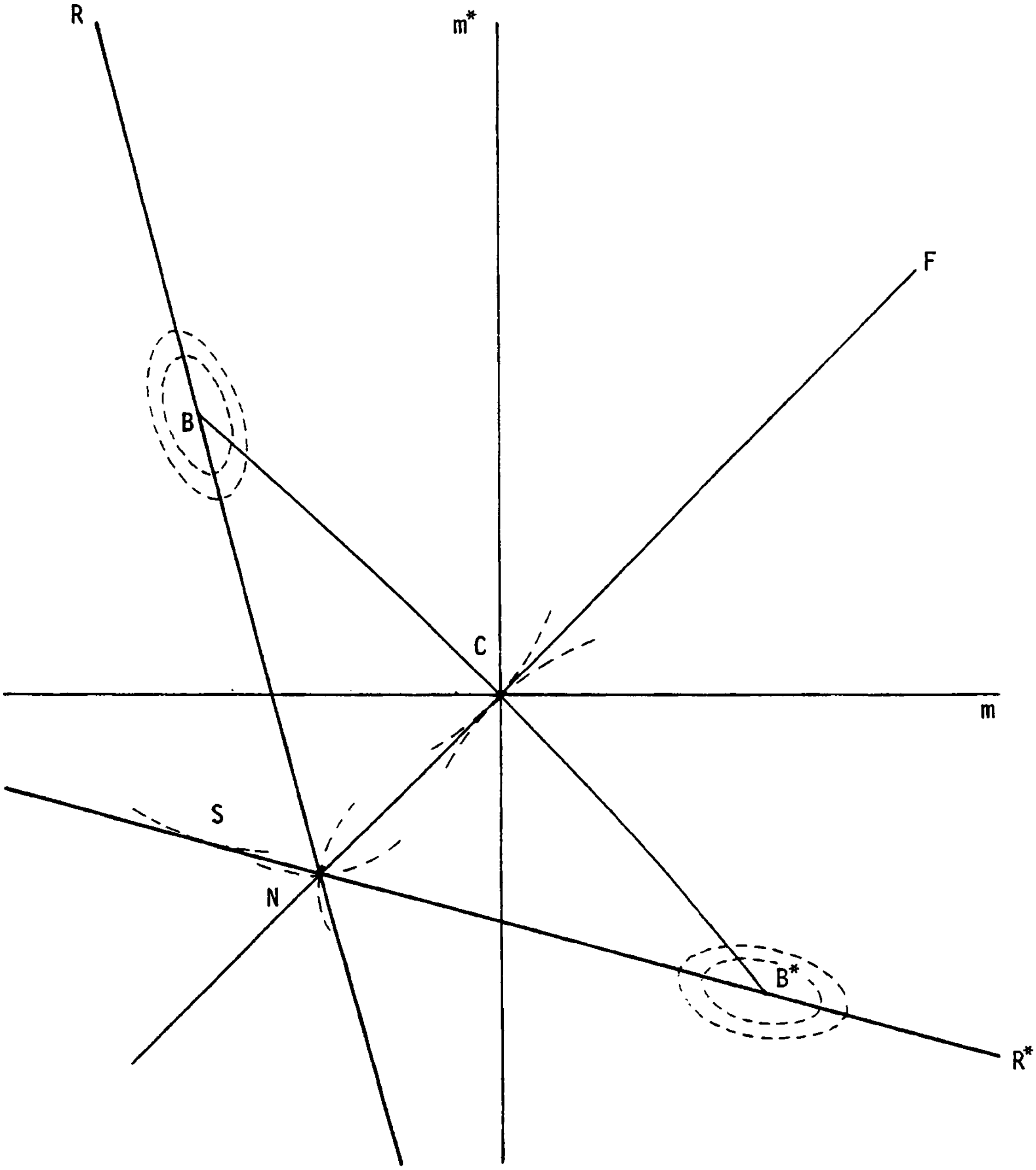
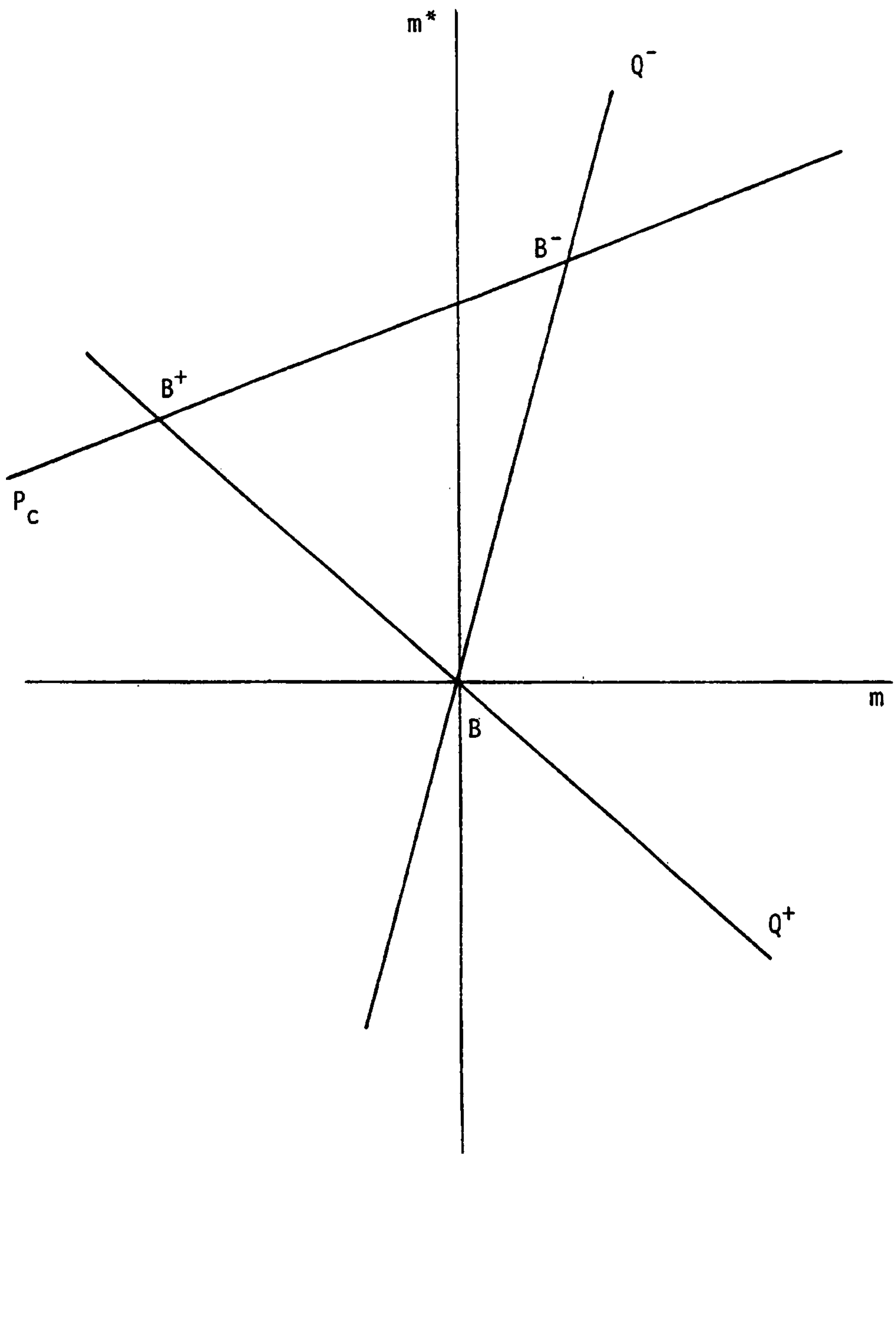


Figure 4



(1985) have pointed out, in the case of symmetric-positive spillover the leader country and the follower country have very different views on the desirability of a Stackelberg regime compared to the Cournot-Nash regime.

2.2. Fixed Exchange Rate Regime

As in the symmetric-negative spillover case, the fixed exchange rate regime offers a Pareto-optimal outcome. The difference now is that while for the follower country a fixed rate regime is clearly superior to the Cournot-Nash solution, for the leader country the situation may or may not be desirable. If for example point C is more "external" than point S with respect to B, the leader country could prefer a Stackelberg regime. However, if the follower country is allowed to choose which reaction function to offer to the leader country, the fixed exchange rate regime will prevail 16/.

V. Conclusions

In the preceding sections we have described the case of symmetric-positive and symmetric-negative spillover in a two-country world under flexible exchange rates.

The possible implications of domestic monetary policy for the rest of the world have been analyzed under different game-strategic assumptions.

The main conclusions arising from this analysis can be summarized in the following points. First, the nature and the scale of policy conflicts, as measured by the relative positions of the utility maps of both authorities, depend on a large set of parameters, including the policy multipliers, the targets of the authorities, the relative weight of each target in the utility function; and on the size of exogenous disturbances.

Second, the size and the signs of these parameters have a determinant influence on the feasibility of strategic equilibria. Third, if the rules of the game are changed, a country can be forced to change its strategic decisions.

Needless to say, the policy relevance of the game-theory approach prescriptions could be greatly increased by an empirical evaluation of the crucial parameters. Oudiz and Sachs (1984) have developed an original methodology to give empirical content to game-theory approach propositions. Unfortunately, in the light of recent research 17/ this methodology turns out to be virtually tautological. Accordingly we cannot but stress the need for further and more successful analysis in this direction.

Notes

1/ See Aoki (1981) and Cooper (1985).

2/ This result has been obtained through numerical simulations of two-country systems by Cooper (1969) and has been recently demonstrated on the basis of a rigorous formal analysis by Gandolfo (1986).

3/ Recent valuable contributions are also included in the conference issue of the Economic Studies Quarterly, Vol. 3, N° 2, June 1986 ("Symposium on the Coordination of Economic Policies between Japan and the United States") and in the conference volume edited by Buiter and Marston (1985).

4/ See Cooper (1985).

5/ A detailed analysis of the many possible implications of wage indexation and imperfect capital mobility for monetary and fiscal multipliers can be found in Oudiz and Sachs (1984).

6/ See Oudiz and Sachs (1984), p.14.

7/ This is the sense in which the term is used by Canzoneri and Gray (1985). The same term is used in the opposite sense by Turnovsky and d'Orey (1986): in their "beggar-thy-neighbour" world a monetary expansion in one country is transmitted positively to the other, thereby leading to a contractionary monetary response by the foreign authorities.

8/ The existence of an exogenous disturbance is crucial to the game-theory model. See for example the oil price shock in Canzoneri and Gray (1985) and the productivity disturbance or the demand shift in Canzoneri and Henderson (1985). We want to stress that taking different sources of disturbance or modelling it in a different fashion does not change the main implications of the model.

9/ This proposition, widely used in the specific literature, reflects the belief that under the non-cooperative assumption (Nash equilibrium) players' behaviour is "naive" or "myopic". According to Johansen (1982) this belief is wrong, since decisions in accordance with the Nash non-cooperative equilibrium are to be regarded as individually rational.

10/ It is interesting to note that likewise in the well-known "cobweb theorem", point N is dynamically stable (since $b > c$). In this case, if we are at a point different from N, through iterative adjustments the system will converge on N.

11/ It should be noted that in the extreme case in which $\alpha = 1$ ($\alpha = 0$) the cooperative equilibrium is located at point B (B*). However, since in terms of welfare this equilibrium is probably inferior to Nash equilibrium for at least one country, the situation is unstable. In an asymmetrical world where one country has a much larger weight than the other, coordination may result in a point on the contract curve which is inferior to Nash for the smaller country. In this case the Nash point becomes a threat point, i.e. the point the smaller country will choose in abandoning the coordination situation. See Hughes Hallett (1985).

12/ This property, which derives from the definition of the reaction function, can be easily demonstrated by noting that setting (39) equal to zero, we obtain the home reaction function.

13/ It should be noted that this interpretation of "fixed exchange rates", which corresponds to a situation where m =

m*, is strictly connected with the peculiar choice of the basic model and cannot be considered a general definition.

14/ See also Canzoneri and Henderson (1985).

15/ This proposition can be proved by considering that since the slopes of home country utility ellipses are zero along the home country reaction function, point S could at the most coincide with point N, in the extreme case in which the slope of R* is zero and the slope of R is infinity. For $(dm^*/dm)_{R^*} < (dm^*/dm)_R < 0$, that is our basic assumption, S can be found only to the left of N.

16/ See Canzoneri and Gray (1985).

18/ See Martinez Oliva (1987).

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