C.E.P.R.E.M.A.P March 1990

THE ROLE OF A FIXED EXCHANGE RATE SYSTEM WHEN CENTRAL BANKERS ARE INDEPENDENT

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This research has received financial support from Commissariat General du Plan as part of a research program in International Economics. The author is solely responsible for the views expressed in this paper.

ABSTRACT

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It has been emphasized that, in a symmetric model, a fixed exchange rate system allows to reach the cooperative solution in the game between central bankers. However, as cooperation can be counterproductive, such a property may actually not be favorable. In this paper we reconsider this issue by introducing independent central bankers who need not share the social preferences. We show that cooperation between central bankers becomes neither productive nor counterproductive. Consequently, a fixed exchange rate system is preferred to a flexible one because it eliminates the inefficiency created by the lack of international cooperation in the choices made by countries of the central bankers themselves.

RESUME

LE ROLE D'UN SYSTEME DE CHANGE FIXE

QUAND LES BANQUES CENTRALES SONT INDEPENDANTES

On sait que, dans un modèle symétrique par rapport aux pays, un système de change fixe permet d'atteindre la solution coopérative dans le jeu entre banques centrales. Cependant, comme la coopération peut être contre-productive, une telle propriété n'est pas nécessairement favorable. Dans cet article on reconsidère cette question en introduisant des banques centrales indépendantes qui ne représentent pas nécessairement les préférences sociales. On montre que la coopération n'est alors ni productive ni contre-productive. Par conséquent, un système de change fixe est préféré à un système de change flexible parce qu'il permet d'éliminer l'inefficience créée par l'absence de coopération internationale dans le choix fait par les pays des banques centrales elles-mêmes.

Mots clefs : Système de change fixe - Union Monétaire - Banques centrales indépendantes - coopération internationale contre-productive.

Fixed exchange rate system - Monetary union - Independent central banks - Counterproductive international coopération.

J.E.L 430-310

1. INTRODUCTION

One of the good properties of a fixed exchange rate system which has been emphasized, is that it prevents countries from manipulating the exchange rate at the detriment of other countries. Thus, the negative effects of competitive depreciations or appreciations are eliminated. The argument has been given a formal content in the literature on monetary interdependence in the context of a game theoretical framework. When the exchange rate is flexible, it has been shown that the non-cooperative equilibrium is inefficient and that, in the symmetric case where countries are exactly alike (same size, same structure, same shocks), the cooperative solution can be reached in a decentralized way through a fixed exchange rate system[1].

However, such an argument in favor of a fixed exchange rate system may be weakened for two kinds of reasons. First, countries may not be in exactly the same situation. In that case a fixed exchange rate system may be detrimental by preventing the real exchange rate to fully adjust[2]. Second, even in the case of purely symmetric economies, the previous argument may actually not be favorable to fixed exchange rates because, as it has also been shown in the literature, international cooperation may be counterproductive[3]. The first argument (an asymmetric situation) against a fixed exchange rate has a clear intuitive appeal and has been recognized for long[4]. It will not be discussed here. The second type of argument (counterproductive cooperation) may be more fundamental by raising doubts on the validity of preventing competitive appreciations or depreciations, and will be further examined in the present paper.

In all these previous analyses it has been assumed that the central bankers who decide on monetary policies share the social loss functions of their respective countries. However, as explained in Rogoff (1985a) in a closed economy framework, there are good theoretical reasons to suppose that this is not the case. Thus, it may be beneficial that central bankers put more weight on fighting inflation that society does (i.e. be "conservative"). The reason is that this alleviates the credibility problem which arises when central bankers have an incentive to inflate in order to increase employment, but cannot commit themselves to predetermined rules for monetary policies. This also seems to be in accordance with what can be observed in the real world. The central bankers appear to be mainly in charge of preserving the value of money and, for that, may have to resist pressures to manipulate the money supply in order to satisfy other objectives like employment.

In the present paper, we will introduce the possibility for the central banker of each country to be independent, in the sense of putting a relative weight on its inflation target which is different from that of society. In this extended framework we will consider the issue of the role of a fixed exchange rate system. Thus, our analysis will have the three following characteristics. First, we will consider the purely symmetric case where countries are in exactly the same situation. Second, we will allow for counterproductive cooperation. Third, we will make a distinction between the loss functions of central bankers and the social loss functions.

By allowing countries to optimally choose their central bankers, we obtain a rationalization for a fixed exchange rate system which is different from the one previously considered in the literature. We find that a fixed exchange rate system is useful because it solves the problem of international cooperation in the choices made by countries of their central bankers. The present analysis shifts the focus from the problem of coordination of monetary policies to the problem of cooperation in choosing the central bankers themselves.

Section 2 presents the framework, and section 3 examines the issue of counterproductive coperation in that framework. This allows to reconsider the role of a fixed exchange rate system in section 4. Section 5 summarizes the results.

2. THE FRAMEWORK

The framework has already been considered in Laskar (1989)[5], and will be briefly exposed here (in the purely symmetric case). We use a two-country macro-model with wage contracting and rational expectations which is directly taken from Rogoff (1985b). Nominal wages are set one period in advance and workers agree to supply whatever amount of labor is demanded by firms in the current period. Equating the nominal wage to the marginal value product of labor gives the following employment equations.

$$\text{(1a)} \quad n_t = \bar{n} + \gamma(p_t - \bar{w}_t) + \gamma z_t \qquad \gamma > 0$$

$$\text{(1b)} \quad n_t^* = \bar{n} + \gamma(p_t^* - \bar{w}_t^*) + \gamma z_t$$

A star is attached to variables of country 2, and lower case letters represent logarithms of the corresponding variables; n_t and n_t^* are the employment variables and $\bar{n}$ is a constant which, without loss of generality, will be taken to be equal to the target employment rate of wage setters in each country; p_t and p_t^* are the nominal prices in period t of the goods produced by country 1 and 2 respectively, and $\bar{w}_t$ and $\bar{w}_t^*$ are the nominal wage rates contracted in period t-1. z_t is a serially independent zero-mean productivity shock which is common to the two countries.

The inflation rates π_{It} and π_{It}^* are defined in terms of price indices p_{It} and p_{It}^* where each good enters with a weight 1/2. We have

$$\text{(2)} \quad \pi_{It} = p_{It} - p_{It-1} \; ; \; \pi_{It}^* = p_{It}^* - p_{It-1}^*$$

$$\text{(3)} \quad p_{It} = p_t + \frac{1}{2} q_t \quad ; \; p_{It}^* = p_t^* - \frac{1}{2} q_t$$

where $q_t = e_t + p_t^* - p_t$ is the real exchange rate, and e_t is the nominal exchange rate (assumed for the moment to be flexible).

The rest of the model specifies equilibria in the market for each good, the equalities between supply and demand for money in each country, and uncovered interest rate parity. Expectations are rational and, at each period, all present and past variables are supposed to be known to everybody.

The reduced form for p_t, p_t^* and q_t can be written :

(4a) $p_t = \bar{w}_t + a_1 \mu_t + a_2 \mu_t^* + \xi_t$ $\qquad a_1 > 0 \; ; \; |a_2| < a_1$

(4b) $p_t^* = \bar{w}_t^* + a_2 \mu_t + a_1 \mu_t^* + \xi_t$

(4c) $q_t = b(\mu_t - \mu_t^*)$ $\qquad b > 0$

where ξ_t is a serially independent zero-mean random variable which depends on the (common) supply and demand shocks which affect the two economies; the variable μ_t (or μ_t^*) is directly related to the money supply of country 1 (or country 2), and can be taken as the instrument of monetary policy of the central bank of that country.

The target employment level for wage setters is $\bar{n}$ in each country. Taking a quadratic loss function around $\bar{n}$, equations (1) imply that the nominal wage rates are set at the levels

(5) $\bar{w}_t = E_{t-1}\, p_t \; ; \; \bar{w}_t^* = E_{t-1}\, p_t^*$

where E_{t-1} is the expectation conditional on information available at t-1.

Because of distortionary factors like taxes, the society's target rate for employment $\tilde{n}$ in each country is larger than the target rate $\bar{n}$ for wage setters. Society also cares about inflation, and $\tilde{\pi}_I$ is the target inflation rate. The social loss functions are :

(6a) $\Lambda_t = (n_t - \tilde{n})^2 + \chi(\pi_{It} - \tilde{\pi}_I)^2$ $\qquad \chi > 0$

(6b) $\Lambda_t^* = (n_t^* - \tilde{n})^2 + \chi(\pi_{It}^* - \tilde{\pi}_I)^2$

The loss functions of central bankers are different from the social loss functions and are given by

$$(7a)\quad I_t(\varepsilon) = (n_t - \tilde{n})^2 + (\chi + \varepsilon)\ (\pi_{It} - \tilde{\pi}_I)^2 \qquad \chi + \varepsilon > 0$$

$$(7b)\quad I_t^*(\varepsilon^*) = (n_t^* - \tilde{n})^2 + (\chi + \varepsilon^*)\ (\pi_{It}^* - \tilde{\pi}_I)^2$$

In each country the weight given to inflation relative to employment by the monetary authorities is $(\chi + \varepsilon)$ (or $(\chi + \varepsilon^*)$) instead of χ; and ε(or ε^*) may be called the "degree of conservatism" of the central banker.

There are two stages in the policy decision process. At the first stage central bankers are chosen by countries through the choices of ε and ε^*. Then, at the second stage, these central bankers decide on monetary policies μ_t and μ_t^* respectively. Each of these two stages can be cooperative or non-cooperative and such a distinction will play an important role in our analysis. We also assume that, when they set their nominal wages $\bar{w}_t$ and $\bar{w}_t^*$, the private sectors of the two countries know the values of ε and ε^* chosen at the first stage[6].

3. ON COUNTERPRODUCTIVE COOPERATION

Now, we will consider the case of a flexible exchange rate and analyze the issue of counterproductive cooperation in our framework. As indicated in the introduction, such an analysis is important because, in a symmetric model, a fixed exchange rate system leads to the cooperative solution in the game between central bankers. In this section we will restrict our attention to the case where, at the first stage of the policy decision process, the two countries cooperatively choose their central bankers through the choice of a common degree of conservatism. Therefore we impose $\varepsilon = \varepsilon^*$, and the two countries cooperatively choose the optimal value of ε. (The case of a non-cooperative choice of ε and ε^* play a role in section 4 below).

We are interested in the effect of cooperation between central bankers at the second stage, in the monetary game where μ_t and μ_t^* are the strategies. We will denote by (C, NC) and (C,C) the two flexible exchange rate systems we will compare in this section. The first "C" reminds us that the first stage (choice by countries of their central bankers) is cooperative. The second stage may be either non-cooperative (NC) or cooperative (C). All the formal derivations of the results in this and the following section are given in the Appendix.

The result we find is that the two systems (C,NC) and (C,C) are actually equivalent. They lead to the same monetary policies, same inflation rates, and same values for all variables (except, as we will see, for the degrees of conservatism of central bankers). In that sense, cooperation between central bankers is neither productive nor counterproductive.

The reason of the result will more clearly appear if we consider the expected social loss functions. In the absence of cooperation between central bankers (system (C,NC)) we have[7]

$$(8)\quad E_{t-1}\,\Lambda_t = E_{t-1}\,\Lambda_t^* = (\tilde{n}-\bar{n})^2 + \chi\,\frac{\gamma^2}{s^2}\,(\tilde{n}-\bar{n})^2 + \gamma^2\frac{s^2+\chi\,\gamma^2}{(s+\gamma^2)^2}\,\sigma_z^2$$

where

$$(9)\quad s = (\chi + \varepsilon)(1+\frac{b}{2a_1}) > 0$$

In the case of cooperation (system (C,C)) we have

$$(10)\quad E_{t-1}\,\Lambda_t = E_{t-1}\,\Lambda_t^* = (\tilde{n}-\bar{n})^2 + \chi\,\frac{\gamma^2}{\Psi^2}\,(\tilde{n}-\bar{n})^2 + \gamma^2\frac{\Psi^2+\chi\,\gamma^2}{(\Psi+\gamma^2)^2}\,\sigma_z^2$$

where

$$(11)\quad \Psi = \chi + \varepsilon > 0$$

The only difference between (8) and (10) is that in (10) we have Ψ instead of s. In each of these expressions the second term represents the loss due to excessive anticipated inflation. We have $E_{t-1}\,\pi_{It} - \tilde{\pi}_I$ equal to (γ/s) $(\tilde{n}-\bar{n})$ in the system (C,NC) and to $(\gamma/\Psi)(\tilde{n}-\bar{n})$ in the system (C,C). As usual in such a model, this loss is due to the credibility problem which arises when central bankers cannot commit themselves to their monetary policies in the future and are therefore constrained to follow time-consistent policies (let us call it the "time-consistency loss"). The last terms of (8) and (10) indicate the response to (symmetric) shocks, where σ_z^2 is the variance of the common productivity shock z_t[8].

For any given ε, the possibility of counterproductive cooperation arises from the inequality $s > \Psi$, which implies a higher expected inflation rate in the cooperative case: the credibility of central bankers of not increasing their money supplies in order to raise their employments is diminished in that case, because central bankers do not have to fear the inflationary effects of a real exchange rate depreciation (the two central bankers would cooperatively decide to expand at the same time). When, as in Rogoff (1985b), we a priori have $\varepsilon=0$, there is still some ambiguity as to whether cooperation is counterproductive or not. The reason is that the response to shocks is better in the cooperative case: when ε is equal to zero, the last term in (10) is lower than that in (8). Then, the answer to the issue of whether cooperation is counterproductive depends on the ratio $(\tilde{n}-\bar{n})^2/\sigma_z^2$, a large value of this ratio tending to make cooperation counterproductive.

However, when ε is optimally chosen by countries, the answer is different. In that case countries choose the value of ε which minimize $E_{t-1}\,\Lambda_t$ given by (8) or (10). (Because $E_{t-1}\Lambda_t^*$ is equal to $E_{t-1}\,\Lambda_t$, this is equivalent to minimizing $E_{t-1}\,\Lambda_t+E_{t-1}\,\Lambda_t^*$). As ε only appears through s or Ψ, and as (8) and (10) are otherwise identical, the optimal values s^0 and Ψ^0 of s and Ψ are equal ($s^0= \Psi^0$), and the two systems yield the same levels of expected social utilities[9]. In fact, all variables become equal in the two systems. The only difference concerns the optimal degree of conservatism ε^0. For, the equality $s^0 = \Psi^0$ implies

(12) $\varepsilon^0_{(C,NC)} < \varepsilon^0_{(C,C)}$

This result can be looked at from two points of view. First, consider the situation where cooperation would be counterproductive in the case $\varepsilon = 0$ and where, as a consequence,one would be mainly interested in reducing the credibility problem which is at the origin of counterproductive cooperation. Then, inequality (12) says that, by choosing more conservative central bankers when these cooperate, countries can correct for the lower credibility implied by such a cooperation, and make the expected inflation be the same as in the case of no cooperation between central bankers.

Now consider the situation where cooperation would be productive in the case $\varepsilon=0$ and where, therefore, one may primarily want to eliminate the inefficiency of the non-cooperative equilibrium in the responses to shocks. From this point of view, inequality (12) says that by choosing, in the non-cooperative case, central bankers who are less conservative, it is possible to get rid of this inefficiency. This indeed corresponds to the argument underlined in Laskar (1989) that symmetric shocks tend to make conservative central bankers detrimental to both countries in the absence of cooperation between central bankers. (Thus in the case $\tilde{n}-\bar{n}=0$, "liberal" central bankers would be required: from (8) and (9) we have $s^0= \chi$, and therefore $\varepsilon^0< 0$).

Here, the interesting point is that, whatever the point of view one may want to adopt, both types of losses (time-consistency losses and the responses to shocks) are simultaneously equalized through an adequate choice of ε. Thus, when we want to make the expected inflations the same in the two systems, the losses corresponding to the responses to shocks happen to be also equalized, and vice versa. This is obviously a crucial point for our result of equivalence between the two systems. In that respect, the assumption of complete symmetry of the model is important. For, this implies that the model is symmetric both in expected values and for shocks. Therefore, in the absence of cooperation between central bankers, the same type of mechanism of competitive manipulation of the exchange rate is involved when we consider the time-consistency loss as well as the response to shocks. Such a mechanism has a favorable effect on the time-consistency loss but a detrimental one on the response to shocks. The identity of the mechanism involved in the two kinds of losses explains why a suitable choice of the degree of conservatism of central bankers may eliminate both effects at the same time[10].

4. THE ROLE OF A FIXED EXCHANGE RATE SYSTEM

If we consider only the second stage of the policy decision process, where central bankers in place decide on monetary policies, a fixed exchange rate system allows to reach the cooperative solution in the flexible exchange rate system. This is the usual result obtained in the literature in the completely symmetric case. But, in the previous section it was shown that, in a flexible exchange rate system, cooperation between central bankers is neither productive nor counterproductive. Does this mean that a fixed exchange rate system is equivalent to a flexible exchange rate system (even when central bankers do not cooperate)? The answer is actually negative because there is still an important distinction to be made when we consider the first stage, where central bankers are chosen by countries.

In the analysis of the previous section it was actually assumed that, at the first stage, central bankers were chosen cooperatively by the countries (through the choice of a common value $\varepsilon=\varepsilon^*$). But this does not seem to be realistic. A better assumption would be that, at any stage, international cooperation is difficult to realize. Therefore, the flexible exchange rate system to which we would like to compare a fixed exchange rate system is not (C,NC) as in the previous section, but (NC,NC) where, at the first stage, ε and ε^* are also chosen non-cooperatively by the countries. Now, if we compare these two flexible exchange rate systems we find that (C,NC) is better than (NC,NC). Thus, there is a loss of efficiency by not choosing cooperatively the central bankers at the first stage.

More precisely, we can show that, in the absence of international cooperation, countries choose central bankers who give too much weight to their inflation objectives, i.e who are too conservative. Let $(\varepsilon^N_{(NC,NC)}, \varepsilon^{*N}_{(NC,NC)})$ be the values of $(\varepsilon,\varepsilon^*)$ at the Nash equilibrium in the system (NC,NC). We obtain $\varepsilon^N_{(NC,NC)} = \varepsilon^{*N}_{(NC,NC)}$ and

(13) $\varepsilon^N_{(NC,NC)} > \varepsilon^0_{(C,NC)}$

The reason of this inequality is the following. As it has already been emphasized, in the absence of cooperation between central bankers at the second stage, symmetric shocks tend to make conservative central bankers detrimental to both countries. As a consequence, choosing a lower degree of conservatism for central bankers at the first stage becomes a public good. In the absence of cooperation, an insufficient amount of that public good is produced, which is what inequality (13) says.

Our results so far can be written

(14a) (C,C) = (C,NC)

(14b) (C,NC) > (NC,NC)

where a sign "=" means "yields the same levels of expected social losses for all countries" and a sign ">" means "yields lower levels of expected social losses for all countries".

Now, consider a fixed exchange rate system where the central bank of one country has to peg the exchange rate through foreign exchange interventions. Because of interest rate parity, these interventions cannot be completely sterilized, and this central bank can only have a passive role, letting its money supply adjust to the level of the money supply given by the central bank of the other country. This last country, which determines the monetary policy of the zone, may be called the "dominant" country or the "leader" of the fixed exchange rate system. Note that, because of the complete symmetry of the model, the issue of which country is the leader is irrelevant.

We still have the same two-stage decision process. At the first stage countries choose their own central bankers, while at the second stage these set monetary policies. Here, the important point is that, in the fixed exchange rate system, there is only one "active" central banker, that of the dominant country. The degree of conservatism of the passive central banker who pegs the exchange rate is actually irrelevant. Therefore we can reduce the dimension of the problem to one: that of the active central banker. The consequence is that no problem of international cooperation really arises in such a system. The dominant country simply chooses its central banker, who then decides for the monetary policy of the zone[11]. Call (F) this fixed exchange rate system. It is equivalent to the cooperative flexible exchange rate system (C,C). For, being the same at the second stage, the social loss function of the dominant country, say country 1, is still given by (10); and ε is still chosen in order to minimize $E_{t-1}\ \Lambda_t$ given by (10). Therefore we have

(15) (F) = (C,C)

From (14) and (15) we get

(16) (F) > (NC,NC)

We obtain the result that, in the absence of international cooperation and in the purely symmetric case, a fixed exchange rate system is better than a flexible exchange rate system. In this result we have taken into account the possibility of counterproductive cooperation. The crucial point is that a fixed exchange rate system eliminates the inefficiency which, in a flexible exchange rate system, comes from the lack of international cooperation in the choices made by countries of their central bankers.

5. CONCLUSION

When central bankers are independent and, therefore, do not a priori share the social preferences of their respective countries, the role of a fixed exchange rate system appears to be different from what has been emphasized in the literature. Thus, in the purely symmetric case, where countries are exactly in the same situation (which is the case we have considered in this paper), the property of a fixed exchange rate system of preventing competitive depreciations or appreciations of the exchange rate does not lie anymore at the center of the issue. The reason is that such a property per se does not allow to choose between a fixed and a flexible exchange rate system.

It remains true that a fixed exchange rate system is still a substitute for cooperation between central bankers, in the sense that it leads to the cooperative solution when we consider the game between central bankers in the flexible exchange rate system. But the point is that, through an appropriate choice of the types of central bankers (concerning their "degree of conservatism"), the inefficiency of the non-cooperative equilibrium in the responses to shocks, as well as the possibility of counterproductive cooperation, are both eliminated. This simply requires that central bankers put more weight on their inflation objective in the case of cooperation (or equivalently in the case of a fixed exchange rate system) than in the case they do not cooperate. Then, fixed and flexible exchange rate systems become equivalent.

However, this equivalence implicitly assumes that the central bankers can be chosen cooperatively by the countries. But, in the real world, such a choice is also likely to be non-cooperative. If this is the case, we must take into account the inefficiency created by such a non-cooperative choice, which actually leads to central bankers who are too conservative. The consequence is that a fixed exchange rate system becomes superior to a flexible exchange rate one. This result underlines that a fixed exchange rate system can also be a substitute for international cooperation in the choices made by countries of the central bankers themselves; and that such a property is actually crucial when one wants to consider the role of a fixed exchange rate system.

APPENDIX

In the system (C,NC), at the second stage, the Nash equilibrium of the game between central bankers satisfies the first order conditions $\partial I_t(\varepsilon)/\partial\mu_t = 0$ and $\partial I^*_t(\varepsilon)/\partial\mu^*_t = 0$. Using (1),(2),(3), (4) and (7) they give:

(17a) $\gamma a_1(n_t-\tilde{n})+(\chi+\varepsilon)(a_1 + \frac{b}{2})(\pi_{It}-\tilde{\pi}_I)=0$

(17b) $\gamma a_1(n^*_t-\tilde{n})+(\chi+\varepsilon)(a_1 + \frac{b}{2})(\pi^*_{It}-\tilde{\pi}_I)=0$

By adding and substracting (17a) and (17b), system (17) is equivalent to

(18a) $\gamma[(n_t-\tilde{n}) + (n^*_t-\tilde{n})] + s[(\pi_{It} - \tilde{\pi}_I) + (\pi^*_{It} - \tilde{\pi}_I)]=0$

(18b) $\mu_t = \mu^*_t \quad ; \quad \bar{w}_t = \bar{w}^*_t$

where s is defined by (9).

Equation (18b) may require some explanation. Subtracting (17b) to (17a) and using (1)-(4) gives

$$[\gamma^2(a_1-a_2) + s(a_1-a_2+b)](\mu_t-\mu^*_t) - s(a_1-a_2+b)(\mu_{t-1}-\mu^*_{t-1}])$$
(19)
$$+ s[(\bar{w}_t - \bar{w}^*_t) - (\bar{w}_{t-1}-\bar{w}^*_{t-1})] = 0$$

Note first that we have $E_{t-1}\,\mu_t = E_{t-1}\,\mu^*_t = 0$ (this is clear by taking the expected values at t-1 of (4a) and (4b) and by using (5)). Then take the expected value of (19) at t-1 and substract it to (19). This gives $\mu_t = \mu^*_t$. Then, from the first order condition at t-1 we also get $\mu_{t-1}=\mu^*_{t-1}$. Using these last two equalities in (19) yields

$\bar{w}_t - \bar{w}^*_t = \bar{w}_{t-1} - \bar{w}^*_{t-1}$. Therefore $\bar{w}_t - \bar{w}^*_t$ is constant through time. Some additional normalization is needed to give a value to this constant. We have taken it equal to zero, which actually corresponds to the normalization $E_{t-1}\ e_t = 0$. Thus we obtain (18b). Conversely, (18b) (written for all t) obviously implies (19).

The expected social loss function (8) can easily be derived from (18), (6) and the equations of the model (1)-(5) (and this has actually been done in Laskar (1989) where the system (C,NC) is studied in more details).

In the system (C,C), at the second stage, the cooperative solution between central bankers is given by the first order conditions $\partial[I_t(\varepsilon)+I^*_t(\varepsilon)]/\partial\mu_t = 0$ and $\partial[I_t(\varepsilon)+I^*_t(\varepsilon)]/\partial\mu^*_t = 0$. Using (1), (2), (3), (4) and (7) this gives

(20a) $\gamma a_1(n_t - \tilde{n}) + (\chi+\varepsilon)(a_1 + \frac{b}{2})(\pi_{It} - \tilde{\pi}_I) + \gamma a_2(n^*_t - \tilde{n}) + (\chi+\varepsilon)(a_2 - \frac{b}{2})(\pi^*_{It} - \tilde{\pi}_I) = 0$

(20b) $\gamma a_2(n_t - \tilde{n}) + (\chi+\varepsilon)(a_2 - \frac{b}{2})(\pi_{It} - \tilde{\pi}_I) + \gamma a_1(n^*_t - \tilde{n}) + (\chi+\varepsilon)(a_1 + \frac{b}{2})(\pi^*_{It} - \tilde{\pi}_I) = 0$

Adding and substracting these equations, (20) is equivalent to

(21a) $\gamma[(n_t - \tilde{n}) + (n^*_t - \tilde{n})] + \Psi\ [(\pi_{It} - \tilde{\pi}_I) + (\pi^*_{It} - \tilde{\pi}_I)] = 0$

(21b) $\mu_t = \mu^*_t \quad ; \quad \bar{w}_t = \bar{w}^*_t$

where Ψ is defined by (11).

Comparing (18) and (21) we see that the only difference between these two systems of equations is that s in (18) has been replaced by Ψ in (21). Therefore, the expected social loss functions (10) are simply obtained by substituting Ψ to s in (8). But this also implies that the optimal values of s and Ψ are equal ($s^0 = \Psi^0$). Then, equations (18) and (21) become identical and, consequently, the monetary policies μ_t and μ^*_t, and all other variables, are the same under (C,NC) and (C,C).

Now consider fixed exchange rate systems. From (4) and the definition of q_t, the fixity of the exchange rate ($e_t = 0$) can be written

$$(22)\ \mu_t = \mu_t^* \quad ; \quad \bar{w}_t = \bar{w}_t^*$$

Take, for instance, country 1 as the leader in the fixed exchange rate system. Country 1 chooses μ_t in order to minimize $I_t(\varepsilon)$, taking in to account the constraint (22) of the fixity of the exchange rate. Using (1)-(4) and (7a) this gives the first order condition

$$\gamma(a_1+a_2)(n_t-\tilde{n}) + (\chi+\varepsilon)(a_1+a_2)(\pi_{It}-\tilde{\pi}_I) = 0$$

which can be written

$$(23)\ \gamma\ (n_t-\tilde{n}) + \Psi(\pi_{It}-\tilde{\pi}_I) = 0$$

As (22) and (1)-(4) imply $n_t^*-\tilde{n} = n_t-\tilde{n}$ and $\pi_{It}^* - \tilde{\pi}_I = \pi_{It}-\tilde{\pi}_I$, we see that {(22),(23)} is equivalent to (21). Therefore the fixed exchange rate system yields the same solutions as (C,C) at the second stage. As underlined in the text, the first stage also yields the same optimal value for Ψ. Consequently (F) and (C,C) give identical solutions for all variables.

The flexible exchange rate system (NC,NC) has been studied in Laskar (1989). But , in that article, the determination of the equilibrium solution (ε^N, ε^{*N}) has been made explicit only in the case $\tilde{n}-\bar{n}=0$. Therefore, we have to more closely examine the case $\tilde{n}-\bar{n}\neq 0$. From Laskar (1989) the expected social loss function of country 1, at the Nash equilibrium between central bankers when we a priori have $\varepsilon \neq \varepsilon^*$, can be written (in the case of only symmetric shocks):

$$(24)\ E_{t-1}\ \Lambda_t = (\tilde{n}-\bar{n})^2 + \chi\ \frac{\gamma^2}{s^2}\ (\tilde{n}-\bar{n})^2 + \gamma^2\ \frac{s^2 + \chi\ \gamma^2}{[A(s^*)s+\gamma^2 B(s^*)]^2}\ [C(s^*)]^2\ \sigma_z^2$$

where s^* is defined in the same way as s in (9) and where $A(s^*)$, $B(s^*)$ and $C(s^*)$ are the following linear functions

$$A(s^*) = (a_1-a_2+b)s^* + (a_1-a_2+\frac{b}{2})\,\gamma^2$$

$$B(s^*) = (a_1-a_2+\frac{b}{2})s^* + (a_1-a_2)\,\gamma^2$$

$$C(s^*) = (a_1-a_2+b)s^* + (a_1-a_2)\,\gamma^2$$

At the first stage country 1 minimizes $E_{t-1}\,\Lambda_t$ with respect to s, taking s^* as given. The first order condition can be written

$$(25)\quad F(s,s^*) \equiv -\frac{\chi}{\gamma^2}\frac{(\hat{n}-\bar{n})^2}{\sigma_z^2}\left[\frac{A(s^*)}{B(s^*)}+\frac{\gamma^2}{s}\right]^3 + \left[\frac{C(s^*)}{B(s^*)}\right]^2\left[s-\chi\,\frac{A(s^*)}{B(s^*)}\right] = 0$$

Both s and s^* are positive. As we have $\partial F(s,s^*)/\partial s > 0$, and as $F(s,s^*)$ is negative for s close to zero and positive for large values of s, this leads to a unique solution s of (25) for a given s^*. We can also see that the second order condition is always satisfied. As we have $\partial F(s,s^*)/\partial s^* > 0$ (at least when $s - \chi\, A(s^*)/B(s^*) > 0$, which is verified when (25) holds), we obtain a negatively sloped reaction function $s = R(s^*)$ for country 1. In the same way we have the reaction function $s^* = R(s)$ for country 2. In the interval $]0, +\infty[$ the function R is continuous and decreases from $\bar{s} > 0$ to the limit $\underline{s} > 0$. Therefore, there exists a unique Nash equilibrium (s^N, s^{*N}) such that $s^N = s^{*N}$. (Furthermore, from the first order condition (25) and the corresponding one for country 2, it is possible to show that there cannot exist Nash equilibria $(s^{N'}, s^{*N'})$ where $s^{N'} \neq s^{*N'}$. Therefore (s^N, s^{*N}) is the unique Nash equilibrium).

Now, by definition, in the system (C,NC) the optimal value s^0 minimizes the expected loss functions when central bankers do not cooperate, for all cases where $s=s^*$. (The loss function (24) becomes identical to (8) when we have $s=s^*$). Therefore, the system (C,NC) is at least as good as the system (NC,NC). It is strictly better if we have

$s^N \neq s^0$, which, as we will show, is an inequality which is satisfied. To see this, note that from the first order condition of the minimization of $E_{t-1} \Lambda_t$ given by (8), s^0 satisfies

$$(26)\quad s^0 = \chi + \frac{\chi}{\gamma^2} \frac{(\tilde{n}-\bar{n})^2}{\sigma_z^2} (1+ \frac{\gamma^2}{s^0})^3$$

Using (26) to substitute for s in the last bracket of (25) we obtain:

$$(27)\qquad F(s^0,s^0) = - \frac{\chi}{\gamma^2} \frac{(\tilde{n}-\bar{n})^2}{\sigma_z^2} \left[\left[\frac{A(s^0)}{B(s^0)} + \frac{\gamma^2}{s^0} \right]^3 - \frac{B(s^0)}{C(s^0)} \left[\frac{C(s^0)}{B(s^0)} (1+ \frac{\gamma^2}{s^0}) \right]^3 \right]$$

$$- \left[\frac{C(s^0)}{B(s^0)} \right]^2 \chi \left[\frac{A(s^0)}{B(s^0)} - 1 \right]$$

But, from the definitions of A(s), B(s) and C(s) given above, we have

$$(28)\quad \frac{A(s)}{B(s)} + \frac{\gamma^2}{s} = \frac{C(s)}{B(s)} (1+ \frac{\gamma^2}{s}) \qquad \text{for all } s.$$

Then using (28) and the inequalities $B(s)/C(s) < 1$ and $A(s)/B(s) > 1$, (27) implies $F(s^0,s^0) < 0$. As we have $F(s^N,s^N)= 0$ and $d[F(s,s)]/ds=\partial F(s,s)/\partial s+\partial F(s,s)/\partial s^*>0$, this gives $s^N>s^0$. Note that in (24) the interdependence between s and s* only goes through the coefficient of σ_z^2 and not through the coefficient of $(\tilde{n}-\bar{n})^2$. Thus, there is no direct externality for the choices of ε and ε* which is related to the time-consistency loss. This is why the intuitive explanation given in the text of the inequality $s^N > s^0$ relies on the effects that the choices of ε and ε* have on the response to (symmetric) shocks.

NOTES

1. See Canzoneri and Gray (1985) and Mélitz (1985).

2. Some aspects of the issues raised by the EMS in the asymmetric case are discussed by Mélitz (1985) in a game theoretical framework.

3. See Rogoff (1985b), Miller and Salmon (1986) and Carraro and Giavazzi (1988).

4. A classical reference is Mundell (1961).

5. In that paper the issue was whether conservative central bankers are beneficial or not when we extend the closed economy analysis of Rogoff (1985a) to a two-country world.

6. Therefore, there is some commitment in the values of ε and ε^*. The interesting aspect of the framework introduced by Rogoff (1985a) is precisely that it replaces a commitment on monetary policies which may be hard to put into practice, at least in a stochastic setting (where contingent monetary rules would be needed), by a commitment on the types of central bankers, which seems a priori simpler to realize.

7. Note that, as in Rogoff (1985b), our analysis implicitly assumes that central bankers can commit themselves not to cooperate. Otherwise, as Carraro and Giavazzi (1988) have pointed out, the non-cooperative case would not be a perfect Nash equilibrium. The reason is that, at period t, when central bankers take the wages $\bar{w}_t$ and $\bar{w}^*_t$ as given, it is always in their interests to cooperate.

8. Common demand shocks do not matter because they can be completely neutralized by a change in the world real interest rate, without affecting the trade-off between inflation and employment.

9. It can easily be shown that there exists a unique value of s or Ψ which minimizes $E_{t-1}\,\Lambda_t$ given by (8) or (10).

10. If we had asymmetric shocks such a result would not hold. However, as explained in the introduction, we already know that with asymmetric shocks a fixed exchange rate system does not exhibit the good properties it has in the symmetric case. Our aim in this paper is not to study counterproductive cooperation per se, but to try to get new insights on the role of a fixed exchange rate system by reconsidering the purely symmetric case in an other framework.

11. In the same way, the active central bank could be a common central bank in a monetary union between the two countries. As we are in a purely symmetric case, first, no conflict would arise in the choice of the type of central banker of the monetary union and, second, such a monetary union would be equivalent to a fixed exchange rate system with one leader. (Note that in our analysis there is no problem of credibility concerning the fixity of the exchange rate in a fixed exchange rate system).

REFERENCES

Canzoneri, M.B. and J.A. Gray (1985) - "Monetary Policy Games and the Consequences of Non-Cooperative Behavior", International Economic Review, Vol. 26, n°3, October, 547-564.

Carraro, C. and F. Giavazzi (1988) - "Can International Cooperation Really be Counterproductive?", NBER Working Paper n°2669.

Laskar, D. (1989) - "Conservative Central Bankers in a Two-Country World", European Economic Review, Vol.33, n°8, 1575-95.

Mélitz, J. (1985) - "The Welfare Case for the European Monetary System", Journal of International Money and Finance, Vol.4, n°4, December, 485-506.

Miller, M. and M. Salmon (1986) - "When does Coordination Pay?", Presented at the Conference "Strategic Behavior and Economic Policy", held at University of Paris 1, December.

Mundell, R.A. (1961) - "A Theory of Optimum Currency Areas", American Economic Review, Vol.51, 657-65.

Rogoff, K.(1985a) - "The Optimal Degree of Commitment to an Intermediate Monetary Target", Quarterly Journal of Economics, November, 1169-89.

Rogoff, K.(1985b) - "Can International Monetary Policy Cooperation be Counterproductive?", Journal of International Economics, 199 - 217.