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ABSTRACT

This paper presents a simple general equilibrium model of two countries using a common currency. The goal is to study how the monetary arrangement influences the optimum financing of a public good.

If the two countries are allowed to print the common currency autonomously, they will finance their fiscal spending with money, oversupplying the public good and crowding out the private sector. The possibility to export part of the inflation creates a distortion in incentives such the resulting equilibrium is strictly welfare inferior to the one prevailing under flexible exchange rates.

If the management of the common currency is deferred to an international central bank, each country will try to use domestic policy variables (taxes) to manipulate in its favor the actions of the bank. With no independent domestic taxes, the bank can improve welfare. However, its policies naturally support the larger country, and to induce the smaller one to participate requires giving it a disproportionately large, politically unrealistic, representation in the bank's objective function.

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Introduction *

The possibility of European monetary integration has been frequently discussed in the past few decades; see for example the volumes edited by Fratianni and Peeters (1979), Johnson and Swoboda (1973), Salin (1984), and Masera and Triffin (1984) . Much of the debate derives from the theory of optimum currency areas originally proposed by Mundell (1961) and extended by McKinnon (1963) (see also a useful recent discussion in Wood (1986)). More generally, Fischer (1983) provides an enlightening commentary on the problems involved. While interesting issues have emerged, the literature has remained informal, with few attempts to provide a systematic foundation on which to base arguments for and against common currency.

Our purpose in writing this paper is to present a formal two country general equilibrium framework in which the question of alternative monetary systems can be addressed, in the spirit of Helpman (1981) and Helpman and Razin (1982). We are especially interested in contrasting three monetary regimes, flexible exchange rates, a common currency issued autonomously by both countries, and a common currency whose management is delegated to a jointly controlled central bank. Flexible exchange rates are the appropriate reference case, since they will prevail whenever either country deviates from the common currency agreement. We keep our model very simple, especially in that we assume complete information and consider only the case of two countries. As an added simplification, we summarize each country's welfare in terms of a single representative citizen. The citizen possesses a parameteric utility function which depends on both the home and foreign goods, which are different, and on the home country government's provision of a public good. Money is needed to help finance the public good, which alternatively can be financed through lump sum taxation.

Broadly stated, we find that establishing a common currency area is difficult, because each country views such a system as a means of exploiting the other. These pervasive free rider problems tend to reduce both countries' welfares, often below that which they achieve under flexible exchange rates. Of course, these difficulties are of the same nature as those studied in the literature on international policy coordination, from Hamada (1976) onwards.

More specifically, when the two countries maintain a common currrency which each can print, the free rider problem leads to an equilibrium that is strictly dominated by the flexible exchange rate case. In our model this result is always true, but more generally it will be true when governments weigh the utility of future generations sufficiently. We argue, therefore, that such a regime is not enforceable, since both countries would have an incentive to deviate by issuing a national currency. This first result suggests that the organization of a jointly controlled central bank is crucial for a common currency, and we devote much of the paper to this case. Unfortunately, even here coordination can be difficult. When the countries maintain control over taxation the central bank is unable to improve over the flexible exchange rate system: each country uses its tax policy to manipulate the Bank, hoping thereby to strengthen its position vis-a-vis the other, but in the process attenuating Bank effectiveness. With no taxes, the Bank can improve welfare. However, if the influence of each country on the decisions of the central bank is proportional to the country's relative wealth, an agreement is attainable only if the two economies are either comparable or extremely asymmetrical in size.

As mentioned, the model is very simple and we do not claim these results to be general. Nonetheless, the incentive effects which arise are likely to be important in evaluating a variety of suggestions for monetary integration. Our results also suggest that considerably more attention should be addressed to the specific organizational features of a jointly controlled central bank. In particular the following seem relevant: the mechansim design literature; the application of Groves' mechanisms as a way for the central bank to coordinate countries' fiscal interventions; and the political forces lying behind the Bank's charter and decision-making body.

Model Specification

The world is comprised of two countries, Red and Blue (R and B). Each period, citizens of each country are born with a fixed endowment of their respective good; Red are born with θ, Blue with $(2-\theta)$. When young, the citizens sell their endowment on a competitive market in their home country. When old, they spend the proceeds from their previous period's sales on purchases of both the domestic and the foreign good; they then return home, consume, and exit the economy.[1] All transactions happen through money.

In addition to the private goods, the consumers' utility depends on the provision of a public good (as in Kehoe (1987)). While demand for the public good might be independent of events in the private sector (for example military spending), we prefer to think of it as directly related to the trading process itself. Thus for example the Red and Blue markets may be situated on the border between the two countries; to arrive at the markets consumers travel on roads maintained by their respective govenments. If the roads are in poor condition, purchased goods depreciate substantially before consumption is possible.

More formally,

$$U_{Rt} = 0.5log(C_{RRt}) + 0.5log(C_{BRt})$$

$$U_{Bt} = 0.5log(C_{BBt}) + 0.5log(C_{RBt})$$

C_{ijt} denotes consumption of good i by a citizen of country j in time period t, and for each period t

$$C_{RR} = \Gamma_R^r R_R \qquad C_{BR} = \Gamma_R^r B_R \qquad r > 0$$

$$C_{BB} = \Gamma_B^b B_B \qquad C_{RB} = \Gamma_B^b R_B \qquad b > 0$$

with R_j (B_j) being the quantity of good R (B) purchased by a citizen of country j during t, and Γ_j representing provision of the public good by the government of country j in the period.

The government supplies the public good by collecting resources from the private sector. This can be done either in the form of direct lump sum taxation of the citizens' endowments (denoted $T_j, j = R, B$), or through the expenditure of fiat money on the domestic market ($M_j, j = R, B$). For each period we define

$$\Gamma_j = T_j + m_j$$

where

$$m_j = M_j/p_j$$

with p_j the nominal price on market j.[2]

Depending on the monetary regime between the two countries, we can solve for the equilibrium prices on the private markets as a function of the governments' policies. This results in country specific indirect utility functions, which the governments in turn maximize over the variables T_j and M_j.

The interest of this simple model rests precisely in the interaction between the two governments' policies. Each country's welfare function depends on foreign choices of taxes and money, and lack of cooperation leads to suboptimal equilibrium.

In the next sections we study different forms of monetary (and fiscal) linkages between the countries; we are interested in which types of linkages lead to effective coordination of the governments' actions and achieve the highest welfare outcomes. We focus on three possible regimes: flexible exchange rates, a common fiat currency printed autonomously by the two governments, and delegation of monetary policy to a common central bank.[3]

Flexible Exchange Rates

Each country issues its own currency which must be used on the local market. Exchange rates are perfectly flexible and there are no transactions costs.

In period t the red consumer maximizes

$$U_{Rt} = r log(\Gamma_{Rt}) + 0.5 log(R_{Rt}) + 0.5 log(B_{Rt}) \tag{1R}$$

subject to the budget constraint

$$p_{Rt}R_{Rt} + e_t p_{Bt} B_{Rt} = p_{R(t-1)}(R_{R(t-1)} + R_{B(t-1)} + m_{R(t-1)}) \tag{2R}$$

where e_t is the exchange rate (defined as units of Red Currency required in exchange for one unit of Blue Currency), $p_{R,(t-1)}$ is the nominal price on the Red market last period, and m_{Rt} is the real money spent by the Red government on the Red market. (The left-hand-side of equation (2R) gives the nominal income earned by a red consumer through the previous period sale of his endowment.)

Similarly a Blue consumer maximizes

$$U_{Bt} = b log(\Gamma_{Bt}) + 0.5 log(B_{Bt}) + 0.5 log(R_{Bt}) \tag{1B}$$

subject to

$$e_t p_{Bt} B_{Bt} + p_{Rt} R_{Bt} = e_t p_{B(t-1)}(B_{B(t-1)} + B_{R(t-1)} + m_{B(t-1)}) \tag{2B}$$

Equilibium conditions on the two markets are

$$\theta - T_{Rt} = R_{Rt} + R_{Bt} + m_{Rt} \tag{3R}$$

$$2 - \theta - T_{Bt} = B_{Bt} + B_{Rt} + m_{Bt} \tag{3B}$$

(where recall that θ and $2-\theta$ are the initial endowments), leading to the demand functions

$$R_{Rt} = \frac{p_{R(t-1)}(\theta - T_{R(t-1)})}{2p_{Rt}} \qquad B_{Rt} = \frac{p_{R(t-1)}(\theta - T_{R(t-1)})}{2p_{Rt}} \bullet \frac{p_{Rt}}{e_t p_{Bt}} \tag{4}$$

$$B_{Bt} = \frac{p_{B(t-1)}(2 - \theta - T_{B(t-1)})}{2p_{Bt}} \qquad R_{Bt} = \frac{p_{B(t-1)}(2 - \theta - T_{B(t-1)})}{2p_{Bt}} \bullet \frac{e_t p_{Bt}}{p_{Rt}}$$

Substituting these demands in $(3R)$ and $(3B)$ determines the market clearing price

$$p_t = \frac{p_{Rt}}{e_t p_{Bt}} = \frac{2 - \theta - \Gamma_{Bt}}{\theta - \Gamma_{Rt}} \tag{5}$$

and the equilibrium relationship between the two inflation rates:

$$1 = \frac{2 - \theta - T_{B(t-1)}}{2(1+\pi_{Bt})(2 - \theta - \Gamma_{Bt})} + \frac{\theta - T_{R(t-1)}}{2(1+\pi_{Rt})(\theta - \Gamma_{Rt})} \tag{6}$$

where $(1+\pi_{jt}) = p_{jt}/p_{j(t-1)}$.

Equilibrium on the Red Currency market requires that the nominal amount spent last period (by Red and Blue consumers and the Red government) equal the nominal private demand for Red currency this period:[4]

$$p_{Rt}R_{Bt} + p_{Rt}R_{Rt} = p_{R(t-1)}(m_{R(t-1)} + R_{R(t-1)} + R_{B(t-1)}) \tag{7}$$

With the budget constraint $(2R)$ this implies

$$p_{Rt}R_{Bt} = e_t p_{Bt} B_{Rt} \tag{8}$$

the equality of cross currency nominal demands. Substituting from the expressions for the equilibrium price (5) and the demand functions we obtain

$$\frac{1+\pi_{Rt}}{1+\pi_{Bt}} = \frac{\theta - T_{R(t-1)}}{2 - \theta - T_{B(t-1)}} \bullet \frac{2 - \theta - \Gamma_{Bt}}{\theta - \Gamma_{Rt}} \tag{9}$$

Finally, (9) and (6) can be solved for the two inflation rates:

$$1 + \pi_{Rt} = \frac{\theta - T_{R(t-1)}}{\theta - \Gamma_{Rt}} \qquad 1 + \pi_{Bt} = \frac{2 - \theta - T_{B(t-1)}}{2 - \theta - \Gamma_{Bt}} \tag{10}$$

Demands for the Red and Blue goods are then given by

$$R_{Rt} = R_{Bt} = (\theta - \Gamma_{Rt})/2 \tag{11R}$$

and

$$B_{Bt} = B_{Rt} = (2 - \theta - \Gamma_{Bt})/2 \tag{11B}$$

and the utility functions can be written

$$U_{Rt} = r log(\Gamma_{Rt}) + 0.5 log(\theta - \Gamma_{Rt}) + 0.5 log(2 - \theta - \Gamma_{Bt}) - log(2) \tag{12R}$$

$$U_{Bt} = b log(\Gamma_{Bt}) + 0.5 log(2 - \theta - \Gamma_{Bt}) + 0.5 log(\theta - \Gamma_{Rt}) - log(2) \tag{12B}$$

Each government chooses the path $\{T_{jt}, m_{jt}\}$ that maximizes the discounted sum of its citizens' utilities:

$$\max_{\{T_{jt}, m_{jt}\}} W_j = \sum_{t=0}^{\infty} \delta^t U_{jt}$$

where δ is the discount rate reflecting the length of the governments' horizon.

The interaction between the governments may therefore be formulated as a dynamic game, possessing multiple equilibria. Since instantaneous utilities only depend on contemporaneous policy variables (i.e. $U_{jt} = U_{jt}(T_{jt}, m_{jt})$), we can easily solve for one possible equilibrium of this game: the "static" equilibrium in which dynamic interactions are neglected, reducing the dynamic case to a sequence of repetitions of the "one-shot" (single period) game. The static solution is a perfect equilibrium of the full dynamic game.

Maximization of U_{Rt} over Γ_{Rt} and U_{Bt} over Γ_{Bt} yields optimal expenditure policies, which are constant over time:

$$\Gamma_R^* = \frac{2r\theta}{1+2r} \qquad \Gamma_B^* = \frac{2b(2-\theta)}{1+2b} \tag{13}$$

Two points are noteworthy. First, whether a country's public good is financed by taxes or by fiat money is irrelevant. An increase in the proportion financed by money increases inflation, while leading at the same time to a proportionate depreciation of the exchange rate. Thus the higher nominal wealth of the country's citizens does not translate into a higher share of world resources. Second, the governments' decisions are independent of one another, even though each country's citizens' utility depends on the other country's policy; this finding is special to the simple Cobb-Douglas utility form we have specified.

Since each government neglects the effect of its public expenditure on the other country's welfare, the non-cooperative Nash equilibrium we have derived is not Pareto optimal. In fact, the two countries spend too large a fraction of their resources on the public good. The intuition is straightforward. An increase in government expenditure reduces the supply of goods for private consumption. While residents are compensated by the additional supply of the public good, foreigners, in our model, do not benefit from it in any way. A central planner, maximizing the sum of the two country's welfare $(U_{Rt} + U_{Bt})$, would set

$$\Gamma^*_R = \frac{r\theta}{1+r} \qquad \Gamma^*_B = \frac{b(2-\theta)}{1+b}$$

Simulation Methodology

Each of the models presented has been simulated over a range of parameter values. We concentrate on variation in two parameters: θ, which measures the relative size of Red as opposed to Blue; and r (with b fixed) which measures Red's relative desire for the public good (the size of the public sector). To calibrate these parameters, consider the left-hand-side of Table 1, which lists the European countries which are members of the EEC, together with their GDP (in ECU units) and the share of GDP devoted to government. The right-hand-side of Table 1 depicts the ranges of θ, r, and b chosen. The variable θ ranges from 1.0 (equal size) through 1.25 and 1.50 to 1.75 (7 to 1 size differential), while b is fixed at 1/2 (government's share is then one third) and r ranges over $1/4, 1/2$, and 1.

Simulation of Flexible Exchange Rate Regime

Figure 1 illustrates Red and Blue utility under flexible exchange rates as a function of the relative endowment (θ), for different values of r (Red's need for the public good). As θ increases, the share of world resources owned by the Blue country falls, and so does Blue welfare. As the weight of the public good in Red utility, r, increases, so does the intervention of the Red government in the Red market. This implies a decrease in the proportion of Red goods available for private consumption, and therefore a loss of utility for Blue nationals.

In the Red country, an increase in θ increases national wealth, but reduces relative world supply of the Blue good. The two effects tend to counteract each other, the first dominating for θ close to one and the second becoming progressively more important, until Red utility begins to fall for θ approximately larger than 1.5. The relevance of this second effect is smaller, as expected, when the public good plays a larger role in utility (r higher).

Table 1

Calibration of Model Parameters

European Statistics*		
	GDP^ (1984)	Government Share (1984)
Belgium	96.9	17.4
Denmark	68.7	25.9
W. Germany	783.8	13.6
Greece	42.7	19.0
Spain	198.5	12.3
France	623.3	16.4
Ireland	22.2	19.0
Italy	445.3	19.4
Luxembourg	4.4	15.7
Netherlands	157.9	16.8
Portugal	24.4	....
United Kingdom	540.3	21.9

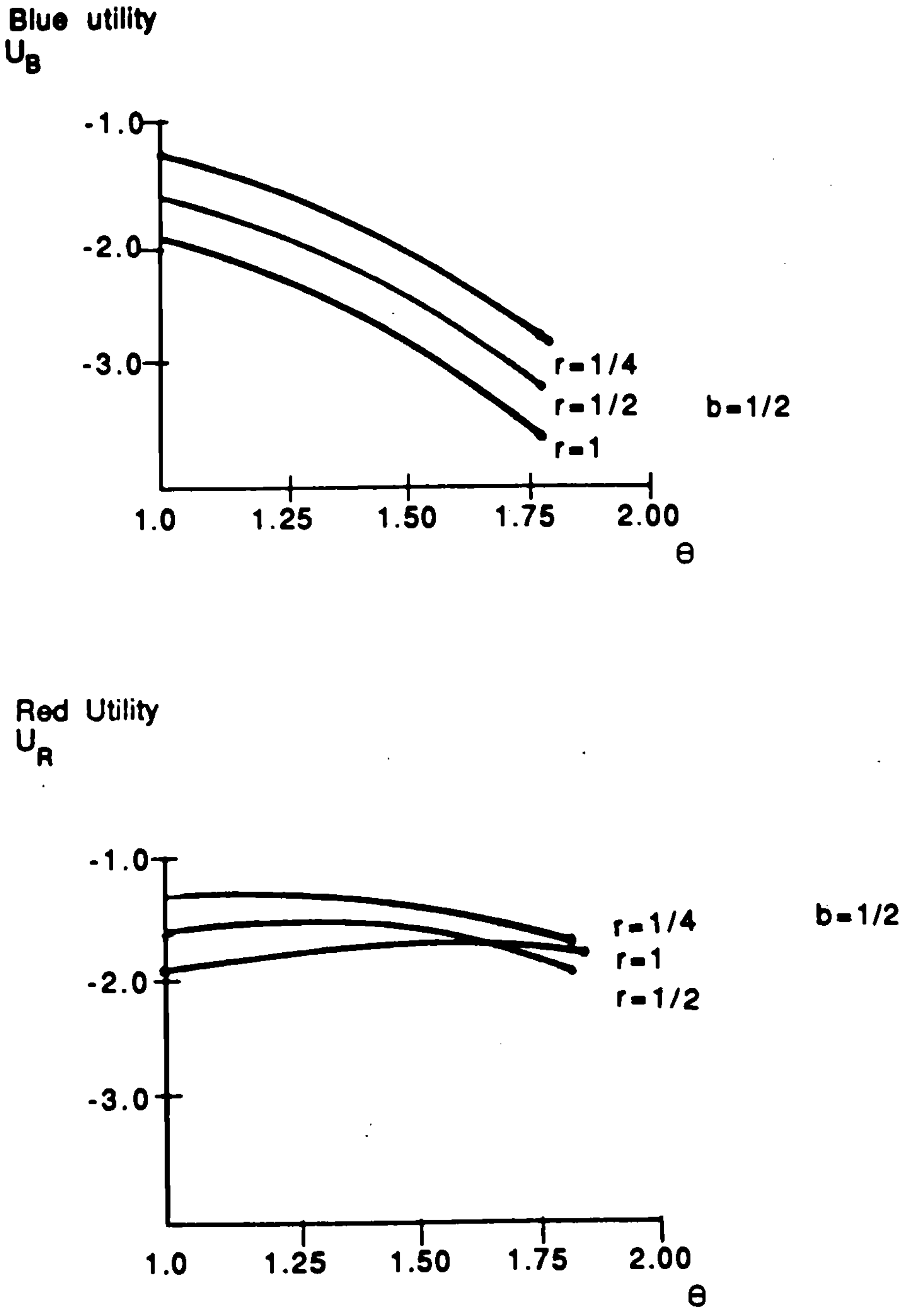
Parameter Values	
Size θ	Government Share r
1.0 (equal)	1/4 (20%)
1.25 (1.67 to 1)	1/2 (33%)
1.50 (3 to 1)	1 (50%)
1.75 (7 to 1)	

*Taken from Eurostat: Basic Statistics of the European Community. Luxenbourg: Office for Official Publications of the European Communities, 1987.

^in ECU.

Figure 1

Utilities Under Flexible Exchange Rates



Common Currency Printed by Both Countries [5]

Suppose now that the two countries use the same currency, and that each country maintains a central bank and can print as much of the currency as it likes. This seems the natural setting for the case of perfectly substitutable currencies studied in the literature (see for example Kareken and Wallace (1981))[6], and is to be distinguished from the case of a common currency printed by a joint central bank.

Derivation of the demand functions is identical to the flexible exchange rate case with e_t set equal to 1 for all t. Substitution of (4) in the two goods markets' equilibrium conditions yields the equilibrium relative price:

$$p_t = \frac{p_{Rt}}{p_{Bt}} = \frac{2-\theta-\Gamma_{Bt}}{\theta-\Gamma_{Rt}}$$

and inflation rates:

$$1+\pi_{Rt} = (1/2)\left[\frac{\theta - T_{R(t-1)}}{\theta-\Gamma_{Rt}} + \frac{(\theta-\Gamma_{R(t-1)})(2-\theta-T_{B(t-1)})}{(\theta-\Gamma_{Rt})(2-\theta-\Gamma_{B(t-1)})}\right] \tag{14R}$$

$$1+\pi_{Bt} = (1/2)\left[\frac{2-\theta-T_{B(t-1)}}{2-\theta-\Gamma_{Bt}} + \frac{(2-\theta-\Gamma_{B(t-1)})(\theta-T_{R(t-1)})}{(2-\theta-\Gamma_{Bt})(\theta-\Gamma_{R(t-1)})}\right] \tag{14B}$$

Demands can then be written

$$R_{Rt} = (\theta-\Gamma_{Rt})(\theta-T_{R(t-1)})(2-\theta-\Gamma_{B(t-1)}) \bullet \Delta_t \tag{15}$$

$$B_{Rt} = (2-\theta-\Gamma_{Bt})(\theta-T_{R(t-1)})(2-\theta-\Gamma_{B(t-1)}) \bullet \Delta_t$$

$$B_{Bt} = (2-\theta-\Gamma_{Bt})(\theta-\Gamma_{R(t-1)})(2-\theta-T_{B(t-1)}) \bullet \Delta_t$$

$$R_{Bt} = (\theta-\Gamma_{Rt})(\theta-\Gamma_{R(t-1)})(2-\theta-T_{B(t-1)}) \bullet \Delta_t$$

where

$$\Delta_t = \frac{1}{(2-\theta-T_{B(t-1)})(\theta-\Gamma_{R(t-1)}) + (2-\theta-\Gamma_{B(t-1)})(\theta-T_{R(t-1)})}$$

Instantaneous utilites are given by

$$U_{Rt} = rlog(\Gamma_{Rt}) + log(\theta - T_{R(t-1)}) + 0.5log(\theta-\Gamma_{Rt}) + \tag{16R}$$

$$log(2-\theta-\Gamma_{B(t-1)}) + 0.5log(2-\theta-\Gamma_{Bt}) + log(\Delta_t)$$

$$U_{Bt} = blog(\Gamma_{Bt}) + log(2-\theta-T_{B(t-1)}) + 0.5log(2-\theta-\Gamma_{Bt}) + \qquad (16B)$$
$$log(\theta-\Gamma_{R(t-1)}) + 0.5log(\theta-\Gamma_{Rt}) + log(\Delta_t)$$

The utility of a consumer at time t now depends both on contemporaneous and last period government policies. However, the problem is greatly simplified by the additively separable form of the utility function. At time t, a government maximizing the present discounted sum of its citizens' utilities can isolate the terms depending on its period t policies. Redefining this sum as the government payoff of the "one-shot" game, the repetition of the static solution yields once more a perfect equilibrium for the dynamic problem, in which each period policy is independent of the previous period choice.

Taking into consideration only the relevant terms, the red government will act at time t so as to maximize the expression

$$rlog(\Gamma_{Rt}) + 0.5log(\theta-\Gamma_{Rt}) + \delta\Big[log(\theta-T_{Rt}) + log(\Delta_{t+1})\Big] \qquad (17R)$$

subject to the constraint $\Gamma_{Rt} = m_{Rt} + T_{Rt}$. Similarly, the blue government maximizes

$$blog(\Gamma_{Bt}) + 0.5log(2-\theta-\Gamma_{Bt}) + \delta\Big[log(2-\theta-T_{Rt}) + log(\Delta_{t+1})\Big] \qquad (17B)$$

subject to $\Gamma_{Bt} = m_{Bt} + T_{Bt}$.

In contrast to the flexible exchange rate regime, the policy mix between money and taxes is now relevant to welfare. The first important observation is that, in this framework, the optimal level of taxes is zero in both countries. Collecting revenues through seignorage has a positive effect on the relative wealth of nationals next period, because the world inflation rate rises less than proportionately. Since this is not true for taxes, all government expenditure will be completely financed by fiat money.

In fact the equations (17R) and (17B) can be written

$$rlog(\Gamma_{Rt}) + 0.5log(\theta-\Gamma_{Rt}) - \delta log\Big[(2-\theta-\Gamma_{Bt}) + \frac{(2-\theta-T_{Bt})}{(\theta-T_{Rt})}(\theta-\Gamma_{Rt})\Big]$$

$$blog(\Gamma_{Bt}) + 0.5log(2-\theta-\Gamma_{Bt}) - \delta log\Big[(\theta-\Gamma_{Rt}) + \frac{(\theta-T_{Rt})}{(2-\theta-T_{Bt})}(2-\theta-\Gamma_{Bt})\Big]$$

For given Γ_{Rt} and Γ_{Bt} each function is strictly decreasing in domestic taxes.

Setting $T_{Bt} = T_{Rt} = 0$ for all t, the governments' problems may be rephrased as:

$$\max_{m_{Rt}} rlog(m_{Rt}) + .5log(\theta-m_{Rt}) + \delta\Big[log(\theta) - log[\theta(2-\theta-m_{Bt}) + (2-\theta)(\theta-m_{Rt})\Big]$$

$$\max_{m_B} b log(m_B) + .5 log(2-\theta-m_{Bt}) + \delta\Big[log(2-\theta) - log[(2-\theta)(\theta-m_{Rt}) + \theta(2-\theta-m_{Bt})\Big] \tag{18}$$

with m_{Rt} and m_{Bt} each restricted to the unit interval.

The nature of the solution depends on the value of δ (the length of the governments' horizon). If δ is equal to zero (the governments do not consider future generations' utilities), then optimal policy is identical to the flexible exchange rate considered above.

$$m_{Rt} = \frac{2r\theta}{1+2r}$$

$$m_{Bt} = \frac{2b(2-\theta)}{1+2b}$$

Utilities are also equal to the flexible exchange rate case. However, as δ increases (as the governments give more weight to future generations' utilities), the optimum amount of money becomes larger since its only partial effect on world inflation allows each government to increase the purchasing power of its future citizens. At the same time, utilities become lower, as the Nash equilibrium yields ever higher world inflation. Eventually, for δ equal to one (the governments care equally about current and future generations), this monetary regime fails to possess a Nash equilibrium: for any amount of currency issued by the foreign government, the home government desires to supply more.

In the simple case $\theta = 2-\theta = 1$, the first order conditions associated with optimization problems (18) are:

$$\frac{r}{m_{Rt}} = \frac{1}{2(1-m_{Rt})} + \frac{\delta}{(2-m_{Bt}-m_{Rt})} = 0$$

$$\frac{b}{m_{Bt}} = \frac{1}{2(1-m_{Bt})} + \frac{\delta}{(2-m_{Bt}-m_{Rt})} = 0$$

If $\delta = 1$ and $r = b = 0.5$, these expressions can be further simplified:

$$m_{Rt} = \frac{m_{Bt}-2}{2m_{Bt}-3}$$

$$m_{Bt} = \frac{m_{Rt}-2}{2m_{Rt}-3} \tag{19}$$

Examination of the equations (19) demonstrates that the two reaction functions do not intersect within the relevant range $[0,1]X[0,1]$.

For different values of δ, we were unable to obtain a simple closed form solution, and we checked our intuition with numerical simulations. The results of the simulations, confirming the expected outcome, are depicted in Figure 2. The conclusion does not depend on the symmetry of this simple example. Different endowments ($\theta \neq 1$) or different needs for the public good ($r \neq b$) did not alter the qualitative nature of our result.[7]

The important point established by this exercise is that, at least in our model, independent printing of a common currency by national central banks is strictly dominated by the flexible exchange rate regime, and is not, therefore, a viable institutional arrangement. Each country has an incentive to deviate, printing a new currency and requiring its exclusive use on the domestic markets.

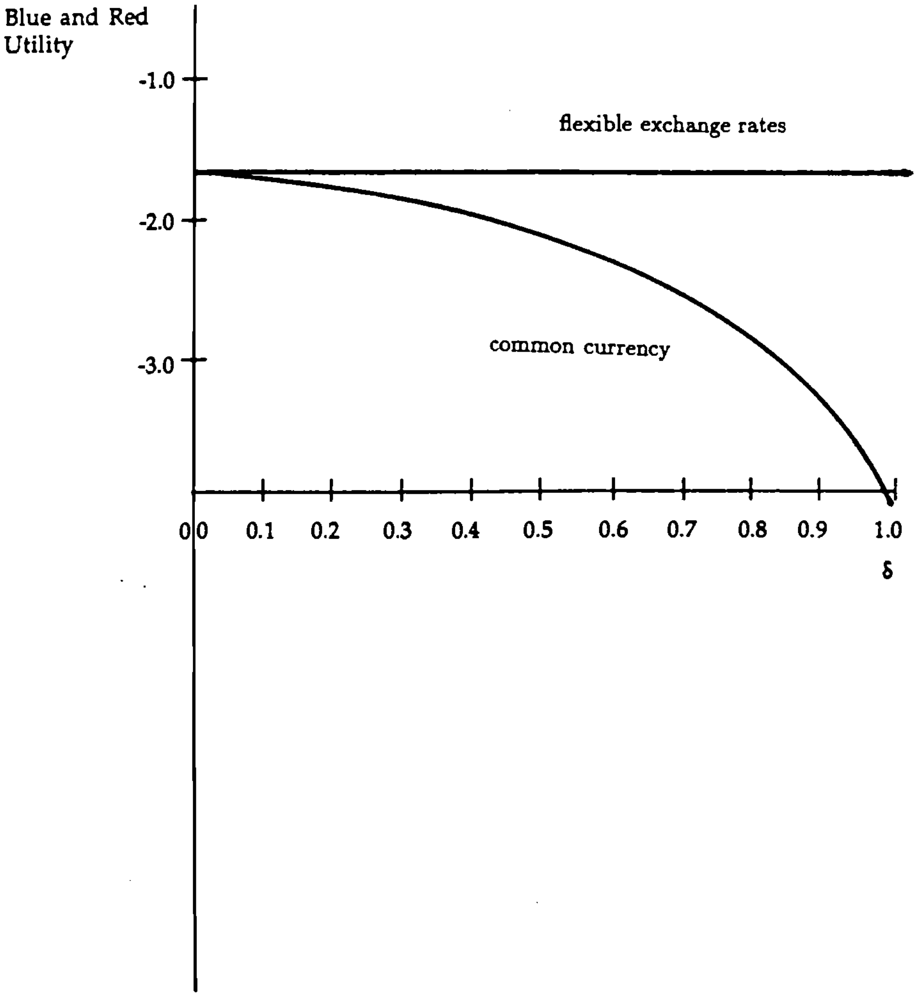
The source of this result lies in two effects. The first one relates to the distortion caused by non-cooperation between the two governments in the flexible exchange rate regime. In our model, the two public sectors in a Nash equilibrium with national currencies are too large. The second effect is the free-rider problem connected with the shift to a common money. If δ is different from zero, such a shift implies an ever higher level of spending by the governments (this is quite general, and does not depend on our specific assumptions). When the two effects are added, the result, or course, is that the institution of a common currency exacerbates the already present distortion and leads to a decrease in welfare. While our result remains true in models in which flexible exchange rates achieve the first best, in a more general setting the welfare comparison would depend on δ. We believe that it is always possible to identify a $\delta^* < 1$ such that welfare under flexible exchange rates is inferior to welfare under common currency and national central banks if and only if $\delta < \delta^*$. In our model, $\delta^* = 0$.

Common Central Bank

Suppose now that the two countries have agreed on the institution of a common central bank to whom decisions concerning the fiat currency are deferred. The central bank acts to maximize the weighted sum of the utility of its members, with the weights reflecting the proportional representation of each country. The Bank determines the paths over time of three quantities, aggregate world money supply, the fraction of that amount spent on each market, and the distribution of seignorage (which may differ from the distribution of money purchases on the two markets) between the two countries.

Figure 2

Common Currency, National Central Banks
Utilities as a Function of the Discount Rate
The Case θ Equal to 1.0, r and b Equal to 0.5



Competition between the two countries now emerges indirectly, in the struggle to manipulate Bank policy. In fact, the setup bears some relationship to the "common agency" framework of Bernheim and Whinston (1986), although we assume that all Bank actions are observable, and, as an initial simple example, that full information about each country's parameters is common knowledge. We also, for the time being, assume that the weight of each country in aggregate welfare is proportional to the size of its endowment ("proportional representation"); we may think of these weights as the countries' relative bargaining powers. While this arrangement is ad hoc, it is a reasonable reference point on which further extensions can be built.

The central bank maximizes

$$\sum_{t=0}^{\infty} \delta^t \left[\theta U_{Rt} + (2-\theta) U_{Bt} \right]$$

with respect to $\{s_{Rt}, s_{Bt}, m_{Rt}, m_{Bt}\}$ and the constraints that $s_{Rt} + s_{Bt}$ equal $m_{Rt} + m_{Bt} = m_t$, and that m_{Rt} not exceed θ and m_{Bt} not exceed $2-\theta$. Here s_{it} are seignorage revenues distributed to country i in period t and m_{it} is the real amount of fiat currency spent on market i during t.

In general, the two countries can supplement Bank action with their own fiscal and monetary interventions. However, as the earlier analysis showed, in the case of common currency, free and independent issuing of money by the two governments results in lower welfare. This remains true when the governments' decisions coexist with a central bank.[8]

More interesting, and relevant, is the case in which each government retains its right to collect taxes from its nationals, while monetary policy is fully delegated to the central bank. Quite suprisingly, it is possible to prove that in this regime it is optimal for the central bank to set new money issues to zero. The two countries will completely finance themselves through taxes, and will achieve exactly the same welfare as in the flexible exchange rate case.

The intuition is as follows. For any positive amount of real money injected into the domestic market, an increase in taxes implies a reduction in the availability of the domestic good in the private sector, and hence a rise in its relative price (relative to the other country's good). This requires a higher level of nominal money from the Bank to achieve the same real money injection, thereby increasing nationals' relative wealth.

In other words, if m_R and m_B are positive, each government chooses a level of expenditure that is larger than in the flexible exchange rate case, in the effort to exploit central bank policy to its own purposes. In equilibrium, this implies a welfare loss. If instead m_R and m_B are both set to zero by the central bank, it is easy to show (by comparing equations (16) and (12)) that the current problem is identical to the flexible exchange rate case.

Slightly more formally, the conclusion follows from proving that, for any m_{jt}, the marginal utility of taxes in country j is higher in the common currency regime than in the flexible exchange case. Substituting the demand functions given in (4), we obtain the discounted sum of the citizens' utility,

$$\frac{dW_j}{dT_{jt}} = \frac{d(j log(\Gamma_{jt})}{dT_{jt}} + 0.5\frac{d(log X_{jjt})}{dT_{jt}} + 0.5\frac{d(log X_{ijt})}{dT_{jt}} +$$

$$\delta[0.5\frac{d(log(X_{jj(t+1)})}{dT_{jt}} + 0.5\frac{d(log X_{ij(t+1)})}{dT_{jt}}]$$

which may be evaluated as

$$\frac{dW_j}{dT_{jt}} = \frac{j}{m_{jt} + T_{jt}} - \frac{d(log(1 + \pi_{jt})}{dT_{jt}} - 0.5\frac{d(log(\theta_j - m_{jt} - T_{jt})}{dT_{jt}} + \tag{20}$$

$$\delta[\frac{d(log(\theta_j - T_{jt})}{dT_{jt}} - \frac{d(log(1 + \pi_{j(t+1)})}{dT_{jt}}]$$

In the flexible exchange rate regime, π_{jt} is given by equation (10); in the common currency regime by equation (14). Examination of these equations demonstrates that $\frac{d(log(1+\pi_{jt})}{dT_{jt}}$ is the same in both, whereas $\frac{d(log(1+\pi_{j(t+1)})}{dT_{jt}}$ is larger in the flexible exchange rate regime for all m_{it} different from zero. Since all other terms in equation (20) are the same across the two regimes, the result follows.[9]

In our model, if the governments retain their fiscal powers, not only is the central bank incapable of improving coordination between the two countries, but in addition any action it takes serves only to introduce incentives driving the countries further away from a first-best outcome. Once again, the unqualified strength of this result depends on the specific assumptions of the model (the direction of the distortion in the flexible exchange rate regime; the lump-sum character of the taxes and their effect on the terms of trade). The point we want to stress is general, however, and, we believe, important: the presence of a common currency, **even under the control of a central planner**, is the source of additional potential distortions. In a world which is not Pareto optimal, the final outcome would then depend on second-best types of arguments.

Consider now the extreme case in which the two governments are not allowed to collect taxes. The only resources available for the supply of the public good are, in each country, those ditributed as seignorage by the central bank.

Since the central bank maximizes weighted aggregate social welfare, its choices will clearly constitute a first best arrangement in this case; what is less clear is how the countries' weights translate into individual country utility, particularly as compared with the earlier monetary regimes.

The instantaneous utilities U_{Rt} and U_{Bt} are given by equation (16), setting T_{Rt} and T_{Bt} to zero. They are rewritten here for convenience:

$$U_{Rt} = rlog(s_{Rt}) + 0.5log(2 - \theta - m_{Bt}) + \tag{16R}$$

$$log(\theta) + log(2 - \theta - m_{B(t-1)}) + 0.5log(\theta - m_{Rt}) + log(\Delta_t)$$

$$U_{Bt} = blog(s_{Bt}) + 0.5log(2 - \theta - m_{Bt}) + \tag{16B}$$

$$log(2 - \theta) + log(\theta - m_{R(t-1)}) + 0.5log(\theta - m_{Rt}) + log(\Delta_t)$$

where

$$\Delta_t = \frac{1}{(2 - \theta)(\theta - m_{R(t-1)}) + (2 - \theta - m_{B(t-1)})\theta}$$

As above, the central bank maximizes the weighted sum of discounted utilities.

If $\theta = 2 - \theta = 1$, the optimal choice for the central bank is characterized by the following equations:

$$s_{Bt} = \frac{b}{r + b} m_t$$

$$m_{Bt} = \frac{m_t}{2}$$

$$m_t = \frac{2(r + b)}{r + b + 2}$$

(Note that δ does not enter these expressions.) The total amount of money is spent on the two markets in equal proportions, while the division of seignorage is determined by the relative need for the public good.

For $\theta \neq 1$ (and $\delta \neq 0$), we have not been able to obtain a closed form solution, and we present the results of numerical simulations. In Figure 3 the welfare of the two countries is depicted as a function of the relative size of the endowments and of the weight of the public good in Red utility (for $\delta = .9^{10}$). As θ increases, the Blue country becomes poorer and has less influence on the decisions of the central bank. As expected, its utility declines. The Blue country's utility is also lower the higher is r, since a higher r implies a proportionally lower Blue share in the division of seignorage. This second effect becomes more important the larger is θ.

As in the flexible exchange rate case, the Red utility increases with θ, until the negative effect of the Blue good's scarcity starts to dominate the positive impact of larger national wealth and larger bargaining power. The relative importance of the negative effect (scarcity of the Blue good) is lower the larger is the weight of the public good in Red utility, since a larger r gives added relevance to Red's increased bargaining power in the sharing of seignorage revenues.

Welfare Comparisons

It is now possible to compare utility levels across different monetary regimes, as functions of the parameters. Since the common currency – national central banks arrangement is strictly dominated by the flexible exchange rate case, we have already argued that such a regime cannot be sustained in our model. In addition, we have proved that when the countries agree on a common currency and a common central bank, but retain fiscal powers, the equilibrium reduces identically to the one characterizing flexible exchange rates. The interesting comparison is therefore between the latter regime and the case in which, with a common currency, the financing of the public good is entirely deferred to the common central bank.

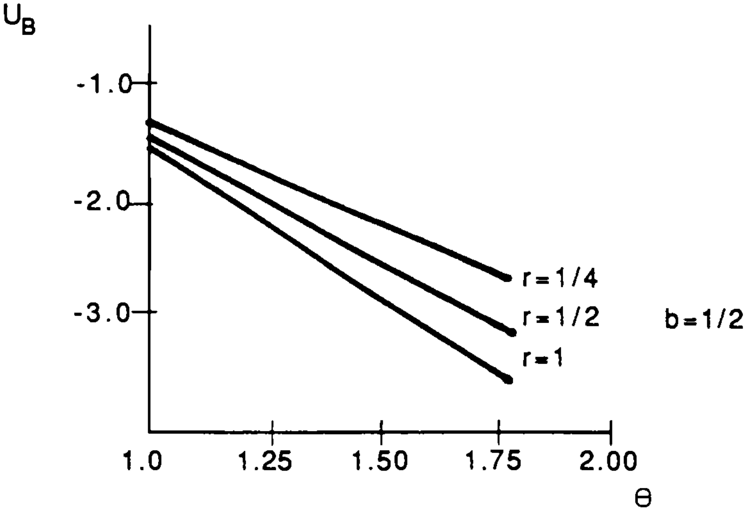
In Figure 4, the welfares of the two countries under the two regimes are drawn as a function of θ, the relative endowment of the Red. When θ is close to one the two countries have similar wealth and similar bargaining power. The central bank case then achieves a first best allocation which is preferred to flexible exchange rates by both the Blue and the Red. However, as θ increases the bargaining power of the Blue country falls (recall that representation is proportional). By the time the Red country is 25% bigger than the Blue (θ equal to 1.125) Blue prefers the flexible exchange rate regime: it will deviate, issuing its own currency and requiring the currency to be used on the Blue market, thereby moving the world economy back to the flexible exchange rate regime.

The relative attractiveness of the two regimes depends in a predictable way on Red's relative need for the public good (see Figure 5). As r falls (diminished need) Blue's

Figure 3

Utilities under Central Bank
(Money Only)
The Case δ Equal to .9

(a) Blue utility



(a) Red Utility

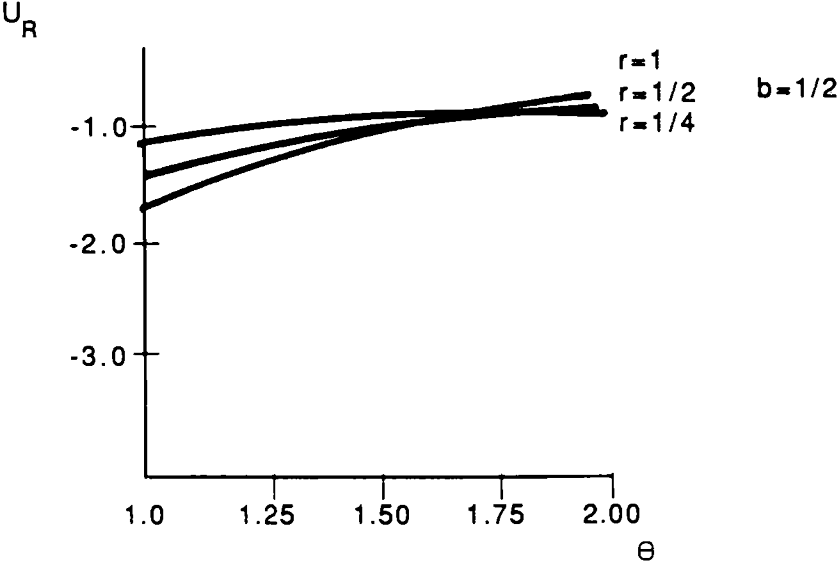
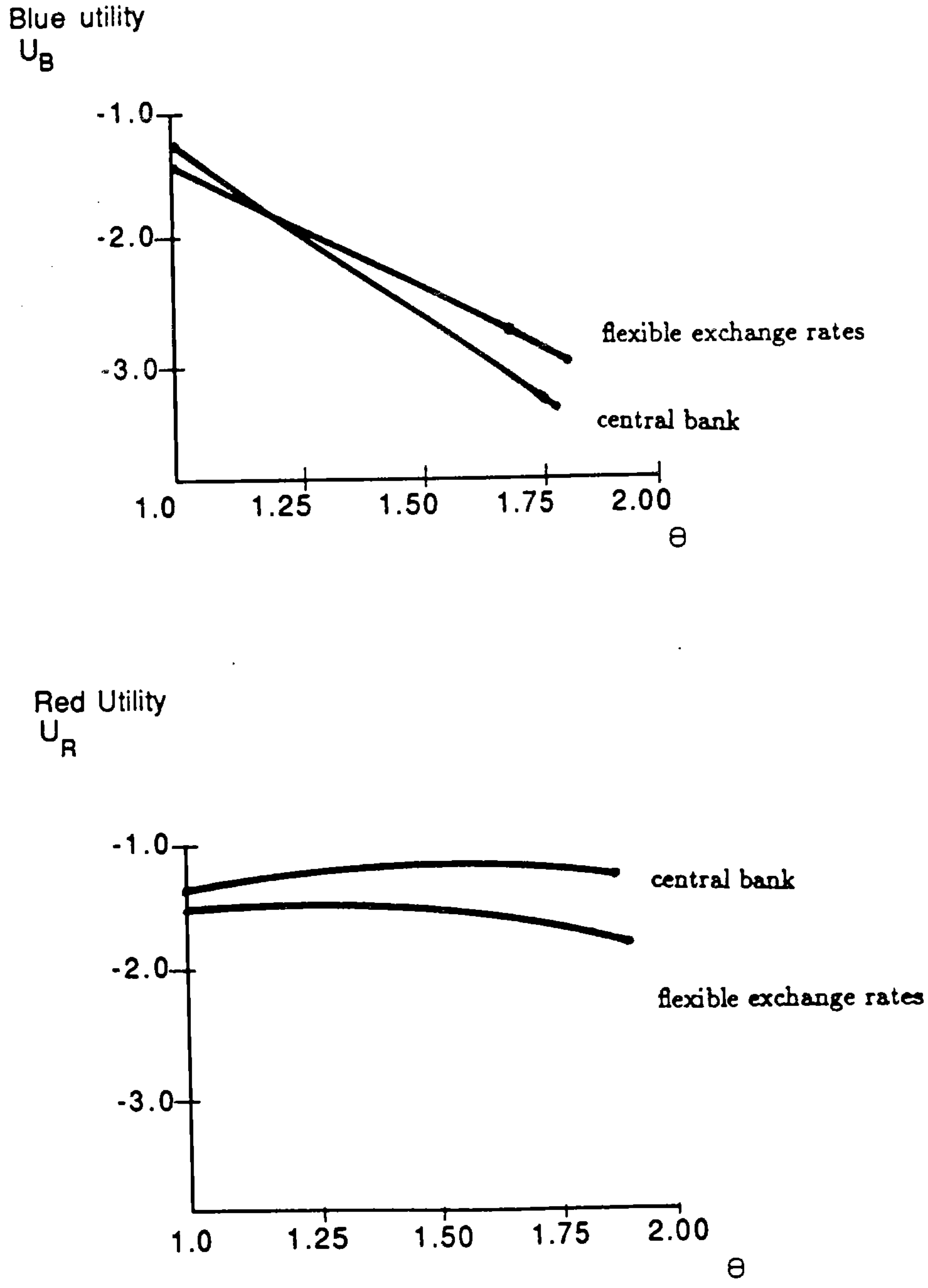


Figure 4

Comparison of Utilities Under Flexible Exchange Rates and Central Bank The Case δ Equal to .9, r and b Equal to .5



Comparison of Utilities Under
Flexible Exchange Rates and Central Bank
Dependence on Need for the Public Good
The Case δ Equal to .9, b Equal to .5, θ Equal to 1.0

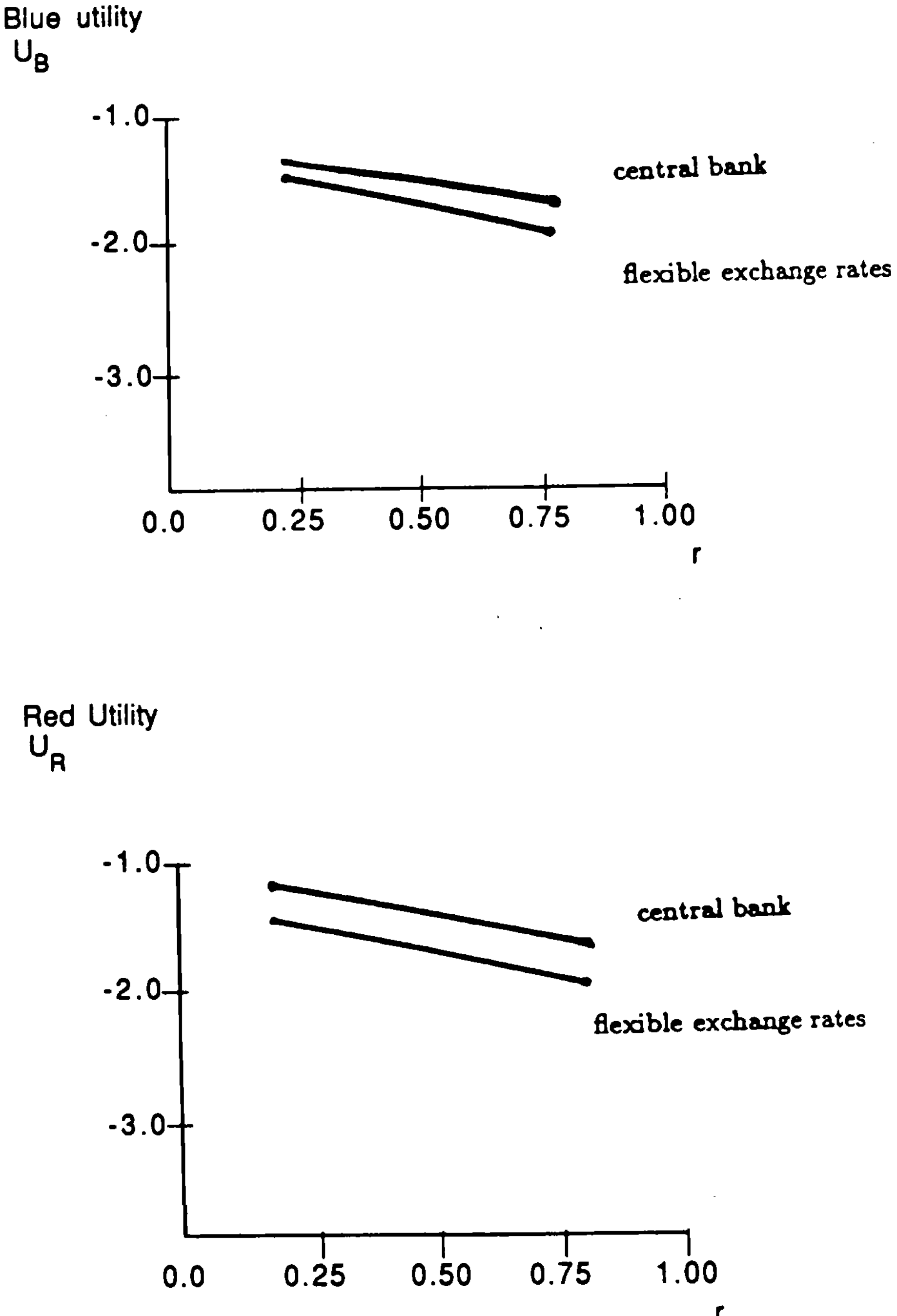
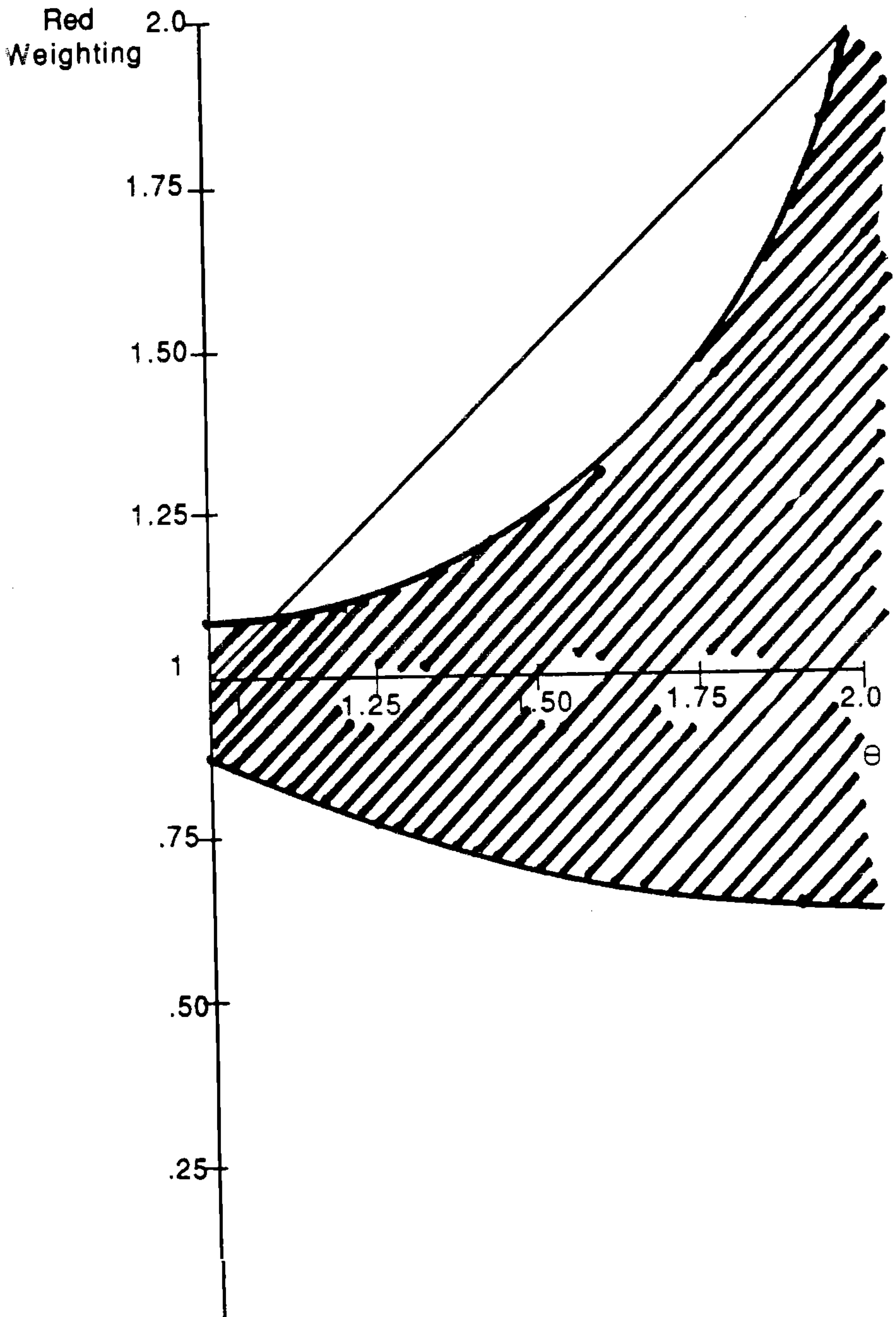


Figure 6

Zone of Participation
Central Bank
(Money Only)
The Case δ Equal to .9, r and b Equal to .5



preference for the central bank increases, and so does the difference in bargaining power necessary for the Blue government to abandon the central bank agreement. As for the Red country, an increase in θ has, in both regimes, the two opposite effects discussed above. In the central bank case, the growing scarcity of the Blue good is partially compensated by Red's increased bargaining power.

What is especially interesting is the finding that **proportional** representation, in which a country's influence on the Bank is proportional to its size, is not a feasible system for even modest deviations of θ from one. Figure 6 explores this issue further, plotting the "zone of participation" for the central bank money only case. The shaded region is, for each θ, the range of weights for which both countries find the central bank preferrable to the default flexible exchange rate regime. The forty-five degree line corresponds to proportional representation and the horizontal axis to a one country – one vote system. As noted above, by the time θ reaches 1.125, proportional representation is not in the feasible (participation) zone. Even though belonging to the union would eliminate the externality, the small country would enjoy less of the public good than under flexible exchange rates, and would face worsened terms of trade in the private markets. These two negative effects disappear as the asymmetry between the two countries widens.

Therefore we reach the (not implausible) conclusion that a common central bank might be relatively easy to establish in a world of either equal or highly unequal trading partners, but not otherwise.

Extensions

We believe the model presented here could be usefully extended in several directions. First, we could investigate more fully the mechanism design problem facing the two countries in the creation of an "optimal" central bank. Since the sharing of power is crucial to the willingness of countries to participate, devising an appropriate system of representation seems to be a crucial issue.

Second, the extension of our model to a multi-country world would be nontrivial. The incentives to join or abandon the union, and the choice of policy, presumably held in common by all members, towards outsiders are examples of important questions that would require analysis.

Third, we can study optimal policy in a world of uncertainty. What we specifically have in mind is a situation where the Red country knows r and the Blue b, but neither country knows the other; by assumption the central bank observes neither r or b, and must solicit each from the respective countries, designing incentives which ensure these are reported truthfully. We would guess that it will be difficult for the central bank to do better in this case than in the perfect information example we have presented.

Finally, there is a more fundamental point that needs to be addressed. While the model we built can be used to study the potential for policy coordination in different monetary regimes, it does not address an important aspect of the current European debate. Specifically, nowhere does it demonstrate (derive endogenously) a need amongst the countries for a common currency, and more generally, common institutions, such as common financial and bank laws. This problem is general and very important. Welfare improving trade between agents requires efficient communication, and this requirement becomes more crucial as the economy grows, with technology becoming more sophisticated and fields of specialization narrower. Traders who "speak a different language" will not only suffer transactions costs, but will increasingly lose opportunities and information. Eventually, they might remain confined to a secluded, low productivity corner of a global market. We are currently developing analyses which address these points.[11]

Footnotes

[*] We thank participants in the Castelgandolfo Conference on European monetary systems held during June 16-17, 1988, and especially our discussants Torsten Persson and Guido Tabellini, for comments.

[1] Simple technical assumptions can give rise to the described sequence of transactions. Suppose, for example, that each good comes in a specific variety and each consumer has specific preferences. Then a competititive market will be needed to provide optimal matching.

[2] In this formulation governments are prohibited from purchasing goods on the foreign market, and of course they can only tax their own nationals.

[3] For completeness, we have also solved the model for the case in which the two countries use the same currency, but this is supplied monopolistically by one of the two. Imagine that the Red currency is needed for transactions on both markets. We write here this solution as a future reference, for comparison with results obtained later in the text. The Red government alone can print the currency, and spends it on the Red market to finance the public good. It can be proved that the Red government will never resort to direct taxation. The two instantaneous utility functions are then:

$$U_{Rt} = rlog(m_{Rt}) + 0.5log(\theta - m_{Rt}) + log(\theta) - 0.5log(2 - \theta - T_{Bt}) - log(2\theta - m_{R(t-1)}) \quad (1AR)$$

$$U_{Bt} = blog(T_{Bt}) + .5log(2 - \theta - T_{Bt}) + log(\theta - m_{R(t-1)}) + 0.5log(\theta - m_{Rt}) - log(2\theta - m_{R(t-1)}) \quad (1AB)$$

Maximization of $\sum_{t=0}^{\infty} \delta^t U_{Rt}$ with respect to m_{Rt} gives the condition

$$m_{Rt}^2(\delta - r - 1/2) = \theta m_{Rt}(\delta - 3r - 1) + 2\theta^2 r \quad (2A)$$

while the Blue government will set T_{Bt} to

$$T_{Bt} = \frac{2b(2 - \theta)}{1 + 2b}$$

The welfare of the two countries can then be derived as a function of the parameters θ, δ, b and r. For example, when $r = b = .5$ and $\delta = .9$, we have for θ equal to one:

$$U_R = -1.39 \qquad U_B = -2.6$$

and for θ equal to 1.5:

$$U_R = -1.33 \qquad U_B = -3.06$$

The general result is that the Red country does better than in any other regime, while the Blue country does worse.

[4] We assume no government intervention in the foreign exchange market.

[5] While it is clear that a better equilibrium can be reached through coordination of financing decisions, there is no reason why we should expect this to occur automatically, or even just more easily, in a world with a unique currency. The shift to such a regime requires justifications that are outside the model presented. As usual, the simplest justification is transactions costs. Think, for example, of a scaling down of utility when consumers purchase on the foreign market, spending time and effort to understand the workings of a foreign currency system. This point is further discussed in the Extensions section of this paper. For an interesting approach to transactions costs in the context of optimum currency areas, see Mundell (in Johnson and Swoboda (1973), Chapter 7).

[6] If there are two distinct currencies, perfect substitutibility requires the highly unlikely existence of fixed exchange rate regime with zero probability of revision.

[7] Two points are worth mentioning. (1) While the dependence of optimal policy on the government's horizon is well-known in the literature (see Alesina and Tabellini (1987)), our model is somewhat special since it focuses on the strategic interaction between the two countries (and not between two successive national governments) when a common currency is used. This explains why our conclusion (a myopic government inflating less than a forward looking one) is in contradiction to previous results. Of course, it would be interesting to extend the analysis to a model taking both effects into consideration. (2) Strictly speaking, the maximization problem is not well defined for $\delta = 1$ (since the objective function is a non-converging infinite sum). We should then rewrite the problem as the maximization of a time average, which we believe would give the same result. This is a minor technical point.

[8] It is presumably possible to design a tax scheme such that the two countries are taxed by the central bank on their additional printing of the common currency, and these tax revenues are then redistributed. It is crucial that each country not receive back what was withdrawn from it in taxes. In fact, in accordance with the Groves' mechanism solution to the free rider problem in public finance, it might be sensible to study an agreement in

which the taxes collected from one government are distributed to the other. The tax rates would then depend on the inflation rate. We would like to develop this point further.

[9] More precisely, our result is obtained by assuming that the central bank acts as a Stackelberg leader with respect to the national governments. The conclusion is sensitive to the equilibrium concept we use.

[10] When θ is different from 1, the solution seems to depend on δ, but only slightly. We have simulated the model for values of δ ranging from .5 to 1, obtaining substantially the same result.

[11] See Casella and Feinstein (1988).

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