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REAL TRANSFERS IN FIXED EXCHANGE RATE SYSTEMS
AND THE INTERNATIONAL ADJUSTMENT MECHANISM

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REAL TRANSFERS IN FIXED EXCHANGE RATE SYSTEMS
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1. Introduction

This paper deals with the properties of fixed exchange rate systems. We discuss different institutional settings to maintain the fixed exchange rate and show that there is an inherent redistribution of purchasing power in some of these stabilization schemes. The importance of recognizing the difference between different systems is illustrated by an examination of the international adjustment to monetary disturbances. The emphasis is on the real effects of these disturbances.

We treat three types of systems. In the first the stabilization operations are carried out by help of interest-bearing reserves. In the second there are non-interest bearing reserves, such as gold or currency. Finally, we consider a third system, where two countries form an Exchange Rate Union and cooperate in a particular way to support the fixed exchange rate.

The analysis relies on a two-country intertemporal general equilibrium framework. It incorporates maximizing agents with perfect

foresight that interact on Walrasian markets. These assumptions are made deliberately to create an idealized situation, which will make it easier to compare the different systems by highlighting their particular institutional features.

The analysis gives an explicit transactions role to money. This makes it possible to consistently treat both money and interest-bearing assets, although there is perfect foresight. Similar approaches have recently been used in other studies of exchange rate systems. An important contribution, to which this study owes a great deal of inspiration, is Helpman (1981); other examples are Stockman (1980), Lucas (1982), Helpman and Razin (1982a), and Greenwood (1983).

It will be illustrative to relate the analysis and the results to the view on the adjustment to monetary disturbances that has been suggested by adherents to the Monetary Approach to the Balance of Payments (MABOP, in the sequel). This view, expressed for example in the seminal paper by Dornbusch (1973), can briefly be summarized as follows (see also Dornbusch (1980, ch. 7) for an extensive summary of the main arguments):

Monetary disturbances in either country will lead to an adjustment in the world economy, where the world money stock is redistributed between countries via the balance of payments. Monetary expansion in one country, for instance, leads to a deficit in that country and a surplus in other countries. This is accompanied by changes in each country's real spending level, upwards in deficit countries and downwards in surplus countries. Therefore the terms of trade will change during the adjustment,

to the extent that marginal propensities to spend are different. What remains in the long run is only a change in the world price level in proportion to the initial change in the world money stock.

This view has given rise to some controversy. However, the discussion has not so much focused on the mechanism per se as on the underlying assumptions, in particular the assumption about market clearing and full employment. Rather, the MABOP view of the adjustment mechanism has become conventional wisdom for the case when markets do clear. With respect to that assumption, the analytical framework used here is similar. ~~However, it differs from the typical MABOP framework in its explicit con-~~ sideration of intertemporal aspects and its separation of money and wealth. It will be seen that the intertemporal aspects, notably the form of each country's wealth constraint, are important in separating the different systems, and that the distinction between different types of assets is crucial for establishing the differences.

The paper is organized in the following way. In section 2 we give a general picture of the analytical framework. Then the subsequent three sections analyze the three different systems with their institutional peculiarities. The idea behind the analysis is simple. If monetary changes are to affect real variables, such as real spending and relative prices, they should somehow affect agents' wealth. Consequently, we examine the form of the two countries infinite horizon wealth constraints in each system. Then it will be seen that, by the perfect foresight assumption, we do in fact internalize the budget that arises from the stabiliza-

tion operations in private agents' wealth. This makes the analysis related to the approach taken in a recent paper by Obstfeld (1982).

We conclude that real variables are not affected by monetary disturbances in systems where the exchange rate is stabilized by the help of reserves of interest-bearing assets. In the other systems real variables are affected, because of a redistribution of wealth between the two countries. It is only in the Exchange Rate Union that the systematic relation between expansions, deficits, and real spending suggested by the MABOP holds without qualifications, however.

In Section 6 we construct a simplified example of the same type of model, although it has two rather than an infinite number of periods. Here, the arguments in the earlier sections are illustrated with some comparative static experiments investigating the effects of monetary disturbances on national wealths and welfare levels, and on relative prices. The paper ends with a section containing some concluding comments and ideas for further research.

2. Preliminaries

Consider a world of two countries: the home country and the foreign country. In each of them, there are representative households and firms, and a monetary authority. In the beginning of each time period markets meet and agents contract. All markets are spot markets, but agents have perfect foresight and optimize over an infinite horizon.

There are perfect world markets for the n (non-storable) goods in

existence. We allow either both countries producing all goods or any degree of specialization. Similarly, there are perfect world markets for financial assets - the two countries monies, and bonds denominated in both currencies. The two monies are traded on the foreign exchange market, while the bonds are issued in connection with short-term borrowing that has to be repaid in the next period. Finally, there are national markets for factors of production, which are trapped behind national borders. All these markets are efficient auction markets.

We study a monetary economy, that is an economy where money is in some sense essential. More precisely, in this economy money has to be one side in each transaction. To purchase foreign goods or assets one has to pay with foreign money.¹ The timing of transactions that corresponds to contracts in different markets is different. In financial assets, transactions are carried out instantaneously when markets meet. With regard to goods, actual payments are made successively during periods, as production and consumption take place. Factor remunerations and profits, finally, are paid out at the end of each period.

The result of these assumptions is a structure, with a well-defined demand for money at each point in time. In the beginning of a typical period the households come to the markets with a given money endowment. They use the financial markets to transfer wealth to the next period and to get the necessary amount of money for their consumption. During the period they pay for the goods they have contracted. The firms accumulate the money received and then pay it out at the end of the period

to its domestic owners and factors of production. Hence, the value of each country's output is distributed to the representative households in the form of domestic money. The households come to the beginning of the next period with this money and may then get a money transfer from (pay a lump-sum tax to) their monetary authority. The process we have outlined is then repeated in each subsequent period.

In this section we do not discuss how an equilibrium in this framework is determined; the reader is referred to Helpman (1981), for example. However, the model we use in Section 6 shows an example of a full equilibrium in a simplified economy of this type.

Instead, let us turn to the representative households. The decision problem for each of them is to determine an optimal plan for its consumption and its portfolio in all periods from now to infinity. In doing so, they maximize intertemporal utility functions defined over consumption of all goods in all periods, subject to a set of liquidity constraints. However, because the bond market allows free borrowing and lending, these liquidity constraints can be consolidated to intertemporal budget constraints on the following form:

$$\sum_{t=1}^{\infty} d_t p_t c_t = \bar{M} + \sum_{t=1}^{\infty} d_t D_t + \sum_{t=2}^{\infty} d_t (p_{t-1} x_{t-1}) \text{ and} \quad (1)$$

$$\sum_{t=1}^{\infty} d_t p_t c_t^* = \bar{M}^* + \sum_{t=1}^{\infty} d_t D_t^* + \sum_{t=2}^{\infty} d_t (p_{t-1} x_{t-1}^*) \quad . \quad (1^*)$$

Looking at the LHS of (1), we have the present value of consumption of the home country household. Here, p_t is an n -vector of spot prices, c_t is the

consumption vector in period t , and d_t is the (market) discount factor defined as $d_t \equiv [\prod_{\tau=1}^{t-1} (1+r_\tau)]^{-1}$, where r_t is the nominal interest rate. The RHS is the households' resource constraint which we refer to as the household's wealth, denoted by W . Here $\bar{M}$ is the initial money stock, D_t is the money transfer (lumpsum tax) that the home household receives (pays) in the beginning of period t , and x_t is the output vector of the home country. In (1*), the foreign household's budget constraint, notation is analogous but an asterisk is attached to foreign variables.

The values of national incomes appear with a one-period lag in (1) and (1*), since households do not get factor payments and profits until the end of the period. Furthermore, in an equilibrium in this type of economy, the law of one price will hold. Therefore, if we set the fixed exchange rate at unity in all periods the spot prices of all goods in terms of both currencies must be equal, that is $p_t = p_t^*$ must hold for all t . Also, the interest rate parity conditions will hold, so for all t we have $r_t = r_t^*$ and hence $d_t = d_t^*$.

In writing (1) and (1*) we have assumed that there is no debt outstanding at the outset. As mentioned in the introduction, we want to treat a friction-less framework, and the assumption of no initial debt eliminates a nominal stickiness that would otherwise arise. For convenience, we choose this simple route, rather than assuming that any non-zero initial debt is completely indexed.

Let us briefly discuss the equilibrium conditions for each period's money markets. With perfect foresight, bonds will obviously domi-

nate money as a store of value as long as nominal interest rates are strictly positive, which we shall assume. This means that private agents will use money only for transactions. With the particular transactions structure described earlier, it is then easy to show that for excess demand for the two monies to be zero, each country's money stock in circulation must correspond exactly to the value of its output in each period,

$$M_t = p_t x_t, \quad t = 1, \dots, \infty, \text{ and} \quad (2)$$

$$M_t^* = p_t x_t^*, \quad t = 1, \dots, \infty, \quad (2^*)$$

Similarly, the world money stock has to be equal to the value of world output,

$$M_t + M_t^* = p_t (x_t + x_t^*), \quad t = 1, \dots, \infty. \quad (3)$$

As a final preliminary step, let us note that, in the present model, the balance-of-payments deficits of the home and the foreign country can be written as:²

$$b_t = M_{t-1} + D_t - M_t, \quad t = 1, \dots, \infty, \text{ and} \quad (4)$$

$$b_t^* = M_{t-1}^* + D_t^* - M_t^*, \quad t = 1, \dots, \infty. \quad (4^*)$$

3. Interest-bearing reserves

Now suppose that one of the monetary authorities, or both together, has decided to stabilize the exchange rate. As mentioned above,

we shall assume that it stays at the same level, unity for simplicity, in all periods. Consider first the case of interest-bearing reserves. To fix ideas, we assume that the home country is the one to carry-out the interventions. In the model then, MA operates its interventions with reserves that consist of (short-term) bonds denominated in foreign currency. In order to sell foreign currency MA has to diminish its bond holdings, while these holdings are increased in periods when foreign currency is purchased.

We can measure the amount of interventions in a given period by the change in MA's assets, taking also last periods interest payments into account. Let us denote the net debt position of MA by S . Then we must have:

$$b_t = (S_t - (1 + r_{t-1})S_{t-1}) , \quad (5)$$

since the deficit in the home country's balance-of-payments must equal MA's sales of foreign money, which are financed by issuing bonds denominated in foreign currency. This is clearly consistent with (4) since M_t is identically equal to $M_{t-1} + D_t - (S_t - (1 + r_{t-1})S_{t-1})$, because of the necessary withdrawal of home money from circulation when MA sells foreign money.

How the foreign money stock develops over time depends on with whom MA transacts when it borrows (lends) the foreign currency it sells (buys) in the foreign exchange market. Either we might think of a cooperation between the two monetary authorities. In that case MA borrows

from the foreign monetary authority (MA*), who exchanges MA's bonds for newly issued money. Then we have:

$$b_t^* = -(S_t - (1 + r_{t-1})S_{t-1}) , \quad (5^*)$$

and foreign money develops according to $M_t^* = M_{t-1}^* + D_t + (S_t - (1 + r_{t-1})S_{t-1})$. Or, alternatively, MA might act on its own, transacting with the private sector abroad. Then, MA borrows (lends) foreign currency which is already circulating, in which case:

$$b_t^* = 0 , \quad (5'^*)$$

and $M_t^* = M_{t-1}^* + D_t^*$. The results to be discussed below are valid for both these cases.³

Let us now take a look at home and foreign wealth, W and W^* . To do this we rewrite the money market equilibrium conditions (2) and (2*) on the particular form they take in a system with interest-bearing reserves, by substituting from (5) and (5*) (or (5'*) and (4) and (4*)). Then, since households have perfect foresight, we may substitute these equilibrium conditions into the RHS of their intertemporal budget constraints, (1) and (1*), which in fact in the present model, amounts to internalizing the intertemporal budget of MA's interventions into household wealth. To arrive at the new expressions for W and W^* , we carry out these substitutions, simplify and impose the solvency constraint $\lim_{t \rightarrow \infty} d_t S_t = 0$ on MA, so as to eliminate its possibility of playing a Ponzi game. For the detailed

derivations, the reader is referred to Persson (1982a); here, we just state the result, namely:

$$W = \sum_{t=1}^{\infty} d_t p_t x_t \quad \text{and} \quad (6)$$

$$W^* = \sum_{t=1}^{\infty} d_t p_t x_t^* \quad . \quad (6^*)$$

Each country's wealth is thus equal to the present value of its output. This makes sense since we know that in any perfect foresight equilibrium the present value of world consumption (the sum of the LHS of (1) and (1*)) must equal the present value of world output. Actually, what is at the RHS of (6) is the present value of the home country's output plus the present value of the MA's borrowing over time. But because the latter is necessarily zero, only the former term remains.

Since this result holds for all developments of money stocks it seems that real spending should not be affected by monetary disturbances, provided, of course, that outputs and relative prices are independent of such disturbances. But that must always be the case in a world with Walrasian markets, perfect foresight, and no nominal stickiness. (We shall demonstrate this point formally in the example in section 6.) The upshot is, of course, that real spending, and real variables in general, are independent of monetary disturbances in a system with interest-bearing reserves.

These neutrality properties were already derived by Helpman (1981), who discussed a system where one country unilaterally fixes its

exchange rates supporting it with interest-bearing reserves - a "one-sided peg". From Helpman's nomenclature (and also to some extent from his discussion) one might get the impression that it is the one-sidedness that is important. However, as the analysis above makes clear, what is crucial for the result is that reserves are interest-bearing, and that MA's budget is intertemporally balanced.

Obstfeld (1982) derives akin results in a different framework, but with a similar underlying intuition. He considers a dynamic portfolio balance model of a single small economy, where the public may internalize the central bank's assets. If they do so and the central bank's foreign reserves are interest bearing, monetary policy has no effect neither in the short nor in the long run.

4. Non-interest bearing reserves

We now instead turn to a system with non-interest bearing reserves. We may again think of the foreign country as a "reserve-currency country," but now the reserves with which MA manages its stabilization operations consist of foreign money. However, the results presented below would hold also under a classical gold standard; see Persson (1982a).

In this regime then, if MA needs to sell foreign currency it does so drawing directly on its reserves. Hence, foreign money is injected into the system, while there is a corresponding withdrawal from the home money stock in circulation. Formally, if we denote MA's reserves by R , the home country's balance-of-payments deficit equals the decrease in R ,

$$b_t = - (R_t - R_{t-1}) , \quad (7)$$

while the foreign country's deficit is the negative of that;

$$b_t^* = (R_t - R_{t-1}) . \quad (7^*)$$

Substituting (7) and (7*) into (4) and (4*) we find $M_t = M_{t-1} + D_t + (R_t - R_{t-1})$, and $M_t^* = M_{t-1}^* + D_t^* - (R_t - R_{t-1})$. These expressions can be substituted into (2) and (2*) and, following the same approach as earlier, the resulting equilibrium conditions can be utilized to rewrite the wealth levels as (again see Persson (1982a) for details)⁴

$$W = \sum_{t=1}^{\infty} d_t p_t x_t + \bar{R} - \sum_{t=2}^{\infty} d_t (r_{t-1} R_{t-1}) \quad \text{and} \quad (8)$$

$$W^* = \sum_{t=1}^{\infty} d_t p_t x_t^* - \bar{R} + \sum_{t=2}^{\infty} d_t (r_{t-1} R_{t-1}) . \quad (8^*)$$

On the RHS of (8) we have again the present value of the home country's output stream, but also two other terms. The second is the initial reserves of foreign currency in the hands of MA, while the third represent the implicit-interest costs associated with MA's holding of foreign exchange reserves that do not bear interest. Hence, we have indeed internalized MA's balance sheet into the home household's wealth.

As for the foreign country, its wealth (8*) incorporates the present value of output and the same two terms as in (8), but with the opposite sign. In other words there is a real transfer between the two countries inherent in this system. The direction of the transfer in

general depends on the entire path of prices, interest rates and reserves, and cannot be determined a priori. However, if we assume fixed outputs and that there is only one good, a sufficient condition for the transfer to be in favor of the home country is that the home money stock grows consistently faster than the foreign money stock. Under these conditions the reserves unambiguously fall over time, and the value of the initial reserves outweigh the interest costs.⁵

What can we then say about the real effects of monetary disturbances? For such disturbances to change real spending, which would then change relative prices and other real variables, they must make an impact on the "real" value of W and W^* , in terms of a numeraire, say. As we have already discussed, the first term in (8) and (8*) would not be directly affected by a monetary disturbance. When it comes to the other two terms, we should expect real effects, though. First, even an expected monetary disturbance, say a one-shot expansion, in either of the countries changes the real value of the initial reserves just by raising nominal prices. In addition it alters the implicit interest costs because of changes in the paths of interest rates as well as reserves. We know that the net result is a redistribution of wealth between the two countries, which, of course, changes the real spending of households. The direction of this redistribution is ambiguous, though. Suppose the expansion occurs in the home country, for instance. Then it leads to lower interest costs since MA's reserves will take a lower path. But also to capital losses on the initial reserves. We cannot exclude that the overall

effect, taking also induced changes in relative prices and interest rates into account, is a redistribution in favor of the foreign country. Hence, monetary expansions should not always be positively correlated with an upward adjustment of real spending as in the MABOP, in a system with non-interest bearing reserves⁶; see the example in section 6 for a further elaboration.

In Obstfeld's paper mentioned above there is a certain parallel. In his analysis if agents internalize and reserves do not bear interest, monetary policy has short-run, but no long-run effects.

5. An exchange-rate union

We finally consider a system, referred to as an Exchange Rate Union (ERU), where the two monetary authorities have agreed on joint interventions. These are supported by a kind of swap-agreement. In the case of an excess demand for foreign currency at the going exchange rate, MA* issues a sufficient amount of new money, hands it over to MA, who sells it at the foreign exchange market and keeps the receipts. But these transactions do not give rise to any claims between the monetary authorities. The main reason for considering this hypothetical construct is that it is quite illustrative from a methodological point of view. If one wants to think about real-world analogues, the issuing of SDR's is probably not such a bad example.

We denote the net money transfer from MA* to MA in period t by T_t (which may, of course, be negative). Obviously, then we must have:

$$b_t = T_t, \text{ and} \quad (9)$$

$$b_t^* = -T_t. \quad (9^*)$$

Straightforward substitutions, along the same lines as before, yield the following expressions for the two wealths:

$$W = \sum_{t=1}^{\infty} d_t p_t x_t + T \text{ and} \quad (10)$$

$$W^* = \sum_{t=1}^{\infty} d_t p_t x_t^* - T, \quad (10^*)$$

where $T \equiv \sum d_t T_t$. We see immediately that in this system there is an inherent transfer of purchasing power between the two countries in favor of the country that has an accumulated (present value) deficit in the balance of payments. This is, of course, a consequence of the rules of the game which imply that a deficit in one of the countries is, in fact, passively financed by the other country's monetary authority. (A similar transfer was shown by Helpman (1981); the ERU is essentially the same system as his "cooperative peg".)

An important consequence of this is that we should expect monetary disturbances to have real effects only by changing the balance-of-payments deficits. Moreover, from (5) there is a positive correlation between D_t and b_t and hence also T_t , and a negative correlation between D_t^* and T_t , for all t . Hence, it seems that the adjustment of real spending in the two countries after a monetary disturbance will take place according to the proposition in the MABOP. (We shall illustrate this point, by help of our

example in the next section.) It is interesting to note that to get this result unambiguously we have in fact eliminated the monetary authorities' intertemporal budget constraints. This seems to put the MABOP view of the adjustment mechanism in some doubt.

6. A two-period example

Let us clarify the arguments in the previous sections by help of a simple example of an intertemporal general equilibrium model of the type discussed there. The example will allow us to discuss the changes in wealths, welfare levels and relative prices in a more precise way. This simplified model has two rather than an infinite number of periods.⁷ To focus on the spending decisions of households, we assume fixed outputs in both periods. (We could think of Walrasian factor markets and fixed factor supplies in the background.) Furthermore, we assume that in the first period there are two goods, which are consumed in both countries. However, each country is completely specialized in production. In the second period there is only one good, consumed and produced in both countries. This particular set of assumptions allows us to treat both atemporal and intertemporal relative prices, but still keeps the model analytically tractable.

Consider first the decision problem of the home country household. It maximizes a well behaved utility function $u = U(c, g, f)$, where consumption of the home good is denoted by c , of the foreign good by g , and of the future good by f . The intertemporal budget constraint (obtained by consolidating two liquidity constraints) can be written:

$$p_1 c + q_1 g + d_2 p_2 f = W \equiv (\bar{M} + D_1) + d_2(p_1 x + D_2) ,$$

where p_1 , q_1 and p_2 are the nominal prices of the three goods, d_2 is the discount factor $1/(1 + r_1)$, x is production of the home good, and $\bar{M}$, D_1 and D_2 have the same meaning as before.

We shall use a standard (present value) expenditure function defined as:

$$E(p_1, q_1, d_2 p_2, u) \equiv \min\{p_1 c + q_1 g + d_2 p_2 f \mid U(c, g, f) \geq u\} ,$$

to represent consumption choices. The treatment of the foreign household is completely analogous.

Remembering that in an equilibrium interest rate parity and the law of one price must hold, and setting the fixed exchange rate $\bar{e} = 1$ as before, we must have $p_1 = p_1^*$, $q_1 = q_1^*$, $p_2 = p_2^*$, and $r_1 = r_1^*$. In other words, agents in the two countries face the same relative prices. Accordingly, choosing p_1 as numeraire, we may define $\pi \equiv q_1/p_1$ and $\delta \equiv d_2 p_2/p_1$, as the common relative prices of foreign goods and future goods, both in terms of home goods.

We may then set up a full perfect foresight equilibrium in this model. First, we have the two budget constraints and the clearing conditions for goods markets, viz.

$$E(1, \pi, \delta, u) = (\bar{M} + D_1)/p_1 + d_2 (p_1 x + D_2)/p_1 , \quad (11)$$

$$E^*(1, \pi, \delta, u^*) = (\bar{M}^* + D_1^*)/p_1 + d_2 (q_1 z^* + D_2^*)/p_1 , \quad (11^*)$$

$$c + c^* = E_1(1, \pi, \delta, u) + E_1^*(1, \pi, \delta, u^*) = x \quad , \text{ and} \quad (12)$$

$$g + g^* = E_\pi(1, \pi, \delta, u) + E_\pi^*(1, \pi, \delta, u^*) = z^* \quad , \quad (12^*)$$

where z^* denotes production of the foreign good. In setting up the system, we have disregarded the market for future goods or, alternatively, the bond market in period 1 (the two amounts to the same thing since there is perfect foresight). This is permitted because of Walras law, given the money market equilibrium conditions below. We have also used that the expenditure functions are homogeneous of degree 1 in prices and that their derivatives with respect to prices are the Hicksian demands for the corresponding goods.

We assume that the three goods are gross substitutes (which guarantess stability) and that there is a taste bias in each country for its own good, in the sense that the marginal propensity to consume home goods (out of total wealth) is higher in the home country, and vice versa.

To close the model we also need the clearing conditions for money markets in the two periods. Drawing on our discussion above, we express them as follows:

$$\begin{aligned} M_1 &= \bar{M} + D_1 - b_1 = p_1 x \quad , \\ M_1^* &= \bar{M}^* + D_1^* - b_1^* = q_1 z^* \quad , \\ M_1 + M_1^* &= p_1 x + q_1 z^* \quad , \end{aligned} \quad (14)$$

$$M_2 = M_1 + D_2 - b_2 = p_2 y \quad ,$$

$$M_2^* = M_1^* + D_2^* - b_2^* = p_2 y^* \quad , \text{ and} \quad (15)$$

$$M_2 + M_2^* = p_2 (y + y^*) \quad ,$$

where y and y^* denote home and foreign production of the future good.

Now, consider a system with interest-bearing reserves. First, what about the analogue to MA's solvency constraint in the infinite horizon case? In this two-period model, the corresponding requirement is simply that MA is able to pay back its debt in the second period. Since there is no credit market in that period, MA must earn a sufficient amount of foreign exchange from its interventions to meet its obligations. In other words, the balance-of-payments deficits must fulfill $b_1 + d_2 b_2 = 0$, since $b_1 = S$, $b_2 = -(1 + r_1)S$ if the condition holds. This, in turn, implies that (given D_1) D_2 becomes an endogenous rather than an exogenous variable. Hence, we capture the institutional details of a system with interest-bearing reserves by setting $b_1 = S$, $b_2 = (1 + r_1)S$, and $b_1^* = -b_1$, $b_2^* = -b_2^*$ (or alternatively $b_1^* = b_2^* = 0$) in (14) and (15).

Now, given these assumptions, we follow the same approach as in the former sections and substitute from (the rewritten form of) the equilibrium conditions (14) and (15) into the RHS of (11) and (11*). This yields:

$$w = x + \delta y \quad \text{and} \quad (16)$$

$$w^* = \pi_Z^* + \delta y^* \quad . \quad (16^*)$$

We can now illustrate our propositions in Section 3. Given (16) and (16*), our system (11) - (13) can clearly be solved for the four variables, u , u^* , π , and δ . Since this holds for all values of national money stocks, we may conclude that real variables are independent of monetary changes. Such changes will, of course, produce effects on nominal variables, which we do not consider here.

Let us so turn to a system with non-interest bearing reserves. We can characterize such a system by substituting $b_t = -\Delta R_t$ and $b_t^* = \Delta R_t$; $t=1,2$, into (14 and (15). However we shall make some further assumptions about MA's monetary policies D_1 and D_2 . First, we have to assume that

D_1 and D_2 are carried out in such a way that the nonnegativity constraint on reserves, $R_t \geq 0$, $t=1,2$, is obeyed. Secondly, it will be convenient to assume that MA has a specific goal for the level of its reserves after the interventions in period 2. This will again imply a particular value of D_2 . We shall assume that this goal is $R_2 = 0$.

Armed with these preliminaries, we make the same substitutions as earlier into households' wealth constraints. It is then straightforward to derive:

$$w = W/P_1 = (x + \delta y) + (\bar{R} - d_2 r_1 R_1)/p_1 \quad \text{and} \quad (17)$$

$$w^* = W^*/P_1 = (\pi z^* + \delta y^*) - (\bar{R} - d_2 r_1 R_1)/p_1 \quad , \quad (17^*)$$

which is the analogue to our general expressions (8) and (8*). Both wealths (expressed in terms of the home good) are the present value of out-

put plus/minus a term which incorporates the initial level of MA's currency reserves plus the interest costs of carry such reserves from the first to the second period. Generally, $d_2 r_1 R_1$ would be quite small compared to $\bar{R}$, and we shall assume that the difference r , $r \equiv (\bar{R} - d_2 r_1 R_1)$, is positive.⁸

Now, what about the real effects of monetary disturbances? Arguing along the same lines as in Section 4, we would expect a monetary expansion in one of the countries to have an effect just by increasing nominal prices, here represented by our numeraire p_1 . Indeed, we see from (17) and (17*) that changes in p_1 lead to a direct wealth redistribution. This in turn should lead to a change in spending, which in turn should change relative prices and overall welfare in the two countries.

Consider then a monetary expansion in either the home country or the foreign country in the first period, that is $dD_1 > 0$ or $dD_1^* > 0$.

Then we get the following results - details can be found in the Appendix - which are valid for both experiments: (i) wealth and welfare increase in the foreign country and fall in the home country, that is $dw^* = -dr$, $du^* > 0$ and $dw = dr$, $du < 0$. (ii) the relative price of foreign goods rises, that is $d\pi > 0$, and (iii) the change in the relative price of future goods is ambiguous, that is $d\delta \lesseqgtr 0$.

The changes in welfare are given by the following expressions:

$$E_u du = -g d\pi + (y - f) d\delta + dr \text{ and} \quad (18)$$

$$E_u^* du^* = g d\pi - (y - f) d\delta - dr . \quad (18^*)$$

Take the change in home welfare du , for example. It is proportional to the expression on the RHS of (18). (E_u is the inverse of the marginal utility of wealth), which includes three terms. The first is a standard terms of trade effect, which is negative in this case. The second is an intertemporal terms of trade effect, which may go both ways. And the third, finally, which is also negative, represents the redistribution of wealth to the foreign country; the capital loss on MA's reserves due to the rise in p_1 . It can be shown that the overall effect is negative; in fact it is a standard result in trade theory that, with stability, the terms-of-trade effects induced by a transfer between two countries cannot reverse the redistributational effects of the transfer itself.

We should thus generally expect an adjustment downwards of home real spending in the first period, and an upward adjustment in the foreign country.⁹ This is true wherever the expansion occurs. On the monetary side, however, there is a unique association between expansions and deficits in the balance-of-payments, that is $db_1/dD_1 > 0$ and $db_1^*/dD_1^* > 0$; again, see the Appendix. Therefore, the positive correlation between spending and deficits suggested by the MABOP holds if the expansion occurs in the foreign country, but not if it occurs in the home country. We have thus given an example of the "perverse" effects discussed in Section 4. Of course, the results for a monetary contraction are completely symmetric. So if MA wants to increase home welfare and spending it should contract rather than expand the home money supply.

Finally, we turn to the ERU. This system does not involve any

restrictions on monetary policies, and we may characterize it simply by setting $b_t = T_t$ and $b_t^* = -T_t$; $t = 1, 2$, in (14) and (15). Once again we substitute the resulting equilibrium conditions into the budget constraints to end up with:

$$w = x + \delta y + t \quad \text{and} \quad (19)$$

$$w^* = \pi z^* + \delta y^* - t, \quad (19^*)$$

where $t \equiv (T_1 + d_2 T_2)/p_1$. Like in our general expressions (10) and (10*), there is a direct redistribution of purchasing power that works in favor of the country that runs an accumulated deficit in the balance-of-payments.

Consider a monetary expansion in the first period that has its origin in the home country, that is $dD_1 > 0$. To simplify the analysis we shall assume that MA adjusts D_2 in such a way that $d_2 T_2/p_1$ stays constant. This means that the redistribution of wealth between the countries is confined to $dt = d(T_1/p_1)$.

In the Appendix it is shown formally that the expansion increases both nominal prices, $dp_1 > 0$ and $dq_1 > 0$. It also increases the home country's balance of payments deficit $db_1 > 0$. The following real effects are also derived: (i) wealth and welfare increase in the home country and fall in the foreign country, that is $dw = dt$, $du > 0$ and $dw^* = -dt$, $du^* < 0$, (ii) the relative price of foreign goods falls, that is $d\pi < 0$, and (iii) the change in the relative price of future goods is ambiguous, $d\delta > 0$.

Hence, a monetary expansion cum deficit in the home country is

associated with an increase in its welfare and real spending. Moreover, it is easy to show that the system is completely symmetric, so for an expansion in the foreign country the above results are completely reversed. Indeed, as we conjectured in the former section, the pattern of adjustment is akin to that portrayed in the MABOP.

7. Concluding Comments

In summary, we have shown that there is an inherent redistribution mechanism in certain fixed exchange rate systems. Also we have argued that when agents have perfect foresight in a world of frictionless market clearing: (i) monetary disturbances should not have any real effects in systems with interest-bearing reserves, (ii) when reserves are non-interest bearing, like currency or gold, we should expect real effects, but not always those proposed in the MABOP, and (iii) in an ERU we should expect real effects consistent with those proposed in the MABOP.

The analytical framework employed in this paper portrays a frictionless world economy. This is deliberate to throw light on the particular aspects of the different monetary arrangements, but as a result that model rests on quite strong assumptions. Various frictions could, of course, be introduced. One example would be if some nominal variables were sticky, for instance because contracts were fixed in nominal terms in bond or labor markets. Under these circumstances the distinction between expected and unexpected disturbances, which was unimportant in this paper, would obviously matter. Not surprisingly, with fixed nominal contracts

unexpected monetary disturbances would affect real variables also in systems with interest-bearing reserves; see Persson (1982a) for an elaboration.¹⁰

Another assumption that might be relaxed is the perfect foresight assumption. In particular, one could introduce systematic errors in agents' expectations, in the sense that the assets and intertemporal budget constraints of the monetary authorities were not fully internalized.¹¹ The issue to what extent such an internalization would occur in reality is, of course, closely related to the issue to what extent "government bonds are net wealth", cf. Barro (1974). In any event, in a framework with less than full internalization, the systematic positive association between monetary expansion and real spending, which we have put in doubt here, would be more likely to occur.

It should be clear that from the analysis that, in the systems with an inherent redistribution mechanism, there is some scope for strategic behavior of the monetary authorities in the design of their policies. An interesting topic for further research would be to allow the two monetary authorities to choose their paths of policies so as to maximize their citizen's welfare in a model like the one we have treated here. The rules of the game would depend on the peculiarities of each system. For example, the assignments of the two monetary authorities, and hence the constraints they face, are similar under a classical gold standard, but quite different in a system with a "reserve currency".

What would then be the properties of equilibria in different

systems? More fundamentally, would such equilibria at all exist? The answers to these questions would not only be interesting from a theoretical point of view, but might also shed light on why certain international monetary arrangements like the different gold standards and the Bretton Woods system actually broke down.

A fundamental question that we have not dealt with is the relative desirability of the different systems. We know that, in the kind of frictionless Walrasian framework that was discussed here, all perfect foresight equilibria are Pareto-efficient from a global point of view; cf. Helpman (1981) and Lucas (1982). This is quite a weak result, however, since any unexpected changes would destroy the efficiency properties, as would short-run rigidities. Since such features are important in the real world, it would seem that a judgement on the preferability of different systems would require an explicit analysis of a situation with uncertainty and incomplete markets.¹² Moreover, recognizing the potential conflict of interests discussed above, one might want to rule out those systems that incorporate strong incentives for strategic behavior.

The issues discussed in this final section all involve hard questions. It is to be hoped that the positive analysis in the present paper can help in providing a starting point for analyzing them.

Footnotes

*This paper is a revised and shortened version of Chapter V in the authors doctoral dissertation - Persson (1982a). This version was prepared during a visit to the NBER in February 1983. The author would like to thank Bill Ethier, Elhanan Helpman, Assaf Razin, Michael Schmid, and Lars Svensson for discussions, and seminar participants at the Institute for International Economic Studies and at Tel-Aviv University for comments. Financial support from the Carl Mannerfelt Foundation is gratefully acknowledged.

1. One might also discuss alternative institutional arrangements. Helpman and Razin (1981) examine an alternative system where transactions with foreigners are instead made in the buyer's currency. They compare the implications of the two systems in a discussion of the relation between exchange rate changes and the current account under floating exchange rates.

2. This way, b_t is just the decline in the home money stock which is not due to monetary transfers. To see how this fits with the real side of the model, define the home current account deficit in period t as $s_t \equiv (p_t c_t - p_t x_t) + r_{t-1} B_{t-1}$, where B is the private sectors' foreign borrowing. The first term in s_t is the trade deficit, while the second is the deficit on the service account. Next, we define the deficit on the capital account $k_t \equiv (B_{t-1} - B_t)$. We add the two to obtain $b_t = s_t + k_t = (p_t c_t - p_t x_t) + r_{t-1} B_{t-1} + (B_{t-1} - B_t)$. However, the increase in the home

household's assets in period t , that is $-(B_t - (1 + r_{t-1})B_{t-1})$ equals $(M_{t-1} + D_t - p_t c_t)$. Substituting this relation and $M_t = p_t x_t$ from (2) into b_t we get (4).

3. When it comes to effects on nominal variables like the world price level there are striking differences between the two regimes. See Persson (1982a), and the references cited therein, for a further discussion.

4. We impose the restriction $\lim_{t \rightarrow \infty} d_t R_t = 0$. Only very perverse behavior of MA would make R grow faster than the interest rate.

5. We have to impose that MA operates within the nonnegativity constraint, so assume that, although M grows faster than M^* in all periods, $R_t > 0$ for all t , but $\lim_{t \rightarrow \infty} R_t = 0$. Then, with the assumptions in the text it can be shown that R_t is monotonically decreasing in t . Then, since we know that $\sum d_t r_{t-1} = 1$, it follows that $\bar{R} > \sum d_t (r_{t-1} R_{t-1})$, which by (8) implies that there is a redistribution in favor of the home country. (The most rational thing to do for MA, if this possibility was open to it, would of course be to reduce R to zero right away and then manage the exchange rate with interest-bearing reserves in the following.)

6. In the limiting small-country case the effect would always be as in the MABOP, though, since then the only effect would be the change in the path of the expanding small country's reserves.

7. See Persson (1982b) for some comments on the relation between an infinite and a two-period horizon in models of this type.

8. This presupposes that the two periods are of comparable length. If one were to think about the second period as the entire future, for instance, this assumption would not be warranted.

9. To eliminate the caveat, we have to assume that the intertemporal substitution effect in the home country is not too strong, in the event that $d\delta < 0$.

10. Helpman and Razin (1982a) deal with fixed nominal debt (under floating exchange rates) and Persson (1982b) deals with fixed nominal wages (under fixed and floating rates) in models that are similar to the one used here.

11. For a formal treatment of such systematic errors in expectations, see Persson and Svensson (1983).

12. See Helpman and Razin (1982b) for an attempt of evaluating the desirability of floating versus fixed exchange rates for a small economy under these conditions.

Appendix

We first derive a general solution to the comparative statics of the 'real' system in equations (11), (11*), (12) and (12*). More precisely, we are interested in the effects on the two welfare levels u and u^* and the two relative prices π and δ , of a direct wealth redistribution between the two countries. That is, if we denote the RHS of (11) and (11*) by w and w^* , we investigate the effects of dw and $dw^* = -dw$.

First differentiate (11) and (11*) to get

$$E_u du = -g d\pi + (y - f) d\delta + dw \quad \text{and} \quad (A1)$$

$$E_u^* du^* = g d\pi - (y - f) d\delta - dw \quad (A2)$$

Next, we differentiate (12) and (12*). Using (A1) and (A2) and rearranging, we get

$$\begin{bmatrix} D_{c\pi} & D_{c\delta} \\ D_{g\pi} & D_{g\delta} \end{bmatrix} \begin{bmatrix} d\pi \\ d\delta \end{bmatrix} = - \begin{bmatrix} (c_w - c_w^*) dw \\ (g_w - g_w^*) dw \end{bmatrix}, \quad (A3)$$

where

$$D_{c\pi} = (E_{1\pi} + E_{1\pi}^*) - (c_w - c_w^*)g > 0, \quad ,$$

$$D_{c\delta} = (E_{1\delta} + E_{1\delta}^*) - (c_w - c_w^*)(y - f) > 0, \quad ,$$

$$D_{g\pi} = (E_{\pi\pi} + E_{\pi\pi}^*) - (g_w - g_w^*)g < 0, \quad \text{and}$$

$$D_{g\delta} = (E_{\pi\delta} + E_{\pi\delta}^*) - (g_w - g_w^*)(y - f) > 0, \quad ,$$

are the partials of world excess demand for the home and foreign goods with respect to changes in π and δ . The signs follow since we assume gross substitutability. As explained in the text, we also assume that each country has a preference for its own good, in the sense that the marginal propensities to consume satisfy $c_w > c_w^*$ and $g_w < g_w^*$.

From (A3) we then have

$$d\pi = (A_1/\Delta)dw \quad \text{and} \quad (A4)$$

$$d\delta = (A_2/\Delta)dw \quad , \quad (A5)$$

where

$$\Delta \equiv D_{c\pi}D_{g\delta} - D_{g\pi}D_{c\delta} > 0 \quad ,$$

$$A_1 \equiv -(c_w - c_w^*)D_{g\delta} + (g_w - g_w^*)D_{c\delta} < 0, \quad \text{and}$$

$$A_2 \equiv -(g_w - g_w^*)D_{c\pi} + (c_w - c_w^*)D_{g\pi} \lesssim 0 \quad .$$

So it is clear that $d\pi/dw < 0$, but the sign of $d\delta/dw$ is unclear.

Substituting from (A4) and (A5) into (A1) we obtain

$$E_u du = [(-gA_1/\Delta) + ((y - f)A_2/\Delta) + 1]dw \quad .$$

The sign of the expression in brackets seems uncertain because of the second term. However, some manipulations reveal that

$$(y - f)A_2/\Delta = -1 + (A_3/\Delta) \quad ,$$

$$A_3 \equiv (E_{\pi\delta} + E_{\pi\delta}^*)D_{c\pi} - (E_{1\delta} + E_{1\delta}^*)D_{g\pi} > 0 \quad .$$

Substituting into our expressions for $E_u du$, we get

$$E_u du = ((A_3 - gA_1)/\Delta)dw \quad (A6)$$

Now, the sign of the expression within the brackets is clearly positive

so despite the ambiguity about $(y - f)d\delta$, we may conclude that du and dw have the same sign. A wealth redistribution in favor of the home country always increases welfare, whatever are the induced changes in the terms of trade. It follows of course from (A2) that

$$E_u^* du^* = - ((A_3 - gA_1)/\Delta) dw \quad . \quad (A7)$$

Let us so examine the system with non-interest bearing reserves. We consider a monetary expansion or contraction in either country in the first period, that is, a change in the world money stock. The redistribution of wealth between the countries we measure by dr (cf. (17) and (17*)). Differentiating the definition of r , and letting hats $\hat{}$ denote relative changes, we have

$$dr = \frac{\bar{R}}{p_1} \hat{p}_1 - \frac{d_2 r_1 R_1}{p_1} (d_2 \hat{r}_1 + \hat{R}_1 - \hat{p}_1) \quad .$$

But our assumption in the text is that $d_2 r_1 R_1$ is small relative to $\bar{R}$. We shall therefore, as a reasonable approximation, disregard the second term and set

$$dr = - \frac{\bar{R}}{p_1} \hat{p}_1 \quad , \quad (A8)$$

which will simplify the analysis considerably.

Now, from the third equation is (14), we can derive

$$\hat{M}_1^W = \hat{p}_1 + n\pi \quad , \quad (A9)$$

where M_1^W denotes $M_1 + M_1^*$ and where $n \equiv q_1 z^* / (p_1 x + q_1 z^*)$. We substitute from (A8) into (A4). The resulting expression together with (A9) can after some rearrangement be expressed by the system

$$\begin{bmatrix} 1 & n \\ \frac{\bar{R}A_1}{p_1 \pi \Delta} & 1 \end{bmatrix} \begin{bmatrix} \hat{p}_1 \\ \hat{\pi} \end{bmatrix} = \begin{bmatrix} \hat{M}_1^w \\ 0 \end{bmatrix},$$

The solutions for $\hat{p}_1$ and $\hat{\pi}$ are

$$\hat{p}_1 = [1/(1 - \frac{n\bar{R}A_1}{p_1 \Delta})] \hat{M}_1^w, \quad \text{and} \quad (A10)$$

$$\hat{\pi} = [-\frac{\bar{R}A_1}{p_1 \Delta} / (1 - \frac{n\bar{R}A_1}{p_1 \Delta})] \hat{M}_1^w. \quad (A11)$$

The terms within square brackets in (A10) and (A11) are both positive, so a monetary expansion, in either country, generates a rise both in p_1 and π . It follows that there is a wealth redistribution in favor of the foreign country, since from (A8) $dr < 0$.

Finally, we would like to determine the effects on the balance-of-payments deficits. Suppose an expansion occurs in the home country $dM_1^w = dD_1 > 0$. Then, from the second equation in (14), we have

$$db_1^* = -z^* dq_1 = -q_1 z^* \hat{q}_1 = -q_1 z^* (\hat{p}_1 + \hat{\pi}) < 0; \quad (A12)$$

there is a decrease in the foreign country's deficit. Since $db_1 = -db_1^*$, a monetary expansion in the home country generates an increase in its deficit.

In a similar manner, we shall examine the effects of monetary changes in the ERU. The wealth redistribution in this system is measured by dt (cf. (19) and (19*)). From the definition of t in the text, we have $dt = d(T_1/p_1) + d(d_2 T_2/p_1)$, but our simplifying assumptions about monetary policies in the second period makes the second term equal to zero. Consider a monetary change in the home country $dD_1 = dM_1^W$. We can determine $dt = d(T_1/p_1) = d(b_1/p_1) = -d(b_1^*/p_1)$ from the second equation in (14). After differentiation and some manipulations, one gets

$$dt = -d(b_1^*/p_1) = \frac{M_1^W}{p_1} [(1 - m_1)\hat{p}_1 + n\hat{\pi}] \quad , \quad (A13)$$

where $m_1 \equiv M_1/M_1^W$. This result, together with (A4) and (A13) implies

$$\begin{bmatrix} 1 & n \\ -\frac{M_1^W A_1 (1 - m_1)}{p_1 \pi \Delta} & (1 - \frac{n M_1^W A_1}{p_1 \Delta}) \end{bmatrix} \begin{bmatrix} \hat{p}_1 \\ \hat{\pi} \end{bmatrix} = \begin{bmatrix} \hat{M}_1^W \\ 0 \end{bmatrix} \quad ,$$

which can be solved to yield

$$\hat{p}_1 = [(1 - \frac{n M_1^W A_1}{p_1 \Delta}) / (1 - \frac{m_1 n M_1^W A_1}{p_1 \Delta})] \hat{M}_1^W \quad , \quad \text{and} \quad (A14)$$

$$\hat{\pi} = [(\frac{M_1^W A_1 (1 - m_1)}{p_1 \Delta}) / (1 - \frac{m_1 n M_1^W A_1}{p_1 \Delta})] \hat{M}_1^W \quad . \quad (A15)$$

The bracketed expression in (A14) is positive (and larger than 1), but the expression in (A15) is negative. Hence, for a monetary expansion in the home country $dD_1 = dM_1 > 0$, we have $dp_1 > 0$ and $d\pi < 0$. But, from our earlier result (A4), we know that this is equivalent to $dw = dt > 0$. This is easy to verify. Substituting from (A14) and (A15) into (A13) and simplifying, we get

$$dt = \left[\frac{(1 - m_1)}{p_1} / \left(1 - \frac{m_1 n M_1^W A_1}{p_1 \Delta} \right) \right] dD_1 > 0 .$$

Finally, to derive the effects on the balance-of-payments deficit in the two countries we can use (A12) directly. Since it is clear from (A14) and (A15) that $|\hat{p}_1| > |\hat{\pi}|$, we must have $db_1^* < 0$ and $db_1 > 0$. Also here an expansion in the home country leads to an increase in its deficit.

Our results (A13) - (A15) do only hold for monetary changes in the home country, however. If they occur in the foreign country the results we get are like a mirror image of those we have derived here. Hence for a monetary expansion abroad $dD_1^* > 0$, we get the real effects $dw = dt < 0$ and $d\pi > 0$. On the monetary side, we have $dp_1 > 0$ and $db_1 = -db_1^* < 0$. The derivation, which is similar to that above, is left to the reader, however.

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