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MONETARY POLICIES AND THE EXCHANGE
RATES IN THE E.C.-COUNTRIES

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1. INTRODUCTION

In this paper we focus on several issues concerning the determination of exchange rates. First, we analyse how, in the context of a multicountry model, monetary shocks are transmitted from one country to the other. This transmission process is analyzed assuming alternatively pure floating of the exchange rates, managed floating, and joint floating (currency union). Second, we study how particular intervention rules in the foreign exchange market and in the domestic money market affect the exchange rates and the intra-country transmission process. The issue which will be taken up is the connection between intervention policies of the "leaning against the wind"-type and sterilization policies.

In order to address these issues we developed an econometric model of the monetary sectors of the E.C.-countries. The model is described in section 2. In section 3 we report the simulation results of the pure floating scenario. In section 4 the results under a managed floating system are reported, and in section 5 the results in a currency union set-up are discussed.

2. THE MODEL

The model consists of national models of the monetary sectors. These national models have essentially the same structure and the equations, whenever possible, taken on the same econometric specification. These national monetary models are then linked together through an equation explaining the Euro-dollar interest rate.

The national models are composed of three blocks : first, a monetary block, second, a policy reactions block, third, a price block. The models are essentially short term in nature. They determine, among others, the spot exchange rate, the interest rate, the stock of international reserves. All "real" variables, e.g. the trade balance, national income in real terms, are assumed to be exogenous.

2.1. Money market block

The money demand equation :

$$\ln M_{it}^d = a_{1i} + a_{2i} \ln Y_{it} + a_{3i} \ln r_{it} + \ln P_{it} \quad (1)$$

where M_{it}^d = the money demand in country i in quarter t

Y_{it} = real GNP in country i in quarter t

r_{it} = the nominal interest rate in country i in quarter t

P_{it} = the price level in country i in quarter t.

The money supply equation is a definition

$$M_{it}^S = m_{it} B_{it} \quad (2)$$

where M_{it}^S = the money supply in country i in quarter t

m_{it} = the money base multiplier in country i in quarter t

B_{it} = the money base in country i in quarter t

The money base (in changes) is defined as :

$$\Delta B_{it} = \Delta R_{it} + \Delta D_{it} \quad (3)$$

where R_{it} = the foreign component of the money base in country i in period t

D_{it} = the domestic component of the money base in country i in period t .

The interest parity relationship takes the following form

$$r_{it} - r_{Et} = x_{it} \quad (4)$$

where r_{Et} = the Euro-dollar interest rate

x_{it} = the forward discount on currency i , i.e. $x_{it} = \frac{F_{it} - S_{it}}{S_{it}} \cdot 400$

F_{it} = the (three-month) forward exchange rate of currency i in quarter t

S_{it} = the spot exchange rate of currency i in period t

All exchange rates are defined as prices of the dollar in terms of domestic currency.

The use of the interest parity equation implies that there is absence of transaction costs. The existence of capital controls and of political risk, however, leads to deviations from the interest parity condition ¹⁾.

Equilibrium in the money market of country i implies :

$$M_{it}^d = M_{it}^s \quad (6)$$

2.2. Wage-price block

The price and wage equations are specified as follows :

$$\ln P_{it} = b_{1i} + b_{2i} \ln PM_{it} + b_{3i} \ln W_{it} + b_{4i} \ln P_{it-1} \quad (7)$$

¹⁾ Aliber (1973) has introduced the idea of political risk as a factor leading to observed deviations from interest parity. See also M. Dooley (1976) on this issue. Dooley's paper contains interesting information on the effects of the German capital controls program during 1973-75 suggesting that these controls explain the large covered differential observed between the Euro-dollar interest rate and the Frankfurt DM interbank rate. The absence of capital controls within the Euro-currency markets also explains why the interest parity holds almost exactly in this market. For evidence see Marston (1976) and Frenkel and Levich (1975) and (1977).

and

$$\ln W_{it} = c_{1i} + c_{2i} \ln PR_{it} + c_{3i} \ln U_{it} + c_{4i} \ln P_{it} + c_{5i} \ln W_{it-1} \quad (8)$$

where PM_{it} = the import price index, in domestic currency i

W_{it} = the index of the wage rate in country i

PR_{it} = the index of average labor productivity in country i

U_{it} = the unemployment rate in country i

The import price index PM_{it} is defined as :

$$PM_{it} = \frac{S_{it}}{S_{io}} \sum \gamma_j^i PX_{jt} / \left(\frac{S_{jt}}{S_{jo}} \right) \quad (9)$$

where PX_{jt} = the export price index of country j expressed in currency j ;

γ_j^i = the share of imports from country j in country i 's total imports;

$PX_{jt} / \left(\frac{S_{jt}}{S_{jo}} \right)$ = the export price index of country j expressed in dollars.

From the preceding it follows that by affecting the import price index exchange rate changes have an influence on the wage price mechanism. This feeds back into the demand for money.

2.3. The Link-block

The national models are linked through a Euro-dollar market submodel. This submodel consists of a demand and supply equation of Euro-dollar deposits. These are a function of the US interest rate and the vector of covered national interest rates. Solving for the Euro-dollar interest rate then yields

an expression relating the Euro-dollar interest rate to these national covered interest rates as follows ¹⁾

$$r_{Et} = \beta_0 r_{At} + \sum_{i=1}^n \beta_i (r_{it} - x_{it}) \quad (10)$$

where r_{At} = the US interest rate.

The expected sign of the coefficients β_0 , β_i is positive.

2.4. The policy reactions block

The policy reactions in the foreign exchange market determine the exchange rate regime. Several alternative exchange rate regimes are studied.

- Pure floating

In this case one sets :

$$\Delta R_{it} = 0 \quad (11)$$

i.e; there is no intervention in the exchange market, and variations in the spot rate together with interest rate movements are necessary to equilibrate the money markets.

- "Leaning against the wind" intervention : Variant I

In this case the intervention behavior is determined by the rule :

$$\Delta R_{it} = \epsilon \Delta S_{it} \quad (12)$$

where $\epsilon < 0$

and where as before S_{it} is the price of the dollar in terms of currency i .

According to this rule the authorities intervene to smoothen the observed variation of the exchange rate. There is evidence that this intervention rule has been practiced in actual intervention behaviour by central banks of major industrialized countries ²⁾.

1) For more detail on the theoretical aspects, see R.C. Marston (1974).

2) For evidence see J. Artus (1976) and P. Quirk (1977).

- "Leaning against the wind" intervention : Variant II

Here the monetary authorities have a target for the exchange rate (which may change) and intervene to keep the observed exchange rate close to this target, i.e. :

$$\Delta R_{it} = \eta (S_{it} - S_{it}^x) \quad (13)$$

where S_{it}^x is the target exchange rate
and $\eta < 0$.

- A currency union (joint floating against the dollar)

The monetary authorities of the member countries of the currency union now intervene to keep their cross rates within specified margins. We now have that :

$$\Delta R_{it} = \vartheta (S_{jit} - S_{jit}^x) \quad (14)$$

where S_{jit} = the price of currency j in terms of currency i in period t;
 S_{jit}^x = the parity exchange rate of j in terms of i.

Note that we must have the following triangular arbitrage conditions :

$$S_{jit} = S_{it}/S_{jt} \quad (15)$$

In addition we must have that :

$$S_{jit} = \frac{1}{S_{ijt}} \quad (16)$$

and

$$S_{jit}^x = \frac{1}{S_{ijt}^x} \quad (17)$$

and

$$S_{iit} = S_{iit}^x = 1 \quad (18)$$

In the simulations the parameter ϑ is varied such that the observed spot rates always remain within the specified margins of fluctuations (2,25 % for the EMS-countries, except for Italy).

It is important to note that the interventions within the currency union have implications for the money supply process in the member countries.

We now have that :

$$\Delta B_{it} = \Delta R_{it} + \Delta D_{it} \quad (19)$$

and

$$\Delta R_{it} = \Delta R_{it}^A + \sum_{j \neq i} \Delta R_{it}^j - \sum_{j \neq i} \Delta R_{jt}^i \quad (20)$$

where R_{it}^A = the dollar holdings of country i;

R_{it}^j = the amount of currency j held by country i;

R_{jt}^i = the amount of currency i held by country j.

Actual intervention can be carried out in two ways. The authorities of country i can buy or sell the currency of country j (ΔR_{it}^j). As a result, an increase (decline) in R_{it}^j raises (reduces) the money base of country i and reduces (increases) the money base of country j, in the absence of sterilization policies.

A second way to intervene is to buy and sell dollars (the outside currency). In that case we have to translate the target cross rates S_{ji}^x in terms of dollar rates. The intervention function then becomes :

$$\Delta R_{it}^A = \vartheta' (S_{it} - S_{it}^x) \quad (21)$$

where $S_{it}^x = S_{jit}^x S_{jt}$

and S_{jit}^x is, as before, the "snake" parity rate between currency i and j, and is exogenous.

Note that $\vartheta' = \vartheta / S_{jt}$

It can easily be seen that a dollar intervention system is equivalent to intervention in snake currencies (as far as its monetary effects are concerned) when we impose the condition that all dollars sold (bought) by country i are bought (sold) by country j. In that case the monetary contraction (expansion) in country i is exactly offset by a monetary expansion (contraction) in country j.

3. SIMULATION RESULTS : THE FLOATING EXCHANGE RATE SYSTEM

In this section we report on simulation results of the model presented in the previous section assuming pure floating of the exchange rates. (The empirical estimates of the equations are presented in appendix). The countries in the model are Belgium, France, Germany, Italy, The Netherlands and the U.K.

The simulations are performed assuming that the shocks introduced into the model are transitory and, therefore, do not affect the expected exchange rates. Assuming that the forward rates reflect the expectations about the future spot rates, they are set at their exogenous values.

The general simulation strategy has been to perform dynamic simulations of the model using the observed values of the exogenous variables. These simulations are then used as control solutions in the policy simulations. The multipliers of the exogenous (or policy) variables are then obtained by computing the deviation between the endogenous variables obtained in the policy simulation and their values in the control solution.

In the present section we report on the simulations of two exogenous shocks. One is an increase in the U.S. short-run interest rate (r_{At}), another is a policy induced increase in the money base in an individual European country. The simulation results reported here are rather straightforward. They will be used as benchmark for comparison with the managed floating and currency union simulations reported in sections 4 and 5.

3.1. Short-term effects of an increase in the U.S. interest rate : the case of perfect capital mobility

An increase of one percentage point in the U.S. short-term interest rate was simulated. This shock was simulated under two assumptions concerning the conduct of monetary policy. In the first assumption all countries use interest pegging policies. In the second assumption they peg the money base ¹⁾. The results are shown in tables 1 and 2.

¹⁾ In the interest pegging strategy the interest rates become exogenous variables, in the money base strategy the money bases become exogenous variables.

The results indicate that with perfect capital mobility and with pure floating the domestic money markets are largely insulated from an increase in the U.S. interest rate. The upward pressure on the domestic interest rate (in the money base policies) is small (table 2), whereas under interest pegging policies the increase in the domestic money supplies is weak (table 1).

The effects on the spot exchange rates are proportional to the increase in the U.S. interest rate in all countries. Thus, with perfect capital mobility, the increase in the U.S. interest rate has similar effects on the spot exchange rates in all countries.

Finally, the Euro-dollar interest rate increases in the same amount as the U.S. interest rate. This is to be expected given the close links which exist between the U.S. money market and the Euro-dollar market in the absence of capital controls.

Table 1 : Effect of a one percentage point increase of the U.S. interest rate
(simulation period 1973 I-II). Interest pegging policies

	on spot rate (in %)	on domestic money supply (in %)	on Euro-dollar interest rate (in percentage points)
Belgium	0.263	0.200	
France	0.243	0.020	
Germany	0.252	0.019	
Netherlands	0.260	0.041	
Italy	0.228	0.008	
U.K.	0.256	0.020	
Euro-dollar market			1.043

Table 2 : Effect of a one percentage point increase of the U.S. interest rate
(simulation period 1973 I-II). Money base pegging policies

	on spot rate (in %)	on interest rate (in percentage points)
Belgium	0.266	0.001
France	0.267	0.003
Germany	0.248	0.001
Netherlands	0.263	0.009
Italy	0.302	0.001
U.K.	0.257	0.004
Euro-dollar market		1.056

3.3. Short-term effects of an increase in the German money base

The second shock which was simulated is an exogenous increase in the target money base in Germany. The results are shown in table 3. The other countries are all assumed to peg their money bases.

The results of table 3 indicate that under perfect capital mobility (and free floating) the German money shock has no perceptible influence on the other countries' interest rates and dollar spot exchange rates. As a result only the cross exchange rates with the DM are affected.

Table 3 : Effect of 10 % expansion of German money base (simulation period 1973 I-II)

	on dollar spot rate (in %)	cross rates	on interest rate
Belgium	-	+0.495	-
France	-	+0.495	-
Germany	+0.495	-	-2.085
Italy	-	+0.495	-
Netherlands	-	+0.495	-
U.K.	-	+0.495	-

4. SIMULATION RESULTS : THE MANAGED FLOAT SYSTEM

In this section the simulations of the managed floating system are reported. We used the intervention rule (13) and assumed that the target exchange rate is the observed one. As a result, when the system is shocked the authorities "lean against the wind" produced by this shock. The benchmark of their intervention behaviour is the spot rate which was obtained in the market in the absence of the shock.

All the simulations were performed under three alternative assumptions concerning the use of sterilization policies. A first assumption is complete absence of sterilization, i.e. a sale (purchase) of foreign exchange reduces (increases) the domestic money base by the full amount of the sale (purchase). A second assumption is full sterilization, i.e. a sale (purchase) of foreign exchange has no impact on the money base. A third assumption is partial sterilization, where the sterilization coefficient was set equal to 0.5, i.e. a sale (purchase) of foreign exchange of 1 dollar reduces the domestic money base by 0.5 dollars (in domestic currency equivalents).

Three different shocks were introduced, an increase in the U.S. interest rate, a domestic monetary expansion in Germany, France and the U.K., and a speculative cycle. All simulations were performed assuming perfect interest arbitrage.

4.1. An increase in the U.S. interest rate

As before the U.S. interest rate was increased by 1 percentage points. The dynamic multipliers are shown in table 4. The results have the following interpretation. In the absence of sterilization (panel A) the "leaning against the wind" reduces the impact of the increase in the U.S. interest rate on the different spot rates. This can be seen by comparing Table 4 with Table 2. The counterpart is an upward pressure on the domestic interest rate. The extent to which the spot rate and the domestic interest rate change, of course, depends on the intervention parameters. In general with an increase in the intervention parameter the domestic interest rate will adjust more and the spot rate less. Here we concentrate on the effects of sterilization policies for a given intervention parameter. Comparing panel B with panel A reveals that the use of complete sterilization insulates the domestic interest rates from

Table 4 : Effect of a 1 percent increase in U.S. interest rate; simulation period 1973 I-II

A. No sterilization

	on interest rate	on spot rate	on international reserves (in billion of national currencies)
Belgium	0.260	0.204	-10.5
France	0.154	0.227	- 5.8
Germany	0.291	0.192	- 1.31
Italy	0.190	0.219	-253
Netherlands ^x	0.002	0.269	-
U.K.	0.258	0.201	-0.244
Euro-dollar	1.056		

B. Full sterilization

	on interest rate	on spot rate	on international reserve
Belgium	0.002	0.267	-13.1
France	0.001	0.266	- 6.5
Germany	0.003	0.264	- 1.70
Italy	0.009	0.263	-288
Netherlands ^x	0.002	0.269	-
U.K.	0.003	0.264	- 0.302
Euro-dollar	1.057		

C. Partial sterilization

	on interest rate	on spot rate	on international reserves
Belgium	0.140	0.230	-11.6
France	0.080	0.246	- 6.1
Germany	0.155	0.226	- 1.47
Italy	0.108	0.239	-264
Netherlands ^x	0.002	0.269	-
U.K.	0.138	0.230	- 0.271
Euro-dollar	1.057		

^x The Netherlands was simulated assuming a freely floating regime. Thus the Dutch authorities do not intervene in the exchange market. The reason is that we encountered technical simulation problems with the Dutch submodel when we assumed "leaning against the wind" intervention by the Dutch authorities.

the increase of the U.S. interest rate at the expense of a higher adjustment of the spot rate. In fact, as the results indicate the size of the adjustment of the spot exchange rate is similar to the one obtained under pure floating (table 2). Thus a "leaning against the wind" strategy combined with full sterilization policies produces adjustments in the exchange rate which have the same order of magnitude as in the free floating system. The reason is not difficult to grasp. When the authorities lean against the wind produced by an increase in the U.S. interest rate and when at the same time they want to maintain the domestic interest rate unchanged they will have to contract the money base in the exchange market and expand it by the same amount in the domestic money market. This keeps the domestic interest rate at its target level but leads to a further depreciation of the currency. "Leaning against the wind" becomes ineffective.

Table 4 also reveals that the amount of intervention is larger when sterilization policies are followed, then in the absence of sterilization. This makes the "leaning against the wind" strategy in the face of an external shock a costly instrument when used together with sterilization policies. Nothing is gained in terms of a reduced impact on the exchange rate when compared to the floating rate system. The cost is a reduction of international reserves.

Finally, with partial sterilization (sterilization coefficient = 0.5) the impact of an increase in the U.S. interest rate on the domestic interest rate is substantially reduced with a concomitant increased impact on the spot rate (compared to the free floating system).

4.2. A domestic monetary expansion

The model was simulated assuming a 10 per cent expansion of the domestic component of the money base (compared to its exogenous value) in Germany, France and the U.K. The results are shown in table 5 ¹⁾. The assumed intervention behavior is the same as in the previous section.

A domestic credit expansion leads in the short run to a decline in the domestic interest rate and a depreciation of the currency. With the use of sterilization policies the decline in the interest rate and the depreciation of the currency will be larger than in the absence of sterilization policies. In addition the

¹⁾ Since the share of the domestic component of the money base is different in every country this produces a different initial percentage expansion of the money base in the three countries (i.e. 1.2 % in Germany, 6.1 % in France and 6.2 % in the U.K.).

Table 5.A. : Effect of a 10 per cent expansion in the domestic component of the money base^x in Germany, simulation period 1973 I-II

	on German interest rate	on dollar/DM spot rate	on international reserves of Germany, in billion DM
no sterilization	-0.155	0.039	-0.296
full sterilization	-0.189	0.047	-0.306
partial sterilization	-0.175	0.044	-0.305

^x This corresponds to the initial expansion of the money base of 1.2 per cent.

B. : Effect of a 10 per cent expansion in the domestic component of the money base in France^x

	on French interest rate	on dollar/FF spot rate	on international reserves of France, in billion FF
no sterilization	-0.138	0.035	-0.951
full sterilization	-0.156	0.039	-1.050
partial sterilization	-0.147	0.037	-0.998

^x This corresponds to an initial increase of the money base of 6.1 per cent.

C. : Effect of a 10 per cent expansion in the domestic component of the money base in the U.K.^x

	on U.K. interest rate	on dollar/sterling rate	on international reserves of the U.K., in billion pounds
no sterilization	-0.430	0.107	-0.167
full sterilization	-0.511	0.128	-0.195
partial sterilization	-0.470	0.117	-0.181

^x This corresponds to an initial expansion of the money base of 6.2 per cent.

loss of international reserves tends to be larger with sterilization than without. The reason is that when sterilization policies are used the authorities will expand domestic credit more than the initial expansion of the domestic component of the money base. This is so because the initial expansion of domestic credit leads to an outflow of international reserves, which is offset by a further domestic credit expansion.

4.3. A speculative run

In a final series of simulation runs we assumed a speculative cycle which took the following form. Changes in expectations produce an increase in the forward rate of 1 per cent compared to its exogenous value during three consecutive quarters, after which the forward rate comes back to its exogenous value. The intervention behaviour is identical to the behaviour assumed in the previous section.

The results are shown in figures 1 and 2. Without sterilization activity the impact of the speculative cycle on the domestic interest rate is substantial. At its peak the interest rate increase is between 4 and 5 percentage points in Germany and France ¹⁾. The increase in the spot rate is substantially lower than the increase in the forward rate. With full sterilization the domestic interest rates are completely insulated from the speculative cycle. The counterpart is that the spot rate closely follows the movement of the forward rate. Thus, we conclude that leaning against the wind intervention cannot reduce the variability of the spot exchange rate produced by speculative cycles when it is combined with complete sterilization policies.

Figures 1 and 2 also show the results with partial sterilization. Partial sterilization significantly reduces the effect of the speculative run on the domestic interest rate, however, at the cost of a higher variability of the spot exchange rate.

¹⁾ Note that an increase in the three-month forward rate of 1 per cent corresponds to a 4 per cent increase on a yearly basis.

Figure 1 : Speculative run Germany (Forward rate = + 1% in 73I, + 2% in 73II, + 3% in 73III, + 2% in 73IV, + 1% in 74I)

No sterilization

Full sterilization

Partial sterilization

— : spot exchange rate (dollar/DM)
 ---- : domestic interest rate

Figure 2 : Speculative run France (Forward rate = + 1% in 1973I, +2% in 73II, +3% in 73IV, +2% in 73IV, +1% in 74I)

No sterilization

Full sterilization

Partial sterilization

— : spot exchange rate (dollar/FF)
 ---- : domestic interest rate

5. SIMULATION RESULTS : THE CURRENCY UNION

In this section the results of the simulations of the currency union are reported.

Two currency unions were studied. In a first union Belgium, Germany and the Netherlands form a "mini-snake". In a second union France is added. The purpose of this two-step simulation strategy is to find out how the extension of the original snake agreement to more countries may affect the monetary interdependencies among the initial members of the snake agreement.

5.1. The mini-snake

The simulation results of the different exogenous shocks are presented under the two alternative intervention systems discussed in the previous section. In the first intervention system countries intervene in each other's currency. In the present set-up Belgium and the Netherlands buy and sell DM to keep the BF/DM resp. guilder/DM within the margin of 2.25 % around the parities. This intervention system will be labeled the DM-intervention system. In the second intervention system Belgium and the Netherlands buy and sell dollars to keep their parities with the DM within the limits. This will be labeled the dollar-intervention system. Note that in this intervention system equation (21) is used.

The results of the simulation of the different shocks are now discussed consecutively.

(a) An increase in the U.S. interest rate

The dynamic multipliers of a one percentage point increase in the U.S. interest rate are presented in table 6. It can be seen that the effects on the DM/BF and DM/guilder rates are almost nihil under both the intervention system. In addition, the interest rates in the three countries move very little and the size of the intervention in either DMs or dollars is very little. Thus an exogenous increase in the U.S. interest rate puts very little strain on the intra-snake movements of reserves and exchange rates. The underlying assumption, here, is that the expected DM/BF and DM/guilder rates are not influenced by the increased US interest rate.

Table 6 : Effect of a 1 percentage point increase in the U.S. interest rate
(73 I - 73 II)

	on dollar spot rates (in %)	on DM spot rates (in %)	on interest rate (in % points)	on reserve flows (in billion na- tion. currencies)
Dollar intervention				
Belgium	0.251	-0.002	0.004	-0.105
Germany	0.253	-	0.003	0.0
Netherlands	0.253	0.0	0.006	-0.003
DM intervention				
Belgium	0.252	-0.002	0.004	-0.097
Germany	0.250	-	0.001	+0.009
Netherlands	0.253	0.003	0.005	-0.003

(b) An expansion of domestic credit in the snake countries

We discuss consecutively the effects of a 10 per cent expansion of the domestic component of the money base in Germany and Belgium.

The effects of a 10 per cent expansion of domestic credit in Germany are shown in table 7 ¹⁾. One now finds significant differences according to which the intervention is in dollars or in DMs. In a dollar intervention system the effects of the German credit expansion on the interest rates of Belgium and the Netherlands are substantially higher than in a DM intervention system.

¹⁾ Note that this corresponds to a 1.2 % expansion of the money base.

Table 7 : Effect of an expansion of domestic credit in Germany (10 per cent)^x
(73 I - 73 II)

	on dollar spot rates (in %)	on DM spot rates (in %)	on interest rates (in % points)	on reserve flows (in billions of nat. currencies)
Dollar intervention				
Belgium	0.031	-0.020	-0.138	+8.3
Germany	0.051	-	-0.186	0.0
Netherlands	0.079	+0.028	-0.254	0.191
DM intervention				
Belgium	0.009	-0.034	-0.036	+1.80
Germany	0.043	-	-0.172	-0.15
Netherlands	0.013	-0.030	-0.047	+0.034

^x This corresponds to an initial increase of the money base of 1.2 %.

Table 8 : Effect of an increase of domestic credit in Belgium (10 per cent)^x
(73 I - 73 II)

	on dollar spot rate (in %)	on DM spot rate (in %)	on interest rate (in % points)	on reserve flows (in billions of nat. currencies)
Dollar intervention				
Belgium	0.011	0.011	-0.050	-1.0
Germany	0.0	-	0.0	0.0
Netherlands	0.0	0.0	0.0	0.0
DM intervention				
Belgium	0.015	0.013	-0.055	-0.8
Germany	0.002	-	-0.010	0.05
Netherlands	0.001	-0.001	-0.002	0.002

^x This corresponds to an initial increase of the Belgian money base of 1.6 %.

The reason is that, in the absence of sterilization policies, the purchase of DMs by Belgium and the Netherlands tends to reduce the money supply in Germany, and thereby diminishes the expansionary effects exerted by the German credit expansion. This is not the case in a dollar intervention system : the dollar purchased by Belgium and the Netherlands have no monetary repercussion in Germany.

The difference in the two intervention systems is also apparent from the size of the intervention. In a dollar-intervention system Belgium and the Netherlands have to buy substantially more dollars (expressed in national currencies) than they have to buy DMs in a DM-intervention system. The reason for this difference is again due to the asymmetries of the dollar intervention system. In this system Belgium and the Netherlands have to absorb more of the German credit expansion. Whereas in a DM-intervention system the Belgian and Dutch interventions are helped by the contractionary effects they produce in Germany, this is not the case in a dollar intervention system. As a result the Belgian and Dutch authorities have to intervene more in the dollar intervention system. Another way of putting this results is that intervening in dollars is less effective from the point of view of Belgium and the Netherlands than intervening in DM.

In table 8 the results of a domestic credit expansion in Belgium are reported¹⁾. These results show that the monetary shock in Belgium has no impact on the other countries' variables in the dollar-intervention system in a DM-intervention system. The effects of the Belgian credit expansion on the other countries' variables is not zero, however, they are very small. This, of course, reflects the small relative size of Belgium so that even in a symmetric intervention system the effects of a Belgian monetary expansion are asymmetric.

(c) Exogenous speculative movements

First, the effects of an expected appreciation of the DM are analysed. This expectational change was assumed to take the following form : the expected appreciation of the DM produces a decline in the forward rate of the DM of

¹⁾ The simulation results of a Dutch credit expansion are similar and are not reported here.

1 per cent (versus the dollar and the other snake currencies), compared to its exogenous value during three consecutive quarters, after which the forward rate comes back to its exogenous value. Thus during the first quarter the forward rate declines by 1 per cent, during the second quarter by 2 per cent (relative to the exogenous value), during the third quarter by 3 per cent, during the fourth quarter by 2 per cent, during the fifth quarter by 1 per cent. During the sixth quarter the forward rate returns to its exogenous value. The results of this speculative run are shown in figure 3.

The results in a dollar-intervention system again illustrate the essential asymmetry of this system. The expected appreciation of the DM leads to equal appreciations of the spot DM versus the dollar. The German interest rate is unaffected. In order to keep the DM/BF and DM/guilder rates within the permissible band the Belgian and Dutch authorities are forced to sell dollars in substantial amount. This puts a strong upward pressure on the Belgian and Dutch interest rates.

These asymmetries are reduced in a DM-intervention system because the sale of DMs by Belgium and the Netherlands reduces the German interest rate. As a result, the upward pressure on the Belgian and Dutch interest rates is lessened. Another implication of a DM-intervention system is that the appreciation of the DM vis-à-vis the dollar is reduced.

In a second simulation of a speculative movement it was assumed that the Belgian franc is expected to depreciate vis-à-vis all the other currencies. The set-up of this speculative run was similar to the previous speculative run. Note that we now have that the forward rate of the Belgian franc increases relative to its exogenous value. The results are shown in figure 4. In the dollar-intervention system Belgium has to bear the full burden of the adjustment, mainly by an increase in the Belgian interest rate. The other countries are completely insulated from the effects of the expected depreciation of the BF. Note also that the spot BF depreciates vis-à-vis the dollar and vis-à-vis the DM in the same proportion.

In the DM-intervention system the upward pressure on the Belgian interest rate is lessened, because the German and the Dutch interest rates move downwards. Note that an asymmetry remains in that the upward movement of the Belgian interest rate is larger than the downward movement of the Dutch and German interest rates. This asymmetry has to do with the small size of Belgium.

Figure 3 : Expected appreciation of the DM

Dollar intervention

DM-intervention

r = interest rate

s = spot rate

Figure 4 : Expected depreciation of the BF

5.2. The effects of sterilization policies

As was shown in the theoretical analysis the systematic use of sterilization policies in a currency union affects the inter-country transmission of monetary shocks within the union. This phenomenon is illustrated in tables 9 and 10.

In table 9 the results of a credit expansion in Germany are reported assuming that Belgium and the Netherlands follow a policy of partial sterilization : Belgium and the Netherlands are assumed to neutralize 50 per cent of their foreign exchange market intervention. The results indicate that Belgium and the Netherlands are able to partially insulate their domestic money market from the monetary shock originating in Germany. Comparing the results of table 9 with table 7 one finds that the decline in the Belgian interest rate now is only 85 basis points versus 138 in the simulation with no sterilization. For the Netherlands the relevant figures are 156 and 254 respectively.

The cost of this greater insulation of the Belgian and Dutch money markets is a higher need to intervene in the foreign exchange market (purchases of dollars). Belgium now purchases 1 billion BF worth of dollar more than in the no sterilization case. In addition, the appreciation of the BF versus the DM is now higher than in the no sterilization case (although well within the permissible band of fluctuation). Thus, it can be said that with sterilization policies the interventions in the foreign exchange market are less effective.

In table 10 the sterilization activity of Belgium is increased from 50 to 90 percent. The results show that the Belgian interest rate is now little affected by the German monetary expansion. However the BF appreciates even more vis-à-vis the German mark and the amount of intervention is now BF 2.3 billion higher than in the no sterilization case.

Table 9 : Effect of expansion domestic credit in Germany (10 %)

Partial sterilization in Belgium, Netherlands (50 per cent)

dollar intervention	dollar spot rate	DM spot rate	interest rate	reserve flow
Belgium	0.020	-0.031	-0.085	+9.3
Germany	0.051	-	-0.186	0.0
Netherlands	0.040	-0.011	-0.156	0.210

Table 10 : Effect of expansion domestic credit in Germany (10 %)

Sterilization : Belgium (90 per cent), Netherlands (50 per cent)

dollar intervention	dollar spot rate	DM spot rate	interest rate	reserve flow
Belgium	0.005	-0.046	-0.021	10.6
Germany	0.051	-	-0.186	0.0
Netherlands	0.040	-0.011	-0.156	0.210

5.3. The enlargement of the currency union

In this section the results of enlarging the currency union by including France, are reported.

(a) Domestic credit expansion

The results are shown in table 11. These results should be compared with those of the mini-snake in table 7.

A first striking result is that in a dollar intervention system, with Germany playing the passive role, the addition of France does not influence the transmission mechanism of a credit expansion in Germany ¹⁾. Thus as in the mini-snake German monetary policies continue to influence the money markets of Belgium and the Netherlands in the same way. The reason has to do with the asymmetrical intervention system analyzed here. The money markets of France, Belgium and the Netherlands are mere extensions of the German money market, without feedback effects going from these countries to Germany. The addition of France, therefore, does not affect the transmission of monetary shocks from Germany to Belgium and the Netherlands.

The situation is drastically changed in the DM-intervention system (without sterilization). Here we observe that the addition of France substantially affects the transmission of a German monetary shock to Belgium and the Netherlands. These two countries are now much less affected by a credit expansion in Germany. Part of the German credit expansion is absorbed by France. This in turn has a feedback effect on Germany, which reduces the effects of the initial credit expansion on the other countries.

¹⁾ The same holds for the transmission of monetary shocks originating in Belgium and the Netherlands.

Table 11 : Effect of an expansion of domestic credit in Germany (10 per cent)
(73 I - 73 II)

	dollar spot rate	DM spot rate	interest rate	reserve flows (in billions of nat. currencies)
Dollar intervention				
Belgium	0.031	-0.020	-0.138	+8.3
Germany	0.051	-	-0.186	0.0
Netherlands	0.079	0.028	-0.254	0.191
France	0.033	-0.018	-0.100	5.1
DM intervention				
Belgium	0.008	-0.016	-0.026	1.30
Germany	0.024	-	-0.117	-0.54
Netherlands	0.011	-0.013	-0.037	0.025
France	0.005	-0.019	-0.016	0.72

In addition, the initial snake countries, Belgium and the Netherlands, have to intervene substantially less when France is in the union. France is now doing a large part of the intervention. The counterpart is that the total official purchases of DM in the foreign exchange market of the union is substantially higher when France is in the union than in its absence (540 million DM instead of 150 million DM). This also implies that the effect of the German credit expansion on the German interest rate is substantially lower when France is in the union. Instead of declining with 172 basis points the German interest rate declines with only 117 basis points when France is in the union.

Another way to put this result is to state that the "offset" of the German monetary expansion by a capital outflow from Germany to the other union members is larger when France belongs to the union. The "offset coefficient"¹⁾ of a domestic credit expansion in Germany implicit in the foregoing simulations is equal to -0.12 in the mini-snake and -0.43 in the union with France. This means that in the mini-snake a DM 1 expansion of credit in Germany is

¹⁾ This is defined as the ratio of the change in (net) international reserves and the change in the domestic component of the money base.

offset by a DM 0.12 reduction of net international reserves in Germany (in fact a purchase of DM 0.12 by Belgium and the Netherlands) and by a DM 0.43 reduction of net international reserves of Germany in the union with France (i.e. a purchase of DM 0.43 by Belgium, France and the Netherlands). Thus the size of the offset coefficient crucially depends on the size of the currency union.

(b) Speculative runs

The model of the currency union including France was simulated under the same speculative movements as those simulated in the mini-snake.

In the dollar intervention system the results for Belgium, Germany and the Netherlands, are identical to the results obtained in the mini-snake (see figure 1). In other words, when Germany plays the role of the "passive" country, the enlarging of the currency union does not affect the inherent asymmetry whereby Germany determines the monetary conditions in the other countries.

Things are radically different in a symmetric DM-intervention system. Figure 5 contains the simulation results of an expected DM appreciation, with France a member of the currency union. Comparing these results with the results of figure 3 (DM-intervention) it is clear that the enlargement of the union matters. A much larger part of the expected appreciation of the DM is now absorbed by Germany, i.e. by a decline of the German interest rate ¹⁾. The counterpart is that the other union members, Belgium and the Netherlands, are now much less affected. In other words, the larger the currency union the smaller is Germany in the whole, and the less the original union members' money markets are affected by changes in expectations concerning the DM.

A final simulation is presented in figure 6. Here it is assumed that a speculative run against the BF develops, i.e. the BF is expected to depreciate. The format of this speculative run is the same as the one reported earlier. Comparing figure 6 with figure 4 (DM-intervention) it appears that with the addition of France, the Belgian money market has to absorb the speculative

¹⁾ The decline of up to 6 percentage points may seem large. One should remember that an expected appreciation of 3 per cent on a quarterly basis corresponds to an expected appreciation of approximately 12 per cent on a yearly basis.

shock more than in the mini-snake. Thus with France in the union, an expected depreciation of the BF leads to a stronger upward movement of the Belgian interest rate. The counterpart of this result is that the Dutch and German interest rates are less affected when the currency union includes France than otherwise. Note also that in the larger union the dollar exchange rates of the DM and the guilder are less affected by the speculative movement against the BF. This also implies that the dollar rate and the DM rates of the BF move closer together.

These results are in the same logic as the results of the expected DM appreciation. The larger the union, the smaller the relative size of any one country. As a result, the inter-country feedback effects are smaller. Thus an expected appreciation (or depreciation) of the currency of one country in the union leads to a smaller effect on the interest rate of the other countries, so that the domestic interest rate has to adjust more in a larger currency union than in a smaller one.

Figure 5: Expected appreciation of the DM (DM-intervention)

Figure 6: Expected Depreciation of the BF (DM-intervention)

5. CONCLUSION

The exchange rates of major currencies have exhibited a large volatility in recent years. Many explanations have been offered in the literature. The most convincing explanations have been those stressing the stock adjustment effects of changing expectations in an uncertain environment.

In this paper we have analyzed other sources of variability of exchange rates, i.e. those that originate from the intervention behaviour of the national monetary authorities. Our conclusions were that policies of "leaning against the wind" in the foreign exchange market when combined with sterilization policies will be ineffective in reducing the volatility of exchange rates.

In addition, these policies lead to increased reserve flows between countries. In a sense it can be said that these policies combine the disadvantages of fixed and floating exchange rates. They keep the exchange rates volatile and lead to substantial flows of international reserves.

We also studied the monetary transmission process in a currency union, and the implications of such a system on the exchange rates. We noted the importance of the choice of the intervention currency within the unions. In particular it was found that the use of an external currency (e.g. the dollar in the EMS) may substantially reduce the effectiveness of control over intra-union exchange rates.

In concluding, it is important to stress the limitations of the present study. The major limitation is the short-term nature of the model, which led us to assume that expectations are exogenous. Further work should go into the problem of endogenizing expectations. This is especially important as one expects that the intervention rules used by the monetary authorities affect the expectations about the future spot rate.

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APPENDIX : THE ESTIMATED EQUATIONS

In this appendix the estimated equations of the model are presented. The money demand equations are presented in table A.1, the price equations in table A.2, the wage equations in table A.3. Table A.4 contains the Euro-dollar equation. In table A.6 the money demand equations in inverted form (i.e. as explaining the interest rate) are presented. These were used in the managed float simulations, instead of the normal money demand equations.

The data sources were :

DATA	SOURCE
SPOT RATES	IFS : line AE
FORWARD RATES	IFS except for Italy (E.E.C.)
INTEREST RATES	MORGAN GUARANTY, WORLD FINANCIAL MARKETS
MONEY STOCK	IFS : line 34-35
MONEY BASE	IFS : line 14
INTERNATIONAL RESERVES	IFS : line 11 - line 16c
NATIONAL INCOME	IFS : quarterly data calculated with industrial production indices
CONSUMER PRICES	IFS : line 64
WAGES	IRES -
PRODUCTIVITY	IRES -
UNEMPLOYMENT RATE	O.E.C.D.
PAR RATES SNAKE	NATIONALE BANK VAN BELGIE

Table A.1 : M-demand functions - log linear specifications

Country	Var.	CTE	P	Y	r	lagged Var.	R ²	DW	Average lag
Belgium	M1	-0.419 (0.43)	0.566 (0.12)	0.203 (0.09)	-0.057 (0.02)	0.433 (0.12)	0.98	2.6	1.76
Germany	M1 ^x	-3.349 (0.29)	1.00	1.224 (0.04)	-0.077 (0.01)	-	0.94	2.24	-
France	M1	-0.29 (0.26)	0.631 (0.16)	0.086 (0.05)	-0.027 (0.02)	0.471 (0.13)	0.987	2.23	1.89
Italy	M2	-12.79 (1.9)	1.193 (0.07)	1.625 (0.18)	-0.048 (0.04)	-	0.98	1.28	-
The Netherlands	M1 ^x	-0.61 (0.19)	1.00	0.858 (0.038)	-0.094 (0.012)	-	0.93	1.99	-
United Kingdom	M1	3.52 (0.31)	0.785 (0.028)	0.818 (0.13)	-0.044 (0.02)	-	0.99	0.73	-

(^x) Estimated in real terms

Figures between brackets are standard deviation.

Table A.2 : Price Functions - Log Linear Specification - '66 I - '77 IV

Country	CTE	Wages	Import Prices	Lagged Prices	R ²	DW	Average Lag (in quarters)	Long Run Import Price Elasticity
Belgium	0.0936 (0.0699)	0.057 (0.015)	0.0569 (0.0126)	0.87 (0.025)	0.99	1.8365	7.69	0.437
Germany	0.319 (0.085)	0.089 (0.019)	0.039 (0.018)	0.80 (0.0517)	0.99	1.6575	5.0	0.195
France	0.425 (0.069)	0.1378 (0.0198)	0.052 (0.0084)	0.72 (0.0386)	0.99	1.579	3.57	0.186
Italy	0.278 (0.059)	0.0621 (0.0128)	0.0718 (0.0113)	0.81 (0.03)	0.99	2.007	5.26	0.378
The Netherlands	0.27 (0.076)	0.1205 (0.0286)	0.0147 (0.016)	0.81 (0.048)	0.99	2.519	5.26	0.077
United Kingdom	0.076 (0.039)	0.0898 (0.0407)	0.0533 (0.031)	0.84 (0.036)	0.99	1.5615	6.25	0.333

Figures between brackets are standard deviations.

Table A.3 : Wage Functions - Log Linear Specifications - '66 I - '77 IV

Country	CTE	Prices	Productivity	Unemployment Rate	Lagged Wages	R ²	DW
Belgium	-1.747 (0.498)	0.5915 (0.183)	0.1107 (0.064)	-0.014 (0.003)	0.70 (0.10)	0.99	2.92
Germany	-0.599 (0.262)	0.169 (0.114)	0.0603 (0.0641)	-0.0091 (0.0027)	0.911 (0.05)	0.99	1.98
France	-1.069 (0.499)	0.401 (0.20)	0.094 (0.0629)	-0.00108 (0.0063)	0.743 (0.141)	0.99	1.76
Italy	-1.158 (0.39)	0.106 (0.085)	0.264 (0.089)	0.0005 (0.004)	0.888 (0.064)	0.99	1.63
The Netherlands	-0.519 (0.34)	0.156 (0.176)	0.187 (0.065)	0.0083 (0.0064)	0.763 (0.123)	0.99	2.29
United Kingdom	-0.773 (0.388)	0.146 (0.131)	0.165 (0.0879)	-0.00965 (0.0047)	0.87 (0.126)	0.99	1.81

Table A.4 : The Euro-dollar equation (CORC-estimate)

$$r_{Et} = \underset{(0.05)}{0.83} r_{At} + \underset{(0.05)}{0.23} \sum_j \epsilon_j (r_{jt} - x_{jt})$$

$$R^2 = 0.97 \quad DW = 2.08 \quad S.E. = 0.38 \quad \rho = 0.35$$

The ϵ_j 's are the weights given to the individual currencies j .

It is defined as :

$$\epsilon_j = \frac{M_{jt}}{\sum_j M_{jt}} \quad \text{for } j = 1, \dots, 6$$

Table A.5 : Interest rate-functions 66 I - 77 IV

COUNTRY	ESTIMATES (ln = logs)
BELGIUM	$r_t = -0.616 + 6.91 (\ln p_t - \ln p_{t-1}) - 6.769 (\ln M1_t - \ln M1_{t-1}) + 0.0011 \cdot Y_t + 0.748 \cdot r_{t-1}$ <p style="text-align: center;">(1.36) (23.2) (4.05) (0.0007) (0.09)</p> $R^2 = 0.755 \quad D.W. = 1.198$
GERMANY	$\ln r_t = -16.32 - 2.07 \ln M2_t + 4.331 \ln Y_t - 0.855 (\ln p_t - \ln p_{t-1}) + 0.755 \cdot \ln r_{t-1}$ <p style="text-align: center;">(6.17) (0.79) (1.62) (4.12) (0.09)</p> $R^2 = 0.83 \quad D.W. = 1.65$
FRANCE	$r_t = 0.565 + 4.398 (\ln p_t - \ln p_{t-1}) - 3.35 (\ln M2_t - \ln M2_{t-1}) + 0.00062 \cdot Y_t + 0.84 \cdot r_{t-1}$ <p style="text-align: center;">(1.08) (9.67) (7.19) (0.000009) (0.08)</p> $R^2 = 0.80 \quad D.W. = 1.298$
ITALY	$r_t = -8.507 + 33.8 (\ln p_t - \ln p_{t-1}) - 13.78 (\ln M1_t - \ln M1_{t-1}) + 0.00011 \cdot Y_t + 0.58 \cdot r_{t-1}$ <p style="text-align: center;">(3.7) (14.6) (6.0) (0.00004) (0.10)</p> $R^2 = 0.85 \quad D.W. = 1.68$
NETHERLANDS	$\ln r_t = -35.3 + 6.74 \ln p_t - 6.74 \ln M1_t + 5.95 \ln Y_t - 0.098 \ln r_{t-1}$ <p style="text-align: center;">(6.60) (1.31) (1.12) (1.32) (0.123)</p> $R^2 = 0.59 \quad D.W. = 1.93$
U.K.	$r_t = -4.77631 + 16.29 (\ln p_t - \ln p_{t-1}) - 6.779 (\ln M1_t - \ln M1_{t-1}) + 0.316 \ln Y_t + 0.635 \cdot r_{t-1}$ <p style="text-align: center;">(3.29) (15.7) (6.66) (0.15) (0.132)</p> $R^2 = 0.687 \quad D.W. = 1.48$

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