ETLA ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 609 900 Telefax 601753

Keskusteluaiheita - Discussion papers

No. 372

Markku Kotilainen

EXCHANGE RATE UNIONS: A COMPARISON TO CURRENCY BASKET AND FLOATING RATE REGIMES - A THREE-COUNTRY MODEL WITH ENDOGENOUS PRICES*

* This is a preliminary report of an ongoing research project. I thank Kari Alho, William Brainard, Vesa Kanniainen, Jukka Lassila and Pentti Pikkarainen for comments; I am, however, solely responsible for any remaining errors. All further comments are welcome. Financial support from the Academy of Finland is gratefully acknowledged. A previous version of the paper was published under the same title as Working Paper 4/91, Business and Economic Studies on European Integration, Copenhagen Business School.

ISSN 0781-6847 29.07.1991

KOTILAINEN, Markku, **EXCHANGE RATE UNIONS: A COMPARISON TO CURRENCY BASKET AND FLOATING RATE REGIMES - A THREE-COUNTRY MODEL WITH ENDOGENOUS PRICES.** Helsinki : ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1991. 47 p. (Keskusteluaiheita, Discussion Papers, ISSN 0781-6847; no. 372).

ABSTRACT: The paper is the second preliminary report of a project in which exchange rate unions are systematically compared to currency basket and floating rate regimes in the framework of a three-country macroeconomic model. Membership in an exchange rate union can be interpreted to characterize pegging to the European Currency Unit (ECU), or membership in the European Monetary System or Union (EMS or EMU). The currency basket exchange rate regime in this study is a system where the domestic exchange rate is pegged to a trade-weighted basket. The first report of the project includes the results obtained in another version of the model where prices are assumed to be fixed (ETLA Discussion Paper, No. 356). (In a forthcoming third report the effects of inflation are also taken into account.) When compared to the fixed price version of the model, it is shown in the current paper that the results concerning the insulation properties of different exchange rate regimes in the face of exogenous shocks are modified when prices are allowed to change and to influence aggregate supply.

KEY WORDS: exchange rate regimes, European monetary integration, exchange rate unions, currency basket exchange rate regime, floating exchange rates

CONTENTS

1. Introduction

This paper is the second preliminary report of a project in which exchange rate unions are systematically compared to currency basket and floating rate regimes in the framework of a three country macroeconomic model. The first report includes the results obtained in a model version, where prices are assumed to be fixed (Kotilainen, 1991a). The present report includes supply reactions and changing prices. A forthcoming third report includes a model version where the effects of inflation are also taken into account (Kotilainen, 1991b).

The main focus in the analysis is put on the effects of foreign shocks in different exchange rate regimes. The effects of domestic shocks are considered only briefly. One reason for this is that making a distinction between exchange rate unions and currency basket regimes in this respect requires a model, where so-called credibility aspects are explicitly taken into account. These kinds of models (often game theoretic) are outside the scope of the present study. (For various aspects of the choice of an exchange rate regime in the face of European integration, see for example Kotilainen and Peura, 1988 and 1989.)

The idea behind the adopted "shock approach" is that stabilization of certain economic variables, especially of output and prices, against temporary shocks is desirable. This objective can be legitimized by assuming that stable economic development produces a higher level of welfare than fluctuating development. This objective can also be motivited by the adjustment costs which are connected to fluctuating economic development.

The framework used consists of macroeconomic models for each of the three countries considered, two of which are assumed to be "big" and the third one small in the sense that its impact on the big countries is small enough to be omitted. The model system is solved by solving the models of the big countries simultaneously, and by inserting these solutions into the small country model in a recursive way. The exchange rate regimes of the big countries are assumed to be floating, whereas in the small country the impacts of shocks are considered in three alternative regimes: floating, exchange rate union and currency basket regime.

The model structure chosen is prompted by the fact that at least three countries are needed in a model where the effects of a monetary union, or those of pegging to several foreign currencies, are analyzed. Compared to one-country models with exogenous foreign shocks, the model structure of this paper, where foreign countries are explicitly modelled, has the advantage that the impacts of foreign shocks in the respective countries can be traced. The shocks faced by the small open economy are thus more realistic than by just assuming changes in the individual foreign variables of the small country model.

The model tries to grasp the essential elements of the regime choice, which a small country, like Finland, faces in a world where the exchange rates of the main currencies are floating. The big countries can thus be interpreted to represent the countries belonging to the European Monetary System (EMS) or to the possibly evolving European Monetary Union (EMU) (country 2), and the USA or the rest of the world (country 1). The exchange rate union alternative for the small country tries to represent membership in the EMS/EMU or unilateral pegging to the European Currency

Unit (ECU). In the study the exchange rate union means thus pegging to the currency of country 2. The currency basket exchange rate regime in turn represents the basic features of the system, which was formerly in practice for example in Finland, Norway and Sweden, where the exchange rate was pegged to a trade-weighted basket. These countries have during the years 1990-1991 shifted to pegging unilaterally to the ECU.

The contents of the report are as follows. In the second section the structure of the model is presented. In the third section the effects of domestic shocks on the small country are briefly described. In the rest of the paper the effects of shocks originating in the big countries are considered: the impacts of goods demand shocks in section four, those of monetary shocks in section five, and those of supply shocks in section six. An evaluation of the results is presented in section seven, and the summary in section eight.

2. The structure of the model

The models for the individual economies are rather traditional IS-LM models (see for example Dornbusch, 1980, p. 199). The three-country framework is not, however, used often. For example Buiter (1986) has used a similar, but a more complex (dynamic) model, in a two-country setting. Bhandari (1985), Marston (1985), and Callan (1989) are examples of studies where a three-country framework, but different kinds of models, are used in analyzing exchange rate regimes.

The models for each country consist of money market (LM) and goods market (IS) equilibrium conditions, and of an interest rate parity condition, which means that nominal interest rates are equalized internationally through perfect capital mobility. Compared to the previous report (Kotilainen, 1991a) the model differs in the way in which goods market behaviour is modelled. In the previous report output was demand determined and prices did not react to changes in demand; the model expressed thus very short-term behaviour of the economy. In this paper supply reactions and changes in prices are also taken into account by adding a supply curve (equations 3, 7 and 11) into each country model. The goods market equilibriums are now expressed with two equations: the goods demand equations (2, 6 and 10) and the above-mentioned supply equations.

Endogenizing prices in this model version serves to shed light on the impacts of changes in relative prices and of supply reactions. The model does not yet include the effects of inflation, because no distinction has been made between nominal and real interest rates (ex ante). The interest rate parity condition is also formulated in a way where exchange rate expectations are static, i.e. exchange rates are assumed to be the same in the future as they are today. Equations (4), (8) and (12) express thus a version of the real interest rate parity condition.

The model is presented in natural logarithms (except interest rates) as follows:

Country 1 ("the USA")

$$(1)\ m_1 - p_1 = k_1y_1 - \Phi_1 i_1$$

$$(2)\ y_1 = -\mu_1 i_1 + \sigma_{12}(e + p_2 - p_1) + \epsilon_{12}y_2 + f_1$$

$$(3)\ p_1 = \alpha_1(e + p_2) + \beta_1 y_1 - s_1$$

$$(4)\ i = i_1 = i_2 = r_1 = r_2$$

Country 2 ("the EMU" or "a hard EMS")

$$(5)\ m_2 - p_2 = k_2y_2 - \Phi_2 i_2$$
$$(6)\ y_2 = -\mu_2 i_2 - \sigma_{21}(e + p_2 - p_1) + \epsilon_{21}y_1 + f_2$$
$$(7)\ p_2 = \alpha_2(p_1 - e) + \beta_2 y_2 - s_2$$
$$(8)\ i = i_1 = i_2 = r_1 = r_2$$

Country 3 ("Finland")

$$(9)\ m_3 - p_3 = k_3y_3 - \Phi_3 i_3$$
$$(10)\ y_3 = -\mu_3 i_3 + \sigma_3[\theta(e_{31} + p_1 - p_3) + (1 - \theta)(e_{32} + p_2 - p_3)] + \epsilon_3[\theta y_1 + (1 - \theta)y_2] + f_3$$
$$(11)\ p_3 = \alpha_3[\theta(e_{31} + p_1) + (1 - \theta)(e_{32} + p_2)] + \beta_3 y_3 - s_3$$
$$(12)\ i = i_1 = i_2 = i_3 = r_1 = r_2 = r_3.$$

The symbols are as follows: m = nominal money stock, p = price level (GDP deflator), k = income elasticity of money demand, i = nominal interest rate, Φ = interest rate semielasticity of money demand, y = real output, μ = real interest rate semielasticity of goods demand, r = real interest rate, σ = elasticity of goods demand with respect to relative prices ("competitiveness elasticity"), e = the price of the currency of country 2 in terms of the currency of country 1, ϵ = elasticity of goods demand with respect to foreign output, α = the elasticity of domestic prices with respect to foreign prices, β = the elasticity of prices with respect to domestic output, f = exogenous goods demand shock, s = exogenous price shock ("productivity shock"), e_{31} and e_{32} = prices of the currencies of country 1 and country 2 in terms of the currency of country 3, respectively. Additionally, relative prices ("competitiveness") are defined as follows: $c = e + p_2 - p_1$, $c_{31} = e_{31} + p_1 - p_3$, and $c_{32} = e_{32} + p_2 - p_3$. All coefficients of the model as defined above are non-negative.

The countries are assumed to produce tradeable goods which can be somewhat different as aggregates. This difference is reflected in the values of σ:s. The form, how the interest rate parity condition is written implies that the assets of different countries are assumed to be perfect substitutes. It implies also that the agents are on average risk neutral.

In the big country model y_1, y_2, p_1, p_2, e and $i_1=i_2$ are endogenous variables. In the small country model y_3 and p_3 are endogenous, and in the floating exchange rate regime also one of the bilateral exchange rates, e_{31} or e_{32}. We can write the other one with the help of e, according to the triangular arbitrage, for example $e_{31} = e_{32} - e$. In the currency basket exchange rate regime the bilateral exchange rates change according to the trade weights so that the effective (trade-weighted) exchange rate remains constant. In the case of an exchange rate union, the exchange rate of the small country is the same as that of country 2.

The ideas behind the money market equilibrium condition and the goods demand equation are straightforward. The supply curve might need some clarification. When solved in terms of y_1, we can write the supply curve for country 1 as follows:

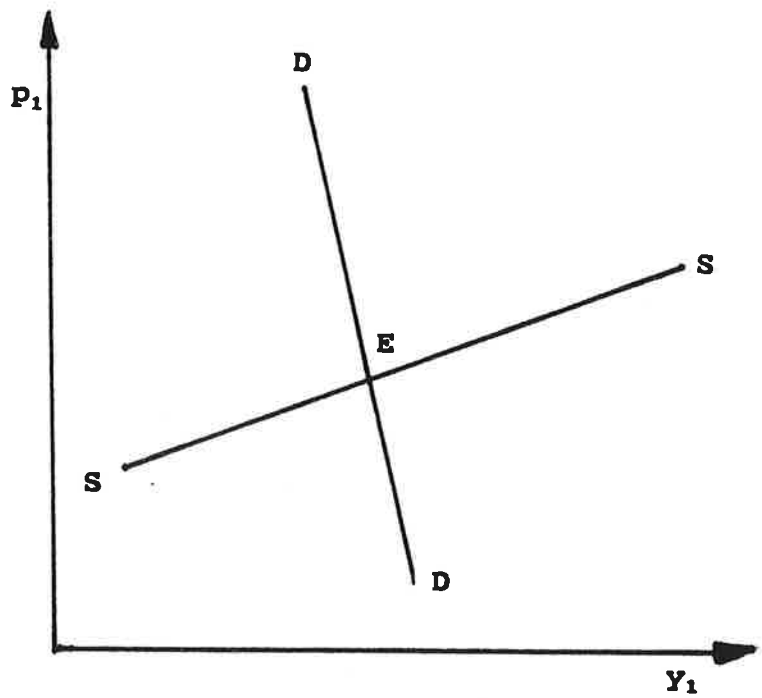
$$(3)' \quad y_1 = (1/\beta_1)p_1 - (\alpha_1/\beta_1)(p_2 + e) + (1/\beta_1)s_1.$$

The supply of the domestic good responds thus positively to an increase in its own price, and negatively to an increase in the price of the foreign good, which is assumed to be used as an input in the production process.

The exogenous shock s_1 is written in the equation as a positive one, which can be interpreted to be, for example, an exogenous increase in the productivity - in principle it can of course be a negative one, too.

The goods market equilibrium is presented in the following figure for country 1 with respect to output and domestic prices. The supply curve is marked with SS and the demand curve with DD. The equilibrium is attained at point E. An increase in domestic prices thus increases supply and decreases demand.

Figure 1. Goods market equilibrium in country 1



In the previous report (Kotilainen, 1991a) rather clearcut results for the big countries were obtained with a model where countries were symmetric, prices were fixed and supply was assumed to be perfectly elastic. When comparing the effects of foreign shocks on the small economy in different exchange rate regimes, we already had to use numerical calculations to some extent, especially to make a distinction between the exchange rate union and the currency basket regime.

After adding a rising supply curve, we are no longer able to draw *a priori* conclusions from the changes in the endogenous variables in the big country model either - the model is too complicated. About the effects of foreign shocks on the small economy *a priori* conclusions can be drawn concerning the relative post-shock output levels assuming that the pre-shock outputs are the same in different exchange rate regimes. The signs of the changes, and so the deviations from zero, are, however, dependent on the parameter values. We must therefore rely on numerical calculations of the equilibrium values of the model. When using this kind of a solution method also sensitivity analyses with various alternative numerical values of the parameters are necessary. In the case of domestic shocks in the small country, *a priori* results can, however, be obtained.

We assume throughout the study that the big countries are symmetric. We thus denote these parameters without a subscript. The smallness of the third country normally implies higher values for the elasticities with respect to foreign demand and relative prices than for the big countries.

When studying the effects of shocks originating in the big countries, we use the following numerical values for the parameters in the base scenario:

<u>common parameters:</u>

$k = k_1 = k_2 = k_3 = 0.67$, $\Phi = \Phi_1 = \Phi_2 = \Phi_3 = 0.46$,

$\mu = \mu_1 = \mu_2 = \mu_3 = 0.2$, $\beta = \beta_1 = \beta_2 = \beta_3 = 0.3$

<u>big country parameters:</u>

$\sigma = 0.1$, $\epsilon = 0.3$, $\alpha = 0.1$

<u>small country parameters:</u>

$\sigma_3 = 0.3$, $\epsilon_3 = 0.6$, $\alpha_3 = 0.3$, $\theta = 0.3$

The parameters presented above are assumed to reflect rather short-term relationships between the variables. Money demand coefficients with respect to income and interest rates are adopted from Kremers and Lane (1990). These values are estimated for the EMS countries as an aggregate, but they are used as an approximation for all countries. In reality these parameter values differ between countries, but because they differ in reality also in time and because the main point in the study is comparing the systemic differences between exchange rate regimes, abstracting from the differences seems legitimate. When comparing the exchange rate union and the currency basket regime the possibly differing money demand elasticities of the small economy are irrelevant. In these regimes money supply is fully elastic, when capital is mobile; the LM curve of the small country can thus be dropped away.

The rest of the parameter values are determined on the basis of econometric studies for the Finnish economy, for example on the basis of ETLA's econometric model. Because most of the parameter estimates needed do not have a direct counterpart in the studies, the values adopted must be considered more or less as "guestimates". The values of σ, ϵ and α are between one third and a half of the small country parameters (in the EC countries one third of foreign trade occurs with non-EC countries).

3. Domestic shocks in the small country

In the model framework used we cannot make a difference between the exchange rate union and the currency basket regime in the case of domestic shocks. The regimes are both fixed exchange rate regimes. A distinction can be made for example in models where the regimes are assumed to differ in terms of the degree of fixity and accordingly in terms of the credibility of the peg. These aspects are neglected at this stage of the study. In the following we confine ourselves to comparing the effects of domestic shocks in the floating and fixed exchange rate regimes.

In the case of <u>a domestic goods demand shock</u> occurring in the small country 3 (change in f_3 in equation 10), output, prices and exchange rates change in the floating rate regime as follows:

$$(13)\ \frac{\delta y_3}{\delta f_3} = \frac{\alpha_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}$$

$$(14)\ \frac{\delta e_{32}}{\delta f_3} = \frac{-\beta_3-k_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}$$

$$(15)\ \frac{\delta p_3}{\delta f_3}=-\frac{\alpha_3 k_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}\ .$$

It is obvious for relevant values of the parameters that the denominator of the above-mentioned multipliers is positive. The negative term is small compared to the other terms; $k_3\sigma_3$ (the product of the income elasticity of money and of the elasticity with respect to relative prices) is for example smaller than one, which alone is a sufficient condition for positiveness. Positiveness is also guaranteed when $\alpha_3 \leq 1$. A positive domestic demand shock thus increases output, appreciates the exchange rate and lowers prices accordingly.

In the fixed exchange rate regime we drop the LM curve from the small country model, because the money supply is perfectly elastic when capital is fully mobile and there is no uncertainty about the level of the exchange rate. We have now two endogenous variables, output and prices, the changes of which are as follows:

$$(16)\ \frac{\delta y_3}{\delta f_3}=\frac{1}{1+\beta_3\sigma_3}$$

$$(17)\ \frac{\delta p_3}{\delta f_3}=\frac{\beta_3}{1+\beta_3\sigma_3}\ .$$

In the fixed rate regime both output and prices increase after a positive real shock.

For values $\alpha_3 < 1$ it can be shown *a priori* that output changes less in the floating rate regime than in the fixed rate regime. If $\alpha_3 = 1$, i.e. domestic prices adjust fully to changes in foreign prices, there is no difference between the exchange rate regimes with respect to the output reaction. This implies the traditional result that floating insulates the output better in the short run against domestic real shocks than fixed rates, and that fiscal policy is less efficient in the floating rate regime than in the fixed rate regime. The short-run means here a period during which domestic prices have not adjusted fully to changes in the exchange rate.

The results concerning the stabilization of prices are not as clearcut. Relative changes in prices depend more on the relative magnitudes of parameter values. If k_3 (the income elasticity of money demand) is great relative to β_3 (the responsiveness of prices to changes in output) fixed rates stabilize prices better than floating, and the other way round.

In the case of a domestic monetary shock (money supply or money demand shock) we obtain the following results in the floating rate regime:

$$(18)\ \frac{\delta y_3}{\delta m_3} = \frac{\sigma_3 - \alpha_3 \sigma_3}{\alpha_3 + \beta_3 \sigma_3 + k_3 \sigma_3 - \alpha_3 k_3 \sigma_3}$$

$$(19)\ \frac{\delta e_{32}}{\delta m_3} = \frac{1 + \beta_3 \sigma_3}{\alpha_3 + \beta_3 \sigma_3 + k_3 \sigma_3 - \alpha_3 k_3 \sigma_3}$$

$$(20)\ \frac{\delta p_3}{\delta m_3} = \frac{\alpha_3 + \beta_3 \sigma_3}{\alpha_3 + \beta_3 \sigma_3 + k_3 \sigma_3 - \alpha_3 k_3 \sigma_3}\ .$$

The denominator of the multipliers is the same as in the case of a demand shock, and thus positive in the relevant cases. We can now conclude that an increase in the money supply (or, correspondingly, a decrease in the demand for money) leads to an increase in the output if $\alpha_3 < 1$. If $\alpha_3 = 1$, the output remains unchanged. We can also conclude that the exchange rate depreciates and prices increase as a result of the above mentioned shock.

In the fixed exchange rate regime the domestic money supply or demand shocks have no effect on the output or prices. International capital flows mitigate immediately any efforts to influence the domestic output through monetary policy.

If there is <u>an exogenous domestic price shock</u> we obtain the following changes in the floating rate regime:

$$(21)\ \frac{\delta y_3}{\delta s_3} = \frac{\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}$$

$$(22)\ \frac{\delta e_{32}}{\delta s_3} = \frac{1-k_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}$$

$$(23)\ \frac{\delta p_3}{\delta s_3} = -\frac{k_3\sigma_3}{\alpha_3+\beta_3\sigma_3+k_3\sigma_3-\alpha_3 k_3\sigma_3}.$$

The denominator is again the same as above, we can thus assume that it is positive. A positive exogenous price shock increases output and decreases domestic prices. The exchange rate depreciates in the short run, because we can assume that $k_3\sigma_3 < 1$.

The result obtained above is crucially dependent on the assumption of unchanged money supply. If the money supply adjusts fully to changes in the domestic price level, the output remains unchanged. For the other endogenous variables we get the following results:

$$(24)\ \frac{\delta p_3}{\delta s_3} = \frac{\delta e_{32}}{\delta s_3} = \frac{\delta m_3}{\delta s_3} = \frac{1}{-1+\alpha_3}$$

Prices, exchange rates and the money supply change thus by an equal amount. This kind of a money supply rule can be followed if α_3 (the response of domestic prices to changes in the exchange rate) is rather small. If it approaches the value 1, the rule leads to an exploding path of prices and exchange rates.

In a fixed rate regime an exogenous price shock leads to the following changes in the output and prices:

$$(25)\ \frac{\delta y_3}{\delta s_3} = \frac{\sigma_3}{1+\beta_3\sigma_3} > 0$$

$$(26)\ \frac{\delta p_3}{\delta s_3} = -\frac{1}{1+\beta_3\sigma_3} < 0.$$

When compared to a floating rate regime with no changes in the money supply, the fixed rate regime leads to a smaller change in output if $\alpha_3 < 1$ and if $k_3\sigma_3 < 1$, which obviously holds at least in the short run. If $\alpha_3 = 1$, there is no difference between the regimes in this respect. When the money supply responds wholly to changes in the price level floating rates insulate the domestic output, but this kind of a policy is obviously not possible in the longer run when α_3 increases.

4. Goods demand shocks in the big countries

4.1. Shocks occurring in country 1

4.1.1. Effects on the big contries

In the model with fixed prices we obtained the following *a priori* results in the case of a (positive) goods demand shock occurring in country 1: (1) outputs of both countries increase with the same amount (assuming symmetry), (2) the competitiveness of country 1 deteriorates because its currency appreciates, and (3) interest rates of both countries increase (Kotilainen, 1991a, p. 9).

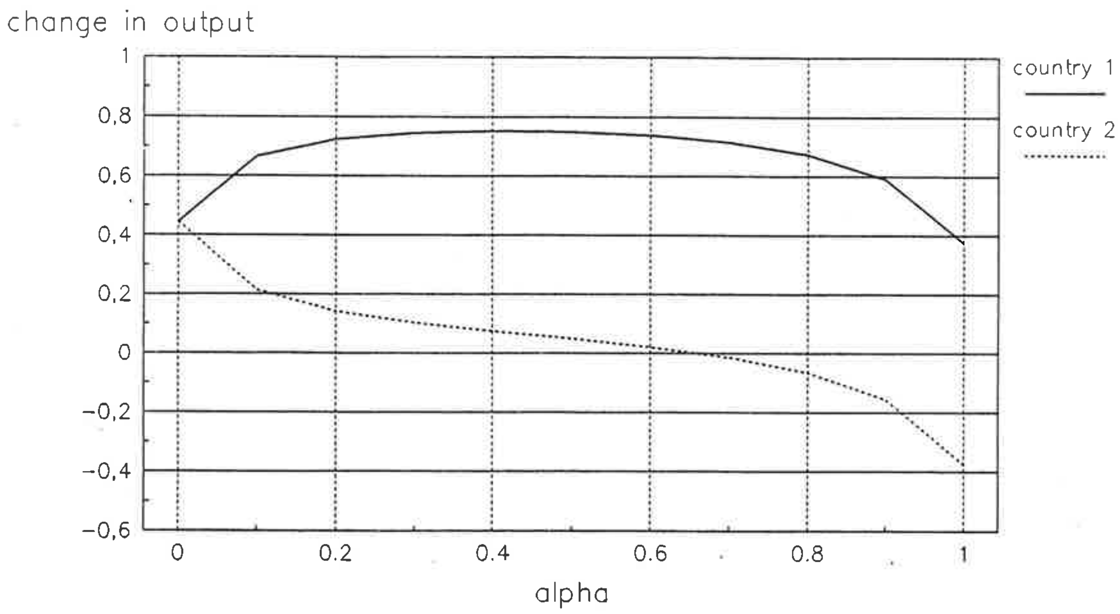
In the case of variable prices we get now the following results for the big countries when using the parameter values of the baseline scenario as described on page 9:

$$\delta y_1/\delta f_1 = 0.667, \qquad \delta y_2/\delta f_1 = 0.213$$
$$\delta e/\delta f_1 = -2.354, \qquad \delta i/\delta f_1 = 0.960$$
$$\delta p_1/\delta f_1 = -0.005, \qquad \delta p_2/\delta f_1 = 0.299.$$

An expansive fiscal policy or some other exogenous demand shock increases thus the output of the home country more than that of the other big country, appreciates the exchange rate, increases the global interest rate, and raises the price level of country 2. These kinds of price changes are due to changes in the exchange rate. In country 1 the appreciation of the exchange rate slows down the pressure on prices, so that the price level remains almost unchanged. In country 2 the depreciation reinforces the price increases.

The breakdown of the symmetry result in the case of output changes is due to the parameter α, the response of domestic prices and output supply to foreign trade prices. This can be seen in the following sensitivity analysis (other parameter values except those of α are the same as in the baseline scenario) (figure 2). In a one-country model an increase in α can be presented as an upwards shift of the SS curve in figure 1 (p. 7).

Figure 2. Goods demand shock in country 1: sensitivity of output reactions with respect to α in the big countries



When there is no response to foreign prices (α = 0), the symmetrical result is established, even if output supply reacts to domestic prices (β = 0.3). At the other extreme, when domestic prices are assumed to respond fully to foreign trade prices (α = 1), the output of country 2 decreases as much as that of country 1 increases. This result can be shown *a priori*, too, for positive values of the parameters.

In the baseline scenario the assumption of α = 0.1 is motivated by the import content of domestic final demand based on input-output calculations. The idea behind this assumption is that domestic producers are assumed to follow a kind of mark-up pricing. The possibly following inflationary process is thus not taken into account.

4.1.2. Effects on the small country

Even if we are not able to compare *a priori* the deviations of economic variables, because we do not know the signs of the effects, we can compare the post-shock levels, as was the case in the previous report, too (Kotilainen, 1991a). Assuming that the output is in all exchange rate regimes at the same level before the shock, it can be shown that the exchange rate union leads to a higher output after a positive real shock occurring in country 1 than the basket regime. The difference between the output effects is as follows:

$$\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg) - \frac{\delta y_3}{\delta f_1}(basket) = \frac{(1-\alpha_3)(\beta+k+\alpha k)\sigma_3\theta}{2(\alpha+\alpha\epsilon+\beta\sigma+k\sigma-\alpha k\sigma)(1+\beta_3\sigma 3)}.$$

It can be shown that the above mentioned formula is positive for values $0 \leq \alpha \& \alpha_3 < 1$ and $\theta > 0$. If $\alpha_3 = 1$, σ_3

= 0 or θ = 0, the formula is zero and there is no difference between the output effects in the exchange rate union and in the basket regime. The difference between the output effects in these regimes consists of the competitiveness effect and of the price effect through the supply side. If α, α_3, β and β_3 are all zero, we are back in the fixed price case, where the above-mentioned formula reduces to the difference in the exchange rate effect. When assuming symmetry between all three economies, it can additionally be shown that floating leads to an even higher post-shock output level than the union in the case of a positive shock. It must be assumed that $0 \leq \alpha < 1$ and $0 \leq \theta < 1$.

We next study the effects of the shock in the baseline numerical calculation. In the floating rate regime the shock leads to an increase in the output of the small country, to an increase in prices, to a depreciation of the effective exchange rate and, accordingly, to an improvement in the competitive position (=relative prices):

$$\delta y_3/\delta f_1 = 0.185, \ \delta p_3/\delta f_1 = 0.318, \ \delta c_3/\delta f_1 = 0.556.$$

The currency of the small country depreciates in relation to the currency of country 1, but appreciates slightly in relation to that of country 2.

In the case of an exchange rate union the bilateral exchange rate with respect to the currency of country 2 is fixed, but that with respect to country 1 is floating. The effective exchange rate depreciates somewhat more than in the floating rate regime. The changes in the output, prices and competitiveness are as follows:

$$\delta y_3/\delta f_1 = 0.192,\ \delta p_3/\delta f_1 = 0.332,\ \delta c_3/\delta f_1 = 0.582.$$

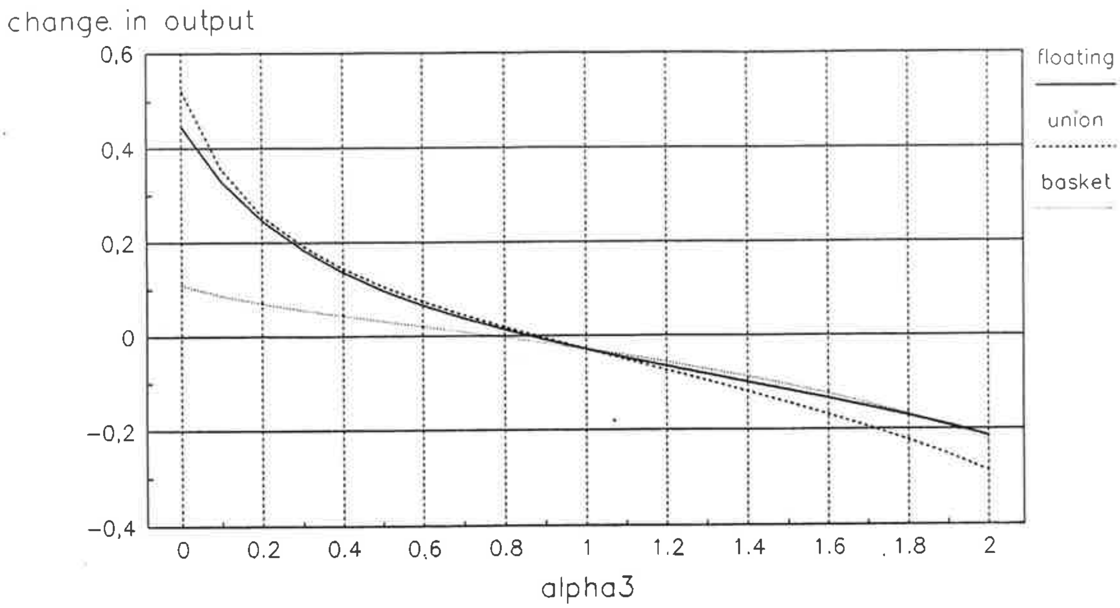
In the basket regime the effective (trade-weighted) exchange rate is stabilized. This leads to a rather small increase in competitiveness and domestic prices, and is also reflected in a smaller change in output than in the other exchange rate regimes considered. The multipliers are as follows:

$$\delta y_3/\delta f_1 = 0.056,\ \delta p_3/\delta f_1 = 0.079,\ \delta c_3/\delta f_1 = 0.179.$$

The conclusion that the currency basket exchange rate regime stabilizes the output better than the other two regimes holds for different values of α and α_3, too, as is seen in figure 3 on page 19. However, if $\alpha_3 = 1$, i.e. if domestic prices adjust wholly to foreign trade prices, there is no difference between the regimes in this respect. This is the same result which was obtained in the case of domestic shocks, too (page 11). The basket regime stabilizes also domestic prices better than the other regimes with the respective values of α and α_3. Floating is the second best.

The above-mentioned results apply to an economy, where output is rather responsive to changes in competitiveness and foreign demand. In more closed real economies, with small values of σ, σ_3, ϵ and ϵ_3, the change in the interest rate can outweigh the effects of export demand so that a positive goods demand shock occurring in country 1 can lead to a decline of the small country's output in the currency basket regime. In this case it is possible in principle that the exchange rate union leads to a smaller change in output than the basket peg regime (appendix 3).

Figure 3. Goods demand shock in country 1: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



4.2. Shocks occurring in country 2

4.2.1. Effects on the big countries

Because of the assumption of symmetry between the big countries, the effects of a demand shock occurring in country 2 are the same as in the case when the shock originates in country 1 - the countries just change places. The results are as follows:

$$\delta y_1/\delta f_2 = 0.213, \qquad \delta y_2/\delta f_2 = 0.667$$
$$\delta e/\delta f_2 = 2.354, \qquad \delta i/\delta f_2 = 0.960$$
$$\delta p_1/\delta f_2 = 0.299, \qquad \delta p_2/\delta f_2 = -0.005.$$

A positive goods demand shock in country 2 increases the output of the home country more than that of the neighbouring country, increases the interest rate globally, and appreciates the exchange rate of country 2. Because of the appreciation, the price level of the home country remains almost unchanged, whereas that of country 1 rises.

4.2.2. Effects on the small country

The difference between the post-shock output levels is the same as in the case, when the shock occurs in country 1 (page 17). Now, however, the basket peg regime leads to a higher output level than the exchange rate union. The deviation from zero is again dependent on the parameter values. In the case of symmetry between the economies it can be shown that floating leads to the highest post-shock output. (We must assume: $0 \leq \alpha < 1$, $0 < \epsilon < 1$ and $\theta < 1$.)

In the floating rate regime the effects of this shock are different from those of a shock occurring in country 1, because country 2 is assumed to be a more important trading partner than country 1. This result differs from that obtained with a fixed price model (Kotilainen, 1991a, pp. 13, 35 and appendix 2). The reason for this difference is that export demands from the big countries differ in this model version; in the fixed price model outputs of both big countries changed by an equal amount.

In the case of a shock occurring in country 2 the export demand of country 3 grows by more than when the shock occurs in country 1. According to the goods and money market equilibrium conditions the effective exchange rate of the small country depreciates also less in this case, and accordingly the domestic price level rises less. Also the improvement in competitiveness is smaller. The results of the baseline calculation are as follows:

$$\delta y_3/\delta f_2 = 0.246, \ \delta p_3/\delta f_2 = 0.277, \ \delta c_3/\delta f_2 = 0.399.$$

In the exchange rate union the effects of an increasing export demand are about fully compensated for by the increasing interest rate and the deteriorating competitiveness, which results from the appreciating effective exchange rate. The appreciation causes also a decrese in the domestic price level. The result differs from the effects occurring in country 2, in the respect that the real shock there is internal and affects demand directly. In the small country the increase in demand is indirect and smaller.

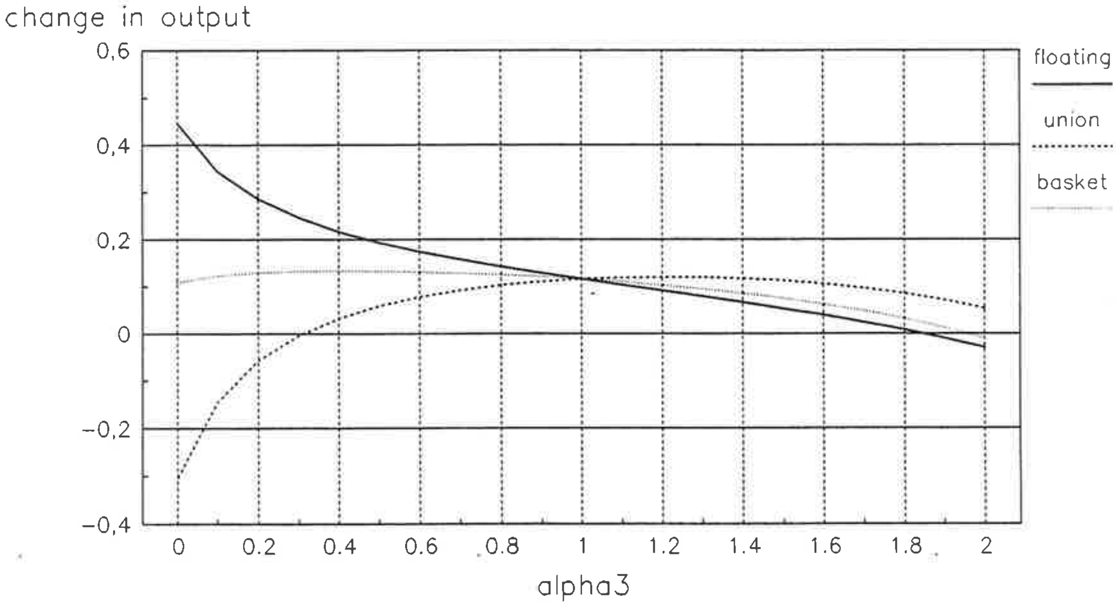
$$\delta y_3/\delta f_2 = -0.003, \ \delta p_3/\delta f_2 = -0.187, \ \delta c_3/\delta f_2 = -0.867$$

In the currency basket exchange rate regime the effective exchange rate remains constant and stabilizes again prices and competitiveness better than the other regimes, but is exactly for this reason worse in stabilizing output than the exchange rate union. In the face of an increasing export demand only the rising interest rate tends to lower the growth effect.

$$\delta y_3/\delta f_2 = 0.133, \ \delta p_3/\delta f_2 = 0.066, \ \delta c_3/\delta f_2 = 0.020$$

The sensitivity of the output effects with respect to different values of α and α_3 is seen in figure 4. If the values of these parameters are very low, the currency basket regime stabilizes the output still the best. Nevertheless, as the parameter values grow, the changing import prices (due to the change in the effective exchange rate) soon make the change in output smaller in the union case. Thus, if there is a positive goods demand shock in country 2, the appreciating exchange rate in the case of the union reduces import prices and increases the output through the supply channel. The currency basket regime stabilizes the output better than floating with all values of $\alpha_3 < 1$. In the case when $\alpha_3 = 1$, there is no difference between the regimes with respect to output stabilization.

Figure 4. Goods demand shock in country 2: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



The currency basket regime is again the best in stabilizing domestic prices with all relevant values of α and α_3. The exchange rate union is now the second best alternative, and floating the worst in this respect.

In an alternative calculation (presented in appendix 3), where all economies respond less to changes in competitiveness and foreign demand, a real shock occurring in country 2 leads to a greater decline in output in the exchange rate union than in the baseline calculation. This result is due to the smaller positive effect of foreign demand and due to the greater negative exchange rate effect - because the exchange rate of country 2 appreciates more than in the baseline calculation. When output reacts less to changes in the exchange rate, a greater change in it is needed to restore equilibrium. In this alternative calculation, when the real sectors of the economies are rather closed, the basket regime leads to the smallest change in output.

5. Monetary shocks in the big countries

5.1. Shocks occurring in country 1

5.1.1. Effects on the big countries

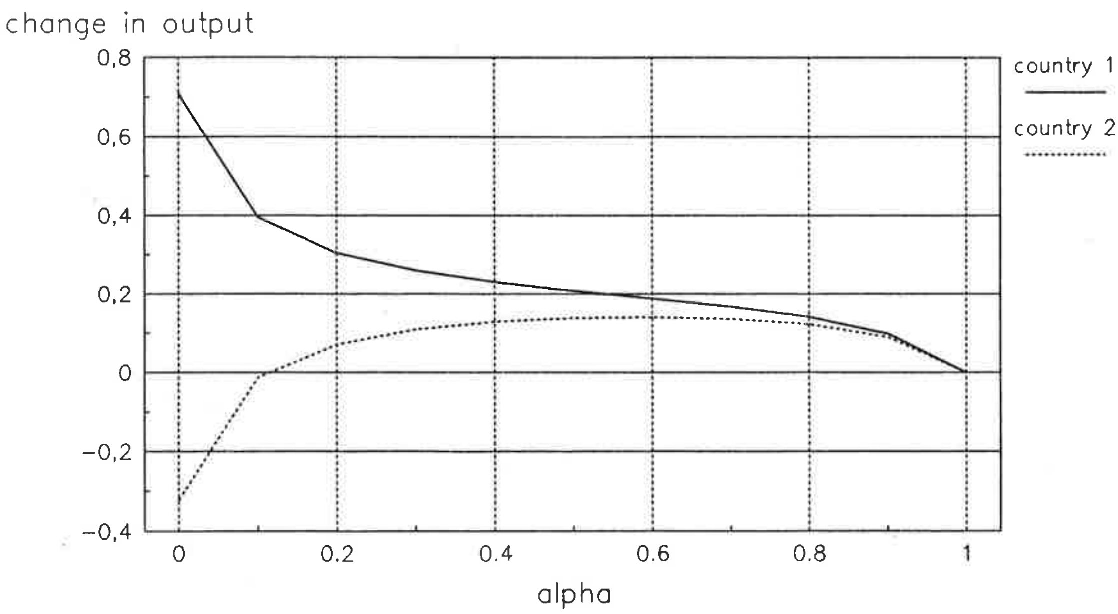
In the case of a money supply shock, or equivalently of a money demand shock with the opposite sign, the endogenous variables change in the following way in the baseline calculation:

$$\delta y_1/\delta m_1 = 0.396, \qquad \delta y_2/\delta m_1 = -0.013$$
$$\delta e/\delta m_1 = 3.382, \qquad \delta i/\delta m_1 = -0.670$$
$$\delta p_1/\delta m_1 = 0.427, \qquad \delta p_2/\delta m_1 = -0.299.$$

If the monetary shock is an increase in the money supply (or equivalently a decrease in money demand) the output of country 1 increases, whereas that of country 2 remains about unchanged. The exchange rate of country 1 depreciates, and the global interest rate decreases. The appreciation and the increase in output lead to a rise in the price level of country 1. In country 2 the opposite development of these variables leads to a decrease in prices.

When looking at the following figure 5, we notice that the beggar-thy-neighbour result is obtained when the value of α is low, but when α increases somewhat above 0.1 the output of country 2 increases, too. This is because of the supply effect of decreasing import prices in country 2. The effects of the shock on the two countries approach each other when α grows. When $\alpha = 1$ the neutrality of money result is established for both countries. This is a general result, which holds for all positive values of the other parameters. Even in the case of $\alpha = 0$ (and $\beta = 0.3$), the increase in output of country 1 is greater than the decrease in the output of country 2. This is the same result, which was obtained in the model with fixed prices. Monetary policy is thus not a zero-sum game worldwide in terms of output changes. There is, however, a net increase in the international price level with all values of α from 0 to 1.

Figure 5. Monetary shock in country 1: sensitivity of output reactions with respect to α in the big countries



5.1.2. Effects on the small country

It can be shown *a priori* that the basket regime leads to a higher post-shock output level in the case of a positive shock, if the pre-shock output level is assumed to be the same in different exchange rate regimes. The difference between the output effects is as follows:

$$\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)-\frac{\delta y_3}{\delta m_1}(basket)=\frac{(\alpha_3-1)(1+\alpha+\epsilon+\alpha\epsilon+2\beta\sigma)\sigma_3\theta}{2(\alpha+\alpha\epsilon+\beta\sigma+k\sigma-\alpha k\sigma)(1+\beta_3\sigma_3)}\ .$$

When assuming $0 \leq \alpha\&\alpha_3 < 1$ and $0 < \theta \geq 1$ the formula is negative. This formula, like that in the case of real shocks, consists of differences in the competitiveness and price effects. If $\alpha = \alpha_3 = \beta = \beta_3$, only the difference in the exchange rate effect is left, and the formula reduces to the same, which was obtained in the fixed price model (Kotilainen, 1991a, p. 42). In the case of symmetry between all economies it can be shown that floating leads to the lowest post-shock output level, when the shock is positive - assuming that the pre-shock output levels are the same in all regimes. It must be assumed that $0 \leq \theta < 1$, $\epsilon < 1$ and $0 \leq \alpha < 1$.

In the baseline calculation the change in foreign demand is rather modest, because in the most important trading partner, country 2, the change in output is small. If there is a positive money supply shock, the export demand, however, increases. The decreasing international interest rate is another factor which tends to increase the output of the small country.

In the floating rate regime the effective exchange rate of country 3 appreciates and leads to a worsening competitiveness, but also to a fall in the price level. Even if the decreasing import prices tend to increase the domestic output, the competitiveness effect is big enough to reduce the growth of output to about zero.

$$\delta y_3/\delta m_1 = -0.009,\ \delta p_3/\delta m_1 = -0.302,\ \delta c_3/\delta m_1 = -0.758.$$

In the exchange rate union the appreciation of the effective exchange rate is somewhat greater than in the case of floating rates. This leads to decreasing import prices, but also to deteriorating competitiveness. The net effect is a bit greater decrease in output than in the floating rate regime. The change is, however, close to zero.

$$\delta y_3/\delta m_1 = -0.028,\ \delta p_3/\delta m_1 = -0.337,\ \delta c_3/\delta m_1 = -0.696$$

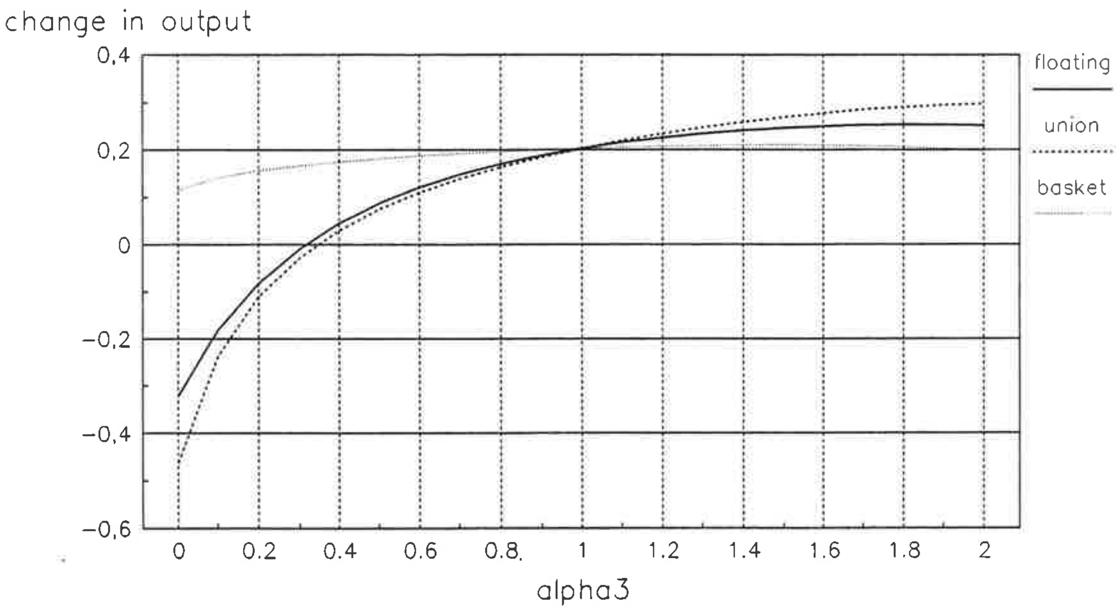
In the currency basket exchange rate regime the effects due to export demand and interest rates are only slightly compensated for by the change in competitiveness. Because the effective exchange rate is stabilized, the effect comes through changes in prices. The change in output is greater than in the cases of floating and the exchange rate union.

$$\delta y_3/\delta m_1 = 0.168,\ \delta p_3/\delta m_1 = 0.026,\ \delta c_3/\delta m_1 = -0.108$$

The output reactions in the floating rate regime and in the exchange rate union are very similar with different values of α and α_3 (figure 6). Changes in output are greater in these regimes than in the basket regime when the values of α and α_3 are very low. Nevertheless already with modest values of these parameters the change becomes smaller. This is due to the strengthening supply effect of import prices. The basket regime stabilizes again domestic prices the best with all values of α and α_3 considered, floating is the second best in this respect and the union the worst.

In the alternative calculation, presented in appendix 3, the ranking of the regimes according to the change in output does not change. The result is thus not sensitive to competitiveness and foreign demand elasticities.

Figure 6. Monetary shock in country 1: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



5.2. Shocks occurring in country 2

5.2.1. Effects on the big countries

In the case of a monetary shock originating in country 2 the effects on the big countries are again the mirror image of a shock originating in country 1. The countries change places. In the baseline calculation the results are as follows:

$$\delta y_1/\delta m_2 = -0.013, \qquad \delta y_2/\delta m_2 = 0.396$$
$$\delta e/\delta m_2 = -3.382, \qquad \delta i/\delta m_2 = -0.670$$
$$\delta p_1/\delta m_2 = -0.299, \qquad \delta p_2/\delta m_2 = 0.427.$$

The output of country 2 increases, that of country 1 remains almost unchanged, the exchange rate of country 2 depreciates and the global interest rate falls. The price level of country 2 increases and that of country 1 decreases. The sensitivity analysis with respect to α is also the mirror image of that presented in figure 5.

5.2.2. Effects on the small country

From the small country's point of view there is a difference between the shocks originating in countries 1 and 2, because country 2 is assumed to be a more important trading partner than country 1. Export demand thus changes more when the shock occurs in country 2. The change in the interest rate is the same, because the big countries are assumed to be symmetric.

It can be shown a *priori* that the exchange rate union leads to a higher post-shock output than the basket regime after a positive shock, assuming that the pre-shock levels are the same in different exchange rate regimes. The difference is the same as in the case of a monetary shock occurring in country 1, but the ranking between the regimes is the opposite. The position of the floating rate regime cannot be shown *a priori*, not even in the case of symmetry.

In <u>the floating rate regime</u> the effects of changes in export demand and interest rates are compensated for by opposite effects of changes in the effective exchange rate and competitiveness. If there is a positive monetary shock in country 2, the effective exchange rate of country 3 appreciates and competitiveness deteriorates.

$$\delta y_3/\delta m_2 = 0.025, \ \delta p_3/\delta m_2 = -0.254, \ \delta c_3/\delta m_2 = -0.348$$

In <u>the exchange rate union</u> the reactions of the effective exchange rate and, accordingly, of competitiveness reinforce the impacts of the shock. In the case of a positive monetary shock in country 2 increasing export demand, declining interest rates and improving competitiveness all tend to increase the output of country 3.

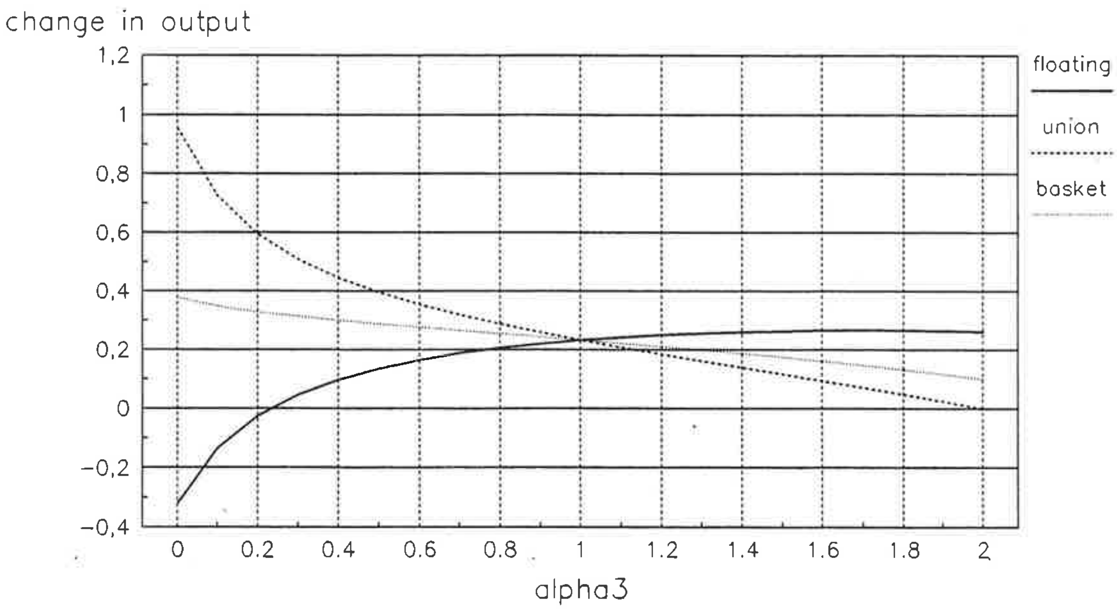
$$\delta y_3/\delta m_2 = 0.509, \ \delta p_3/\delta m_2 = 0.520, \ \delta c_3/\delta m_2 = 0.704$$

In <u>the currency basket exchange rate regime</u> trade-weighted relative prices (= competitiveness) remain almost constant and the change in output is due to changes in export demand and interest rates.

$$\delta y_3/\delta m_2 = 0.313, \ \delta p_3/\delta m_2 = 0.157, \ \delta c_3/\delta m_2 = 0.052$$

The sensitivity analysis with respect to α and α_3 is presented in figure 7. Floating stabilizes the output the best already with zero values of α and α_3. In the fixed price model (Kotilainen, 1991a) the basket regime was somewhat better than floating in the case of this shock, too. Output reaction with respect to domestic prices according to $\beta = 0.3$ in the model of the current paper is the reason for this difference. The currency basket regime stabilizes the ouput better than the exchange rate union with all values of $\alpha_3 = 3 * \alpha$ up to 1, where there is no difference between the regimes. The basket regime is again the best in stabilizing domestic prices, except when $\alpha_3 = \alpha = 0$, and when α_3 is 1.5 or greater. In this case floating is the best. The exchange union is for all values of $\alpha_3 = 3 * \alpha$ the worst in this respect. The results are not sensitive to the values of competitiveness and foreign demand elasticities (appendix 3).

Figure 7. Monetary shock in country 2: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



6. Exogenous price shocks in the big countries

6.1. Shocks occurring in country 1

6.1.1. Effects on the big countries

We assume that there is an exogenous price shock in country 1 due to, for example, a change in productivity. This shock is presented in the supply curve as variable s. An increase in s results from an exogenous decline in domestic costs and is reflected in declining prices and increasing supply of goods (equation (3)' on page 6). A decrease in s results in the opposite reaction. Graphically an increase in s can be presented as a downwards shift of the SS curve in figure 1 on page 7.

In this version of the model a change in s does not lead to any change in monetary policy. This can be motivated, for example, by the difficulty to notice shocks, by the sluggish reaction of monetary policy, or by the difficulties to form a realistic money supply rule. (See pages 13-14 about the effects of a money supply rule in the case of a domestic supply shock occurring in the small country.) The neglect of any money supply reaction implies that the effects must be interpreted to be short-term.

In this kind of a model an exogenous decline in domestic prices (a positive supply shock) leads in the baseline calculation to the following results:

$\delta y_1/\delta s_1 = 0.440,$ $\delta y_2/\delta s_1 = -0.014$

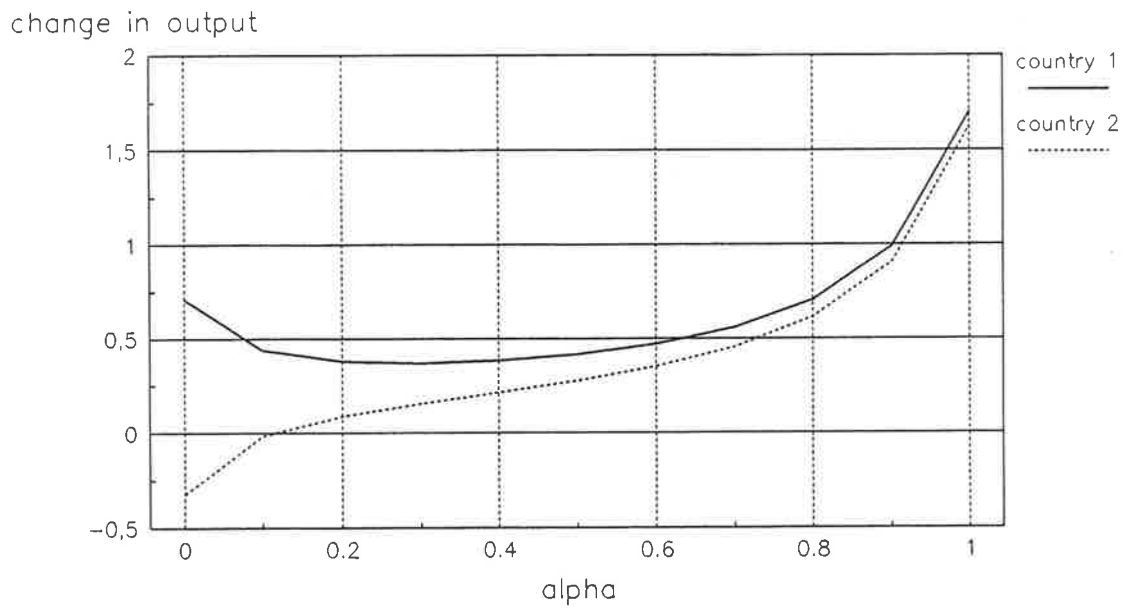
$\delta e/\delta s_1 = 2.646,$ $\delta i/\delta s_1 = -0.744$

$\delta p_1/\delta s_1 = -0.637,$ $\delta p_2/\delta s_1 = -0.333.$

Output of country 1 increases after the shock and that of country 2 decreases slightly. The interest rates also decline globally. Because the money supply does not react to the change in prices, there is an excess supply of real balances, which leads to a depreciation of the currency of country 1. This reinforces the increase in output of this country. The price level falls in both countries.

In the case where the reaction of domestic prices to import prices (α) is small, the output of country 2 decreases. When this reaction is stronger, the output of country 2 increases, too. (Figure 8.)

Figure 8. Exogenous price shock in country 1: sensitivity of output reactions with respect to α in the big countries



6.1.2. Effects on the small country

When the supply shock occurs in country 1, the export demand of the small country does not change very much, because the output of the more important trading partner (country 2) remains almost unchanged. In the case of a positive shock declining international interest rates tend to increase the output of the small country. Basically the effects on output are very similar to those of monetary shocks. This is natural, because in both cases there is a change in real money balances in the country where the shock originates.

It can again be shown *a priori* (under certain assumptions) that the post-shock output is lower in the exchange rate union than in the basket regime assuming that the pre-shock output is at the same level. This can be seen from the following expression:

$$\frac{\delta y_3}{\delta s_1}(EMU\text{-}peg) - \frac{\delta y_3}{\delta s_1}(basket) = \frac{(\alpha_3-1)(1+\epsilon-2k\sigma)\sigma_3\theta}{2(\alpha+\alpha\epsilon+\beta\sigma+k\sigma-\alpha k\sigma)(1+\beta_3\sigma_3)},$$

which is negative, if $0 \leq \alpha \& \alpha_3 < 1$, $\theta > 0$ and $\epsilon > 2k\sigma - 1$. The two first-mentioned conditions are obvious. Because σ (the "competitiveness elasticity" in the big countries) is rather small (clearly less than 0.5), the last mentioned condition holds even if $k = 1$. For floating this kind of a ranking cannot be shown - even in the case of symmetry.

In <u>the floating rate regime</u> output remains almost unchanged in the baseline calculation. The effects of export demand and interest rates are compensated for by the change in the effective exchange rate and thus in the change in the effective exchange rate and thus in competitiveness. The effects of the shock are as follows:

$$\delta y_3/s_1 = -0.010, \ \delta p_3/\delta s_1 = -0.336, \ \delta c_3/\delta s_1 = -0.773.$$

In <u>the exchange rate union</u> the effects are similar to those in the floating rate regime. The change in the effective exchange rate and, accordingly, in competitiveness is somewhat greater, and the price level changes somewhat more.

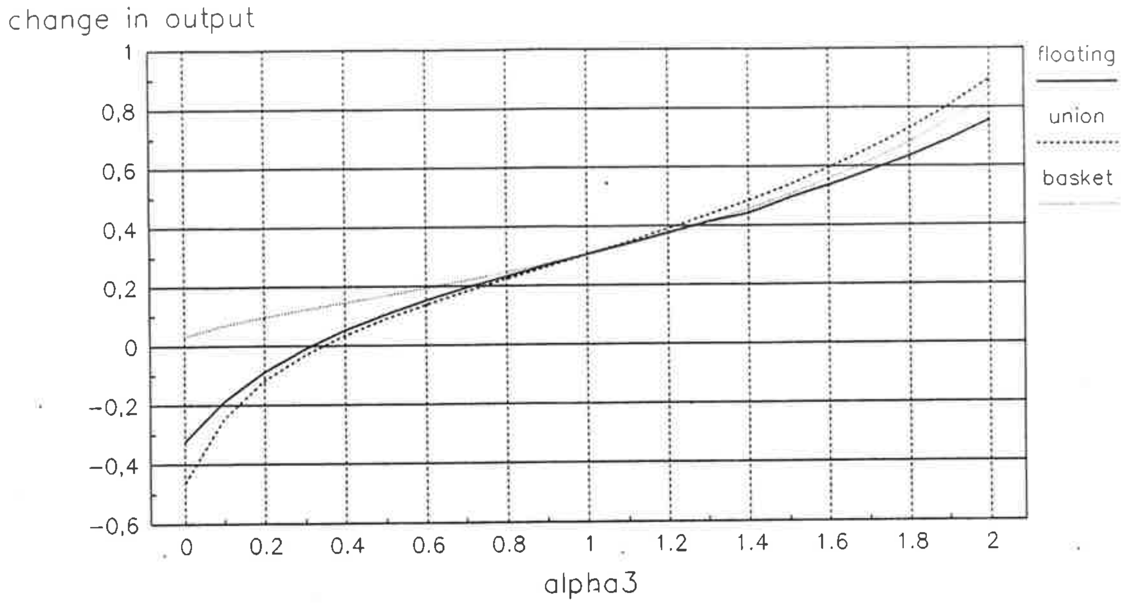
$$\delta y_3/\delta s_1 = -0.031, \ \delta p_3/\delta s_1 = -0.375, \ \delta c_3/\delta s_1 = -0.843$$

In <u>the currency basket regime</u> competitiveness deteriorates only through the price channel, because the effective exchange rate is stabilized. The positive effects due to export demand and interest rates is thus compensated to a smaller degree than in the previous cases. Output changes, accordingly, more.

$$\delta y_3/\delta s_1 = 0.122, \ \delta p_3/\delta s_1 = -0.091, \ \delta c_3/\delta s_1 = -0.333$$

The sensitivity of output effects with respect to α is very much similar to the results obtained, when we analysed the effects of a monetary shock occurring in country 1. The currency basket regime again stabilizes the prices the best with all relevant values of α (from 0 to 1.3), floating is the second best and the union the worst in this respect.

Figure 9: Exogenous price shock in country 1: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



6.2. Shocks occurring in country 2

6.2.1. Effects on the big countries

Because of the assumption of symmetry between the big countries, the results are again the mirror image of those presented in the previous section.

6.2.2. Effects on the small country

The effects on the export demand of the small country are again bigger in this case than in the case when the shock originates in country 1. The results are similar to those of a monetary shock. The most important difference is that in the case of an exchange rate union the depreciation of the currency leads to an increase in prices, whereas in the other regimes prices decline.

Under the same assumptions as presented in the case, when the shock occurs in country 1 (page 33) it can be shown that the exchange rate union leads to a higher post-shock output than the basket regime, assuming that the pre-shock output is at the same level. This result is thus the opposite to the case when the shock occurs in country 1. The difference is the same as presented on page 33, but of an opposite sign.

In the floating rate regime the output effects due to changes in export demand and interest rates are compensated for by the opposite effects of the effective exchange rate and competitiveness. Output is rather well stabilized, and the price level falls. The effects are thus very similar to those in country 1.

$$\delta y_3/\delta s_2 = 0.052,\ \delta p_3/\delta s_2 = -0.377,\ \delta c_3/\delta s_2 = -0.931$$

In the exchange rate union the effective exchange rate depreciates together with that of country 2, although by less. This effect on relative prices is however compensated for by the price development. The price level in country 3 increases contrary to the developments in the other two countries. Relative prices in common currency (competitiveness) remains for this reason almost unchanged, so the output effect is neutral.

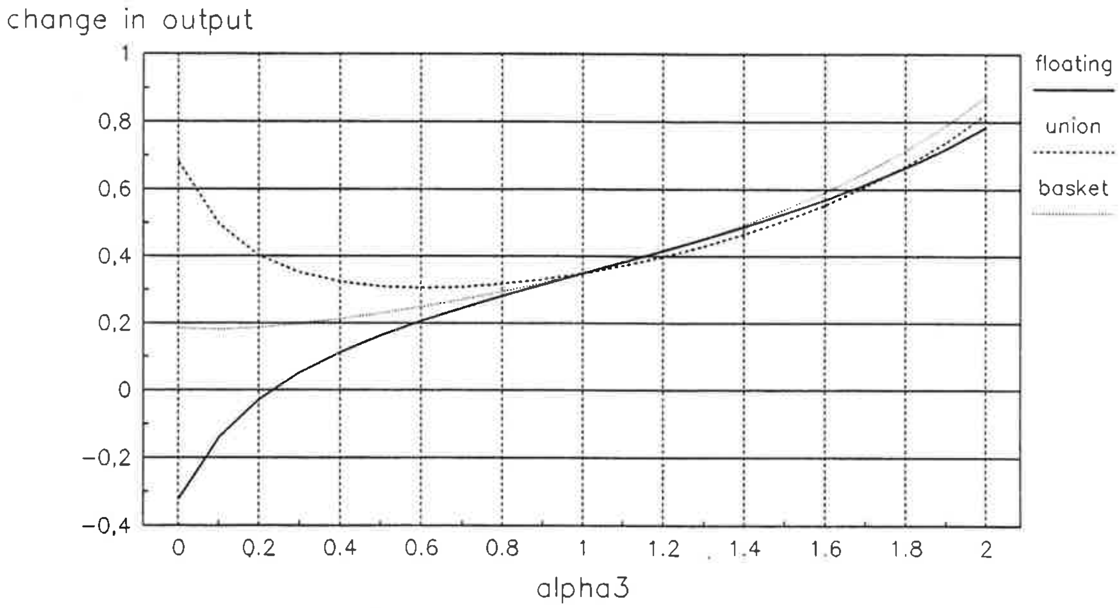
$$\delta y_3/\delta s_2 = 0.351,\ \delta p_3/\delta s_2 = 0.180,\ \delta c_3/\delta s_2 = 0.068$$

In the currency basket exchange rate regime the effective exchange rate is stabilized, but because the prices of country 3 change less than those of countries 1 and 2, the competitiveness affects in the opposite direction than export demand and interest rates, and makes the change in output smaller than in the case of the union.

$\delta y_3/\delta s_2$ = 0.198, $\delta p_3/\delta s_2$ = -0.104, $\delta c_3/\delta s_2$ = -0.442

The sensitivity analysis presented in figure 10 shows that the basket regime stabilizes the output the best only for small values of $\alpha_3 = 3 * \alpha$, and for higher values floating exchange rates are the best in this respect. The basket regime is, however, better than the exchange rate union for all relevant values of α and α_3. The basket regime stabilizes prices the best for the values of α from 0 to 0.3, but after that the exchange rate union alternative gives the smallest change in the domestic price level. Floating leads to the gratest changes in the price level with relevant values of $\alpha_3 = 3 * \alpha$.

Figure 10. Exogenous price shock in country 2: sensitivity of output in the small country with respect to α and α_3 ($\alpha_3 = 3 * \alpha$)



7. Evaluation of the results

In the case of domestic shocks we found in section 3 that floating exchange rates stabilize the output of a small country better against goods demand shocks than fixed rates. In the case of a money supply (or demand) shock fixed exchange rates in turn are better in stabilizing the output. When the small country faces an exogenous price shock, fixed rates stabilize the output better if no monetary policy response is assumed in the case of floating rates. But if money supply adjusts fully to the change in the price level, floating rates insulate the domestic output against the effects of the shock.

In the case of foreign shocks the situation is different. A foreign real shock is not only real from the small country's point of view, and a monetary shock is not only monetary for the small country. Both shocks are composite shocks. A real shock occurring in one of the big countries changes the outputs of the big countries, but also exchange rates and interest rates. The monetary shock also has important real effects.

We could not show the ranking of the regimes with respect to the deviation of output from zero *a priori*, because we did not know the sign of the change. We were, however, in most cases able to determine the difference between the post-shock levels, assuming that the pre-shock outputs were the same in all regimes. The magnitudes of the deviations, even their signs, depend on the values of the parameters. About the output effects of the shocks in different exchange rate regimes according to the baseline calculation see the table on page 41. The symbols R.1. and R.2. refer to real (goods demand) shocks originating in countries 1 and 2 respectively. The symbols M.1., M.2., S.1. and S.2. refer to monetary and supply (exogenous price) shocks, respectively. For an alternative calculation, where the values of the "open economy variables" σ, σ_3, ϵ and ϵ_3 are assumed to be lower, see appendix 3.)

In the baseline calculation the difference between the export demand effects of the monetary and real shocks is not big. Exchange rate, interest rate and price effects however differ more. A real shock has a greater interest rate effect than a monetary one. The exchange rate in turn reacts more in the case of a monetary shock. The price levels of the big countries change in opposite directions in the case of both shocks, but in the case of monetary shocks the difference is greater due to the stronger exchange rate reaction.

In some sense a real shock occurring in the big countries is more monetary than real from the small country's point of view, and the other way round. This obviously explains the result that floating rates are better in stabilizing the output of the small country against foreign <u>monetary</u> shocks.

Table. The effects of foreign shocks on the output of the small country in different exchange rate regimes (the baseline calculation, see page 9)

$$|0.056| \qquad\qquad |0.185| \qquad\qquad |0.192|$$

$$(R.1.)\ \left|\frac{\delta y_3}{\delta f_1}(basket)\right| < \left|\frac{\delta y_3}{\delta f_1}(floating)\right| < \left|\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg)\right|$$

$$|-0.003| \qquad\qquad |0.133| \qquad\qquad |0.246|$$

$$(R.2)\ \left|\frac{\delta y_3}{\delta f_2}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta f_2}(basket)\right| < \left|\frac{\delta y_3}{\delta f_2}(floating)\right|$$

$$|-0.009| \qquad\qquad |-0.028| \qquad\qquad |0.168|$$

$$(M.1.)\ \left|\frac{\delta y_3}{\delta m_1}(floating)\right| < \left|\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta m_1}(basket)\right|$$

$$|0.025| \qquad\qquad |0.313| \qquad\qquad |0.509|$$

$$(M.2.)\ \left|\frac{\delta y_3}{\delta m_2}(floating)\right| < \left|\frac{\delta y_3}{\delta m_2}(basket)\right| < \left|\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg)\right|$$

$$|-0.010| \qquad\qquad |-0.031| \qquad\qquad |0.122|$$

$$(S.1.)\ \left|\frac{\delta y_3}{\delta s_1}(floating)\right| < \left|\frac{\delta y_3}{\delta s_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta s_1}(basket)\right|$$

$$|0.052| \qquad\qquad |0.198| \qquad\qquad |0.351|$$

$$(S.2.)\ \left|\frac{\delta y_3}{\delta s_2}(floating)\right| < \left|\frac{\delta y_3}{\delta s_2}(basket)\right| < \left|\frac{\delta y_3}{\delta s_2}(EMU\text{-}peg)\right|$$

The crucial factor when comparing the effects of the shocks in the exchange rate union and in the basket regime, is whether the change of the exchange rate, which in the union case is determined by the big countries, tends to compensate for the other effects or whether it will reinforce them. When there is a real shock in the union partner country and when there is a monetary shock in the rest of the world, the exchange rate union stabilizes the output better than the basket regime. But when there is a real shock in the rest of the world and when there is a monetary shock in the union partner country, the basket regime stabilizes the output better.

The effects of an exogenous foreign price shock (supply shock) are almost the same as those of a monetary shock, if the money supply is kept unchanged. This is natural because in both cases there is a change in real balances.

The crucial feature of the basket peg regime is that it stabilizes the effective exchange rate. This implies that the basket peg regime stabilizes also the relative prices (=competitiveness) and the domestic price level better against foreign shocks than the other two regimes, where the effective exchange rate changes. (For the changes in competitiveness and the domestic price level see appendices 1 and 2.)

When evaluating the goodness of alternative exchange rate regimes the crucial factor is what is the variable whose stabilization is the objective. Is it output only, or should prices, competitiveness and other possible variables have some weight, too? In this respect the effects of the variability in the different variables should be analysed. Variability in prices and competitiveness might have implications, which have not been caught with the model structure used. One example of the potential effects are the effects due to an inflationary process, which is the topic of the forthcoming paper in this series (Kotilainen, 1991b).

After having an agreement about the socially preferred objective function, the crucial factor is what kinds of shocks are the most probable for the country in question. The impacts of domestic shocks should also be taken into account. An additional factor is which kinds of shocks could be taken care of with economic policy measures and which should be stabilized automatically.

8. Summary

In this paper the effects of different kinds of shocks in different exchange rate regimes have been analyzed in the framework of a three-country macroeconomic model. In the model we had two big economies, one of which was called "the EMS" or "the EMU" and the other "the USA" or "the rest of the world".

The big country model was solved simultaneously by assuming a floating exchange rate between the countries. After solving the big country model, we solved the small country model in a recursive way by using the solutions of the big country model as inputs. In the small economy we studied the effects of shocks in three alternative exchange rate regimes: floating rates, exchange rate union with country 2 ("the EMS/EMU"), and a currency basket exchange rate regime, where the trade-weighted exchange rate was fixed.

At first we studied briefly the effects of three domestic shocks: a goods demand shock, a money supply (or demand) shock, and an exogenous price shock (a supply shock). In the case of domestic shocks we were not able to distinguish between the exchange rate union and the basket peg regime. If no difference is made between the regimes with respect to, for example, credibility, the regimes function in the same way as fixed exchange rate regimes. The results obtained were traditional. The floating rate regime was better in stabilizing the output against domestic goods demand shocks, whereas the fixed rate regime isolated the output from the effects of a domestic monetary shock. Fixed rates were better also in the case of an exogenous price shock, if there was no reaction of money supply in the floating rate regime, but if the money supply responded fully to changes in prices, floating insulated the output completely.

The main focus of the paper was on the effects of the respective foreign shocks. Because of the complicacy of the model and its solutions we could not compare the results a *priori*. We instead had to use numerical calculations. The parameter estimates used in the baseline calculation were based on empirical studies, but because of the lack of direct counterparts, the estimates had to be adjusted ad hoc. They must thus be considered more or less as "guesstimates". To decrease the uncertainty related to this procedure and to control the results, sensitivity analyses were made.

We studied the effects of a goods demand shock, money supply shock and of an exogenous price shock originating in each of the big countries. We noticed that the output effects are different in the different exchange rate regimes. The effects were dependent on both the nature of the shock and the origin of the shock. In the baseline calculation the basket peg regime stabilized the output the best against goods demand shocks occurring in "the rest of the world", and the exchange rate union those originating in "the EMS/EMU" area. Floating was the best in stabilizing the output against monetary shocks. The exchange rate union was almost as good as floating, when the monetary shock originated in "the rest of the world". This was due to the joint floating against this area. But when the monetary shock occurred in "the EMS-area", an exchange rate union with it led to the greatest change in output.

The currency basket exchange rate regime stabilizes the effective exchange rate. This property of the regime implied that it stabilized also the relative prices (=competitiveness) and the domestic price level better than the other two regimes.

REFERENCES

BHANDARI, J. S. (1985) Experiments with the Optimal Currency Composite. Southern Economic Journal, Vol. 51, No. 3.

BUITER, W. H. (1986) Macroeconomic Policy Design in an Interdependent World Economy. An Analysis in Three Contingencies. IMF Staff Papers, Vol. 33, No. 3 (September), pp. 541-582.

CALLAN, T. (1989) Exchange Rate Unions in a Floating Rate World: Implications for Small Member Countries. Paper presented at session on International Policy Coordination. Fourth Annual Congress of the European Economic Association, Augsburg, 2-4 September 1989.

DORNBUSCH, R. (1980) Open Economy Macroeconomics. Basic Books, Inc. Publishers. New York.

KOTILAINEN, M. (1991a) Exchange Rate Unions: A Comparison to Currency Basket and Floating Rate Regimes. ETLA Discussion Paper, No. 356.

KOTILAINEN, M. (1991b) Exchange Rate Unions: A Comparison to Currency Basket and Floating Rate Regimes: A Three-Country Model with Inflation. (Forthcoming in 1991 as an ETLA Discussion Paper.)

KOTILAINEN, M. and T. PEURA (1988) Finland's Exchange Rate Regime and European Integration. ETLA Discussion Paper, No. 277. (Published originally as Kiel Advanced Studies Working Paper No. 135, available also as Bank of Finland Discussion Paper No. 33/1988.)

KOTILAINEN, M. and T. PEURA (1989) Finland's Exchange Rate System and European Integration. Kansallis Economic Review, 1989/1, 36-44. (Published also in "The Nordic Countries and the Internal Market of the EEC" (ed. by Lise Lyck). Copenhagen School of Economics and Business Administration, Serie U nr. 15. 1990.)

KREMERS, J. M. and T. D. LANE (1990) Economic and Monetary Integration and the Aggregate Demand for Money in the EMS. IMF Staff Papers, Vol. 37, No. 4.

MARSTON, R. C. (1985) Financial Disturbances and the Effects of an Exchange Rate Union. In J. S. Bhandari (ed.) Exchange Rate Management under Uncertainty. The MIT Press.

The effects of foreign shocks on the price level of the small country in different exchange rate regimes (the baseline calculation, the parameter estimates on page 9)

$$\quad |0.079| \qquad |0.318| \qquad |0.332|$$

$$(R.1.)\ \left|\frac{\delta p_3}{\delta f_1}(basket)\right| < \left|\frac{\delta p_3}{\delta f_1}(floating)\right| < \left|\frac{\delta p_3}{\delta f_1}(EMU\text{-}peg)\right|$$

$$\quad |0.066| \qquad |-0.187| \qquad |0.277|$$

$$(R.2.)\ \left|\frac{\delta p_3}{\delta f_2}(basket)\right| < \left|\frac{\delta p_3}{\delta f_2}(EMU\text{-}peg)\right| < \left|\frac{\delta p_3}{\delta f_2}(floating)\right|$$

$$\quad |0.026| \qquad |-0.302| \qquad |-0.337|$$

$$(M.1.)\ \left|\frac{\delta p_3}{\delta m_1}(basket)\right| < \left|\frac{\delta p_3}{\delta m_1}(floating)\right| < \left|\frac{\delta p_3}{\delta m_1}(EMU\text{-}peg)\right|$$

$$\quad |0.157| \qquad |-0.254| \qquad |0.520|$$

$$(M.2.)\ \left|\frac{\delta p_3}{\delta m_2}(basket)\right| < \left|\frac{\delta p_3}{\delta m_2}(floating)\right| < \left|\frac{\delta p_3}{\delta m_2}(EMU\text{-}peg)\right|$$

$$\quad |-0.091| \qquad |-0.335| \qquad |-0.375|$$

$$(S.1.)\ \left|\frac{\delta p_3}{\delta s_1}(basket)\right| < \left|\frac{\delta p_3}{\delta s_1}(floating)\right| < \left|\frac{\delta p_3}{\delta s_1}(EMU\text{-}peg)\right|$$

$$\quad |-0.104| \qquad |0.180| \qquad |-0.377|$$

$$(S.2.)\ \left|\frac{\delta p_3}{\delta s_2}(basket)\right| < \left|\frac{\delta p_3}{\delta s_2}(EMU\text{-}peg)\right| < \left|\frac{\delta p_3}{\delta s_2}(floating)\right|$$

The effects of the foreign shocks on the competitiveness of the small country in different exchange rate regimes (baseline calculation, the parameter estimates on page 9)

$$(R.1.)\ \overset{|0.179|}{\left|\frac{\delta c_3}{\delta f_1}(basket)\right|} < \overset{|0.556|}{\left|\frac{\delta c_3}{\delta f_1}(floating)\right|} < \overset{|0.582|}{\left|\frac{\delta c_3}{\delta f_1}(EMU\text{-}peg)\right|}$$

$$(R.2.)\ \overset{|0.020|}{\left|\frac{\delta c_3}{\delta f_2}(basket)\right|} < \overset{|0.399|}{\left|\frac{\delta c_3}{\delta f_2}(floating)\right|} < \overset{|-0.687|}{\left|\frac{\delta c_3}{\delta f_2}(EMU\text{-}peg)\right|}$$

$$(M.1.)\ \overset{|-0.108|}{\left|\frac{\delta c_3}{\delta m_1}(basket)\right|} < \overset{|-0.758|}{\left|\frac{\delta c_3}{\delta m_1}(floating)\right|} < \overset{|-0.696|}{\left|\frac{\delta c_3}{\delta m_1}(EMU\text{-}peg)\right|}$$

$$(M.2.)\ \overset{|0.052|}{\left|\frac{\delta c_3}{\delta m_2}(basket)\right|} < \overset{|-0.348|}{\left|\frac{\delta c_3}{\delta m_2}(floating)\right|} < \overset{|0.704|}{\left|\frac{\delta c_3}{\delta m_2}(EMU\text{-}peg)\right|}$$

$$(S.1.)\ \overset{|-0.333|}{\left|\frac{\delta c_3}{\delta s_1}(basket)\right|} < \overset{|-0.773|}{\left|\frac{\delta c_3}{\delta s_1}(floating)\right|} < \overset{|-0.843|}{\left|\frac{\delta c_3}{\delta s_1}(EMU\text{-}peg)\right|}$$

$$(S.2.)\ \overset{|0.068|}{\left|\frac{\delta c_3}{\delta s_2}(EMU\text{-}peg)\right|} < \overset{|-0.442|}{\left|\frac{\delta c_3}{\delta s_2}(basket)\right|} < \overset{|-0.931|}{\left|\frac{\delta c_3}{\delta s_2}(floating)\right|}$$

The effects of foreign shocks on the output of the small country in different exchange rate regimes in the <u>alternative</u> calculation (the case of low "open economy parameter" values)

We assume the following values for the parameters:
$k = k_3 = 0.67$, $\Phi = \Phi_3 = 0.46$, $\mu = \mu_3 = 0.2$, $\beta = \beta_3 = 0.3$
$\sigma = 0.07$, $\epsilon = 0.15$, $\alpha = 0.1$
$\sigma_3 = 0.2$, $\epsilon_3 = 0.3$, $\alpha_3 = 0.3$, $\theta = 0.3$

Now we get the following values for the output effects in different exchange rate regimes (marked above the effect):

$$(R.1.)\ \left|\underset{|-0.055|}{\frac{\delta y_3}{\delta f_1}(basket)}\right| < \left|\underset{|0.061|}{\frac{\delta y_3}{\delta f_1}(EMU\text{-}peg)}\right| < \left|\underset{|0.063|}{\frac{\delta y_3}{\delta f_1}(floating)}\right|$$

$$(R.2.)\ \left|\underset{|-0.011|}{\frac{\delta y_3}{\delta f_2}(basket)}\right| < \left|\underset{|0.108|}{\frac{\delta y_3}{\delta f_2}(floating)}\right| < \left|\underset{|-0.126|}{\frac{\delta y_3}{\delta f_2}(EMU\text{-}peg)}\right|$$

$$(M.1.)\ \left|\underset{|0.005|}{\frac{\delta y_3}{\delta m_1}(EMU\text{-}peg)}\right| < \left|\underset{|0.013|}{\frac{\delta y_3}{\delta m_1}(floating)}\right| < \left|\underset{|0.151|}{\frac{\delta y_3}{\delta m_1}(basket)}\right|$$

$$(M.2.)\ \left|\underset{|0.041|}{\frac{\delta y_3}{\delta m_2}(floating)}\right| < \left|\underset{|0.231|}{\frac{\delta y_3}{\delta m_2}(basket)}\right| < \left|\underset{|0.376|}{\frac{\delta y_3}{\delta m_2}(EMU\text{-}peg)}\right|$$

$$|0.006| \qquad |0.014| \qquad |0.123|$$

$$(S.1.)\ \left|\frac{\delta y_3}{\delta s_1}(EMU\text{-}peg)\right| < \left|\frac{\delta y_3}{\delta s_1}(floating)\right| < \left|\frac{\delta y_3}{\delta s_1}(basket)\right|$$

$$|0.045| \qquad |0.154| \qquad |0.271|$$

$$(S.2.)\ \left|\frac{\delta y_3}{\delta s_2}(floating)\right| < \left|\frac{\delta y_3}{\delta s_2}(basket)\right| < \left|\frac{\delta y_3}{\delta s_2}(EMU\text{-}peg)\right|$$

ELINKEINOELÄMÄN TUTKIMUSLAITOS (ETLA)
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, SF-00120 HELSINKI

Puh./Tel. (90) 609 900 Telefax (90) 601 753
Int. 358-0-609 900 Int. 358-0-601 753

KESKUSTELUAIHEITA - DISCUSSION PAPERS ISSN 0781-6847

No 344 VEIJO KAITALA - MATTI POHJOLA - OLLI TAHVONEN, Transboundary Air Pollution and Soil Acidification: A Dynamic Analysis of an Acid Rain Game between Finland and the USSR. 23.11.1990. 29 p.

No 345 ROBERT MICHAEL BERRY, Deep Waters Run Slowly. Elements of Continuity in European Integration. 10.12.1990. 31 p.

No 346 ANTHONY J. VENABLES, New Developments in the Study of Economic Integration. 17.12.1990. 30 p.

No 347 JUSSI RAUMOLIN, Euroopan Yhteisön ympäristöpolitiikka. 20.12.1990. 52 s.

No 348 VESA KANNIAINEN, Optimal Production of Innovations Under Uncertainty. 07.01.1991. 39 p.

No 349 KARI ALHO, Bilateral Transfers and Lending in International Environmental Cooperation. 16.01.1991. 24 p.

No 350 VESA KANNIAINEN, Yritysten rahoituspolitiikka: selvitys Suomen pörssiyhtiöistä 1983-87. 24.01.1991. 19 s.

No 351 MARI HARNI - JUKKA LASSILA - HEIKKI VAJANNE, Transformation and Graphics in ETLAs Economic Database System. 25.01.1991. 12 p.

No 352 JUHA KETTUNEN, Heterogeneity in Unemployment Duration Models. 31.01.1991. 22 p.

No 353 PENTTI VARTIA, Experiences from Growth and Transformation in the Post-war Period - The Country Study for Finland. 12.02.1991. 20 p.

No 354 VEIJO KAITALA - MATTI POHJOLA - OLLI TAHVONEN, An Analysis of SO_2 Negotiations between Finland and the Soviet Union. 18.02.1991. 17 p.

No 355 JUHA KETTUNEN, Transition Intensities from Unemployment. 27.02.1991. 24 p.

No 356 MARKKU KOTILAINEN, Exchange Rate Unions: A Comparison to Currency Basket and Floating Rate Regimes. 15.03.1991. 54 p.

Elinkeinoelämän Tutkimuslaitoksen julkaisemat "Keskusteluaiheet" ovat raportteja alustavista tutkimustuloksista ja väliraportteja tekeillä olevista tutkimuksista. Tässä sarjassa julkaistuja monisteita on rajoitetusti saatavissa ETLAn kirjastosta tai ao. tutkijalta.
Papers in this series are reports on preliminary research results and on studies in progress; they can be obtained, on request, by the author's permission.

E:\sekal\DPjulk.chp/29.07.1991