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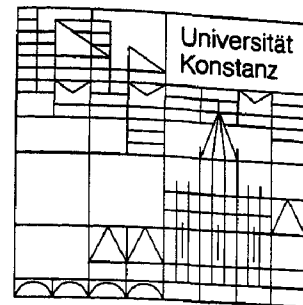
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Diskussionsbeiträge



Juristische
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Fakultät für Wirtschafts-
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**The Transmission of Correlated Shocks
under Mixed Exchange Rates**

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The Transmission of Correlated Shocks under Mixed Exchange Rates

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Abstract

The transmission of correlated economic disturbances is analyzed in a three-country world, where two countries have no macroeconomic impact on a third country but are large enough to influence each other under a system of mixed exchange rates—a system that combines both fixed and flexible exchange rates. Drawing insights from a theoretical three-country model, I present and discuss the consequences for small countries of a variety of correlated shocks under different degrees of indexation. The implications of the results are also indicated (JEL F31).

1 Introduction

In open economy macroeconomic theory, stabilization policies in response to economic shocks may depend on the type of exchange rate regime, the type of disturbance and the degree of capital mobility. Of particular concern has been the extent to which macroeconomic adjustments may be necessary to insulate the economy from foreign disturbances under a flexible exchange rate (FLER) regime. It is also observed that studies with open economy macroeconomic models make a strong case for FLERs¹ than fixed exchange rates (FERs) given the greater insulation properties of the former².

It can be observed that researchers have analyzed specifically the transmission of *one shock coming at a time* in a two or three-country world in the FER, FLER and mixed exchange rate (MER) regimes. However, the extent to which an economy is insulated from a variety of shocks

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¹See Friedman (1953), Meade (1950), Mundell (1963) and (1968), Dornbusch (1976), Mussa (1977), Turnovsky and Kingston (1977), Turnovsky (1981), Marston (1984), Argy et al. (1989) and Läufer and Sundararajan (1992, 1993, 1994).

²The interested readers may further refer to Laursen and Metzler (1950), Branson and Rotemberg (1980), Cox (1980), Schmid (1982), Corden and Turnovsky (1983), Turnovsky (1986) and Argy and Salop (1983).

depends not only on the alternate exchange rate regimes and the degree of capital mobility, but also on the *degree and nature of two or more correlated shocks coming at a time*³. This is especially true in case of the countries in the EMS. The EMS is earmarked by a "high degree of openness, pegged exchange rates and economic integration between member countries" (Läufer and Sundararajan, 1994, p.430). It should also be noted that while the exchange rate within the union is fixed, it is flexible with respect to the rest of the world—a system which is similar to our MER regime. This implies that for a certain critical degree of correlation among economic shocks, the MER regime may immediately be reduced to a system of FERs, while the FLER regime may to a system of MERs as special cases⁴.

An upshot of the above observations is that the degree and nature of correlations among economic shocks also have policy implications for the choice of an appropriate exchange rate regime. Marston (1984) while analyzing the transmission of real and monetary shocks in the FER and FLER regimes, has recognised the importance of correlation patterns among shocks. However, he has *confined* the analysis *only* to the case of *foreign real and monetary disturbances* which are perfectly positively or negatively correlated in the FER and FLER regimes with full indexation abroad. But Marston, as noted by Kenen (1984), assumes full wage indexation abroad in most of the analyses. As recognised by Marston himself, the insulation properties of the FLER are very sensitive to the indexation assumption (p.43). A careful review of literature clearly reveals that a study of correlated disturbances and correlation patterns among various types of economic shocks is conspicuously absent in the MER regime. The primary objective of this paper is to fill this lacunae in the literature by examining the transmissions of correlated economic disturbances and their correlation patterns in the MER regime.

Modelling the correlation patterns of economic shock necessitates the specification of a number of simultaneous shocks that may occur at a time. In a three-country model such as the one in this paper, there are seven independent shocks which influence outputs, prices, exchange rates, etc. In the model, there exists a combination of two to seven shocks that may occur simultaneously with different degrees of correlation. Thus, effectively, there are at least 120 possible combinations of shocks influencing output, prices, and so on. Including all of them would not only make the analyses very difficult but would also considerably complicate the interpretation and discussion of results. Hence, I restrict the analysis to the case of two shocks that may occur simultaneously at a time.

Modelling the correlation pattern will also allow us to address a number of important questions such as: What are the consequences of correlated shocks on small economies? Is there a unique degree of correlation which would completely insulate the small economies from correlated shocks? Is there a unique degree of indexation that would either minimise the effects

³A perfect negative correlation between two monetary shocks, for instance, would leave outputs, prices, exchange rates and interest rates unaffected irrespective of the degree of indexation.

⁴For instance, if the demand shocks of countries a and b are positively correlated, they would not have any effect on the exchange rate between a and b as the appreciation and depreciation would nullify each other.

of correlated shock or provide complete insulation to the economies irrespective of the degree of correlation? Do the correlation patterns among shocks help us understand the problems and derive policy implications for coordinating policies in the EU?

As a starting point of the analysis, section 2 presents the three-country model and derives a framework to derive equations for outputs, producer and consumer prices, exchange rates, reserve stocks, and nominal and real interest rates under MERs. Section 3 simulates the model and discusses the results of a variety of correlated shocks for small countries under different degrees of correlation and indexation. Section 4 contains some concluding remarks.

2 The Model and Framework

The model which is presented and discussed in section 2.1 is the one that Läufer and I developed and discussed in an earlier paper (Läufer and Sundararajan, 1994, pp.431-433). The main contribution of this paper is a detailed development of a framework in section 2.2 for examining correlated shocks and a thorough analysis of the impact of correlated shocks and their correlation patterns for small economies in the ensuing section.

2.1 The Model

Consider a world consisting of three countries (a, b and c). For simplicity, countries a and b are assumed to be identical (symmetric). That is, the structural parameters in the output demand and supply functions, and in the financial equations are the same for both countries. Countries a and b are further assumed to have no impact on country c but are large enough to influence each other. Thus the behaviour of country c is not modelled explicitly. The model has three basic equations: aggregate demand and supply equations for the output produced in a country, and an equation describing equilibrium in financial behaviour. Perfect substitutability is assumed for the non-money assets of all three countries.

Our model differs from other existing three-country models in several key respects. First, Marston's three-country assumption of a small open economy facing two large economies on which it has no impact is replaced by assuming that two countries having no macroeconomic impact on a third country, but are large enough to influence each other. Second, Marston's (1984) worrisome assymetry between the degrees of indexation at home and abroad, as suggested by Kenen (1984) in his comments on Marston's model⁵, is removed. Third, Marston's supply side specification is extended that helped in avoiding the fixed price assumptions of the MER analysis of Levin (1983). Last, real and nominal interest rates are distinguished and expected changes of the flexible exchange rates are also allowed in the model. Thus we avoided money illusion and the exogeneity of the interest rate built into the analysis of Feurestein and Siebke (1990).

⁵See Kenen (1984), p.441.

The model is set out as follows:

$$Y_t^{id} = \alpha_0 + \alpha_1 Y_t^{jd} + \alpha_2 Y_t^c - \alpha_3 r_t^i + \alpha_4 (e_t^{ij} + P_t^j - P_t^i) + \alpha_5 (e_t^{ic} + P_t^c - P_t^i) + u_t^{di}, \quad (1)$$

$$q_t^i = h_{i1} P_t^i + h_{i2} (e_t^{ij} + P_t^j) + h_{i3} (e_t^{ic} + P_t^c), \quad (2)$$

$$Y_t^{is} = \theta (P_t^i - \omega_1 E_{t-1} P_t^i) - \theta b (q_t^i - E_{t-1} q_t^i) - \omega_2 E_{t-1} q_t^i + \theta_0, \quad (3)$$

$$(P_t^i + Y_t^i) - \beta_1 n_t^i + \beta_0 = M_t^{fsi} + \bar{M}_t^{dsi} + u_t^{mi}, \quad (4)$$

$$Y_t^{id} = Y_t^{is} = Y_t^i, \quad (5)$$

$$n_t^i = n_t^c + (E_t e_{t+1}^{ic} - e_t^{ic}), \quad (6)$$

$$r_t^i = n_t^i - (E_t q_{t+1}^i - q_t^i), \quad (7)$$

$$e_t^{ic} = e_t^{ij} + e_t^{jc}, \quad (8)$$

$$e_t^{ab} = \bar{k}^{ab}, \quad (9)$$

$$M_t^{fsa} + (e_t^{ab} + M_t^{fsb}) = \bar{f}^a, \quad (10)$$

$$Y_t^c = \bar{Y}^c + u_t^{yc}, \quad (11)$$

$$P_t^c = \bar{P}^c + u_t^{pc}, \quad (12)$$

$$n_t^c = \bar{n}^c + u_t^{nc}, \quad (13)$$

where $i, j \in \{a, b\}$ and $i \neq j$.

All variables are in logarithms, where superscripts d and s denote demand and supply.

Y^k	real output in country k , where $k = a, b, c$.
$q^i (E_{t-1} q_t^i)$	actual (expected) consumer price index in country i , where $i = a, b$, defined as the weighted average of domestic and foreign producer prices.
$M^{di} (M^{si})$	money demand (supply) in country i .
$M^{fsi} (\bar{M}^{dsi})$	foreign (exogenous domestic) component of the money supply in country i .
$n^k (r^i)$	nominal (real) interest rate in country k (i).
$u^{di} (u^{mi})$	output demand (money supply) disturbance in country i .
$e^{ik} (E_t e_{t+1}^{ik})$	actual (expected) exchange rate of currency i per unit of currency k .
$P^k (E_{t-1} P_t^i)$	actual (expected) producer prices in country k (i).
\bar{f}^a	$2 \ln F^A$
$2F^A$	exogenous value of the sum of the reserve components of the national money supplies in countries a and b expressed in currency units of country a .
\bar{k}^{ab}	exogenous value of the exchange rate between countries a and b .
$\bar{Y}^c (\bar{P}^c, \bar{n}^c)$	exogenous value of output (producer prices, nominal interest rates) in country c .

u_t^{yc} (u_t^{pc}, u_t^{nc})	output (price, interest rate) disturbance in country c .
α_1 to α_5	export, real interest rate, and relative price elasticities of output demand (for theoretical details see Marston (1984), pp. 434-37).
β_1	nominal interest rate elasticity of the money demand.
h_{ik}	expenditure weight in country i for country k 's good.
b	indexation parameter.
δ	elasticity of labor supply with respect to real wages.
$1 - \theta'$	exponent of labor in a Cobb-Douglas production function.
θ	$(1 - \theta')/\theta'$
θ_0	$(1 - \theta')\delta \ln(1 - \theta')/(\theta'\delta + 1)$.
ω_1	$1/(\theta'\delta + 1)$.
ω_2	$\delta(1 - \theta')/(\theta'\delta + 1)$.

Equation (1) specifies the demand for output in country i as a function of foreign output, relative prices of foreign and domestic goods, and the real interest rate. In addition, each country is exposed to a real output demand disturbance (u_t^{di})⁶. Equation (3), which explains the supply side of the economy, is based on a labor contract lag of one period with partial or complete indexation of wages to current prices. This is derived from a Cobb-Douglas production function, the labor market equilibrium condition determining the contract wage, and the wage indexation equation. The contract wage, reflecting expectations at $t - 1$, is based on labor demand and supply⁷. The actual wage rate may differ from the contract wage rate if the indexation parameter is different from zero⁸. Equation (4) is a conventional money market equilibrium condition. Real money demand is a function of real income and nominal interest rate, while the money supply is assumed to be a sum of an endogenously determined reserve component, an exogenously given domestic component of the money supply as well as a money supply shock (u_t^{mi})⁹. Equation (5) describes the goods market equilibrium condition. Equations (6) and (7) are the interest rate arbitrage conditions. Equation (6) explains that the domestic interest rate is equal to the foreign interest rate plus the expected rate of depreciation of the domestic currency, while the real interest rate in (7) is defined as the nominal interest rate minus the expected rate of inflation. Equation (8) determines the exchange rate between i and c as a residual cross rate. Equations (9) and (10) describe the exogenous values of the exchange

⁶In equilibrium analysis a positive (negative) output demand disturbance is equivalent to a negative (positive) output supply disturbance.

⁷The supply of labor is assumed to be an increasing function of real wages.

⁸See Gray (1976), Fischer (1977), Sachs (1980), Flood and Marion (1982), Turnovsky (1983), Aizenman and Frenkel (1985,1986) and Devereux (1988) for studies of wage indexation behaviour.

⁹In equilibrium analysis a positive (negative) money supply disturbance is equivalent to a negative (positive) money demand disturbance.

rate and reserve components of the money supply in the MER regime¹⁰. Equations (11) to (13) explain that all the variables referring to country c are exogenously determined. They are expressed as a sum of a constant and a disturbance term¹¹.

2.2 The Framework

Assuming that expectations follow long-run equilibrium values (\bar{X}), we solve the equation system to obtain reduced forms for deviations from static long-run equilibrium values using the following procedure. I define

$$X_i = \phi u^i, \quad (14)$$

$$u^i \stackrel{def}{=} \begin{bmatrix} u^{di} \\ u^{dj} \\ u^{mi} \\ u^{mj} \\ u^{yc} \\ u^{pc} \\ u^{nc} \end{bmatrix}, \quad \phi \stackrel{def}{=} \begin{bmatrix} \phi_1^1 & \phi_1^2 & \cdots & \phi_1^l \\ \vdots & \vdots & \ddots & \vdots \\ \phi_k^1 & \phi_k^2 & \cdots & \phi_k^l \end{bmatrix}, \quad X_i \stackrel{def}{=} \begin{bmatrix} Y^i \\ P^i \\ Y^i + P^i \\ q^i \\ e^{ic} \\ n^i \\ r^i \\ M^{fsi} \end{bmatrix}.$$

Let $i, j \in \{a, b\}$, $i \neq j$, X_i is the vector of derivatives from their static long-run equilibrium values, ϕ is the matrix of coefficients of economic shocks, u is the vector of economic shocks, X_{ik} is the k th element of X_i , u_{ik} is the k th element of u_i , ϕ_k^l is the k th row and l th column of ϕ , ϕ_k^m is the k th row and m (i.e. $l + 1$)th column of ϕ .

To study the transmission of correlated shocks, I derive from (14) the following equation:

$$\left. \frac{dX_i}{du^{ik}} \right|_{u^{im} = \rho u^{ik}} = \phi_k^l + \rho \phi_k^m \quad (15)$$

¹⁰The specification of equation (10) needs some explanation. From the definition of $2F^A$, the arithmetic average, F^A , is written as follows:

$$F^A \stackrel{def}{=} \frac{\tilde{M}_t^{fsa} + \tilde{e}_t^{ab} \tilde{M}_t^{fsb}}{2},$$

where \tilde{M} and \tilde{e} are non-logarithmic equivalents of M and e . Given that the geometric mean is equal to the arithmetic mean, if $\tilde{M}_t^{fsa} = \tilde{e}_t^{ab} \tilde{M}_t^{fsb}$ which we assume to be the case in initial equilibrium, taking logarithm on both sides we obtain:

$$\frac{1}{2} \ln \tilde{M}_t^{fsa} + \frac{1}{2} (\ln \tilde{e}_t^{ab} + \ln \tilde{M}_t^{fsb}) = \ln F^A.$$

which is equivalent to equation (10).

¹¹The model and discussion given in this section is the same as the one that I had written jointly with Läufer (Läufer and Sundararajan, 1994, pp.431-33). Some passages in this section may have been taken verbatim from this paper.

where ρ is the degree of correlation which we let vary between minus one and plus one with an increment of 0.25. Equations (14) and (15) depend on the indexation parameter, b .

3 Simulation and Discussion of Results

The system presented above is simulated to analyze the quantitative importance of the international linkages. Germany, France and the United States are chosen as examples of countries a, b and c respectively. I treat Germany and France as mirror images of each other (symmetry assumption). In order to calibrate the model, I assume that country a's trade is bilaterally balanced with both countries b and c. Thus differences in the coefficients of an output equation reflect only the role of elasticities and not the influence of trade imbalances. For simplicity, we also assume that trade and expenditure shares are equal ($h_{12} = h_{13} = 0.15$). The trade shares are based on actual data of German exports from the IMF's International Financial Statistics. The values for the remaining behavioural parameters are based on the interpretation of the empirical literature. The parameter values chosen are specified in Table 1. For price elasticities, we used the estimates reported by Spencer's (1984) world trade model for industrial countries. Income elasticities were assumed to be equal to one. These values, the chosen real and nominal interest rate elasticities, expenditure shares and share of labor in output supply are consistent with the elasticities used by Ueda (1984), Sachs and McKibbin (1985), Ishii et al. (1985), McKibbin and Sachs (1986), Dornbusch and Fischer (1981), Argy et al. (1989), Devereux (1988) and Läufer and Sundararajan (1992,1993). The indexation parameter is varied between zero and one with an increment of 0.01¹².

Using the parameterisation just described, the model is simulated to study the effects of correlated disturbances originating at home and abroad for various degrees of indexation and correlation. In Figures 1-8, the graphs with big dashed lines stand for $\rho = -1$, the graphs with small dashed lines stand for $\rho = -0.75$, and so on. The middle (or fifth) graphs stand for $\rho = 0$ ¹³. We assume that the stochastic shocks are of a transitory nature, they have a mean of zero and are serially uncorrelated.

The figures 1-8 are the graphs of the effects of derivatives of the correlated shocks. For simplicity, we represent the derivatives $\left. \frac{dX_{ij}}{du^{di}} \right|_{u^{dj}=\rho u^{di}} = \left. \frac{dY^i}{du^{di}} \right|_{u^{dj}=\rho u^{di}} = \phi_1^1 + \rho\phi_1^2$ by *udaudby*, $\left. \frac{dX_{ij}}{du^{di}} \right|_{u^{mi}=\rho u^{di}} = \left. \frac{dY^i}{du^{di}} \right|_{u^{mi}=\rho u^{di}} = \phi_1^1 + \rho\phi_1^3$ by *udaumay* and so forth. The first six letters designate two random shocks which are correlated (causes), while the last letter(s) stand for the variable whose reaction is to be examined (effect). Thus, *udaudby* is the reaction of real output, y , to two random demand shocks, *uda* and *udb*, from countries a and b¹⁴.

¹²In the graphs of Figs. 1-8 the abscissa represents the degree of indexation in percentage terms.

¹³For $\rho = 0$, the results are reduced to the case of a single shock coming at a time and are similar to the results reported in Läufer and Sundararajan (1993).

¹⁴I use the following terminology in our paper: "convergent reaction curves" are those curves which meet at full

3.1 The Transmission of Correlated Demand Shocks

In this section, I analyze the effects of output demand shocks originating simultaneously in countries a and b on outputs of countries a and b.

3.1.1 Uncorrelated Demand Disturbances

If the degree of correlation among the demand shocks of countries a and b is zero, $\rho = 0$, country a (b) reacts as if it is responding to its own (foreign) positive demand shock which increases (decreases) its real and nominal output, producer and consumer prices, and real and nominal interest rates¹⁵.

3.1.2 Perfectly Negatively Correlated Demand Shocks

Let us first consider the case where the demand shocks (u_{da} and u_{db}) are perfectly negatively correlated ($\rho = -1$)—hereafter PNC—for the case of no wage indexation. It is clear from $u_{da}u_{db}y$ (see Fig.1) and $u_{da}u_{db}y_n$ (see Fig.3) that PNC demand shocks increase both nominal and real outputs in both countries. The initial increase in aggregate demand augments both producer (see $u_{da}u_{db}p$ in Fig.2) and consumer (see $u_{da}u_{db}q$ in Fig.6) prices. But, they have *no effect on exchange rates* (see $u_{da}u_{db}ac$ in Fig.4) *and nominal interest rates* (see $u_{da}u_{db}ni$ in Fig.7)¹⁶. Thus, *the MER regime is reduced to a system of FERs*. Therefore, *output and prices increase more* under PNC demand shock than in case of zero correlation¹⁷. Rising prices create a deflationary expectation which causes real interest rates (see $u_{da}u_{db}ri$ in Fig.8) to rise, albeit a constant nominal interest rates.

As in case of zero correlation, where $u_{da}u_{db}y$ curve has a negative slope, output reaction under PNC demand shocks falls as the degree of indexation increases. Indexation affects supply of output only. The higher the degree of indexation, the steeper the slope of the supply curve (slope effect) and the lower (higher) the increase in equilibrium output (prices). This is consistent with the negative slope of the $u_{da}u_{db}y$ curve in Fig.1, and the positive slope of the $u_{da}u_{db}p$ curve in Fig.2 and $u_{da}u_{db}q$ curve in Fig.6.

wage indexation, "parallel" or "near parallel reaction curves" and the "switching reaction curves" meaning the points of convergence below full wage indexation. In addition, in fig. 1-8, p stands for prices, y_n for nominal outputs, ac for exchange rates, rs for international reserves, q for consumer prices, and i [r] for nominal (real) interest rates.

¹⁵See Läufer and Sundararajan (1993) for more details.

¹⁶Due to symmetry and negative correlation, the effects of the two demand shocks on exchange rates are of opposite in sign but equal in size. The net effect is therefore no change in exchange rates.

¹⁷If country b wants to protect its output from any changes, it ought to have a counter demand shock which have to be lower than the size of u_{da} .

3.1.3 Less than PNC Demand Shocks

If the demand disturbances of countries a and b are less than PNC ($-1 < \rho < 0$), exchange rates do not remain constant. In other words, less than PNC demand shocks do *not completely insulate* exchange rates and nominal interest rates. The following results merit our attention. First, an initial increase in aggregate demand increases nominal and real outputs as well as its producer and consumer prices in countries a and b. Second, a rise in nominal output causes an increase in real and nominal interest rates. Third, the positive and negative demand shocks cause exchange rates to fall and rise respectively. Although countries a and b are symmetric in behaviour, the effects of demand shocks on their exchange rates are opposite in sign but not equal in size. Depending on the degree of correlation (ρ), the exchange rates rise less proportionately than a falling exchange rate. The net effect is therefore falling exchange rates. Fourth, the falling exchange rates of countries a and b reduce the original increase in demand for outputs. Therefore, *outputs increase lesser as the degree of correlation increases*. Last, as in the case of zero and PNC demand shocks, output reaction curve is negatively sloped here as well. This is due to the reaction of the supply of output to wage indexation. Therefore, real output reaction falls and price as well as nominal output reaction rises as the degree of indexation increases.

3.1.4 Perfectly Positively Correlated Demand Shocks

When the demand shocks are perfectly positively correlated (hereafter PPC), i.e. $\rho = 1$, the following observations can be made in the light of figs.1-8. First, positive demand shocks in countries a and b cause outputs, prices and interest rates to rise in their countries. Due to the latter, the dollar exchange rates of countries a and b fall to the same degree. When $\rho = 0$, while a positive demand shock in country a creates an *expansionary effect* on its own output, it produces a *contractionary effect*¹⁸ on output of country b. Thus, the effect of PPC demand shocks on outputs, is a conflation of positive and negative effects. The net effect is increasing outputs and prices but lower than in case of $\rho = 1$ ¹⁹. Second, exchange rates fall twice as much as in case of $\rho = 0$. Third, nominal interest rates rise twice than in case of $\rho = 0$. Fourth, reserve flows are zero. The inflow and outflow of reserves nullify each other, since they are equal in size but opposite in sign. Fifth, both producer and consumer prices rise but less than in case of $\rho = 0$. Last, real interest rates augment more (see udaudbri in Fig.8) than in case of $\rho = 0$ because of a doubled effect on nominal interest rates.

Indexation affects only the supply of output but in two different ways. The indexation will

¹⁸See Läufer and Sundararajan (1993,1994) for a full discussion of these results.

¹⁹The domestic demand shock affects domestic output in four ways: positive income, interest rate, relative price and exchange rate effects. The foreign demand shock influences domestic output through positive income and relative price effects, and negative real interest rate and exchange rate effects. The positive and negative real interest rate and exchange rate effects nullify each other. Therefore outputs increase in countries a and b. See Läufer and Sundararajan (1993,1994) for more details.

steepen the slope of the supply curve and lower the increase in equilibrium output (slope effect), while a falling exchange rate shifts the supply curve to the right and increases output (shift effect). The latter increases with the degree of indexation.

If the shift effect is stronger than the slope effect, output reactions will be larger, and producer and consumer price reactions will be smaller as the degree of indexation increases²⁰. This is confirmed by the positive slope of the u_{daudby} curves in Fig.1, and the negative slopes of the u_{daudbp} and u_{daudbq} curves in Figs. 2 and 6 respectively. Due to the assumption of perfect capital mobility, nominal and real interest rates reaction curves also have negative slopes as the degree of indexation increases.

3.1.5 Less than PPC Demand Disturbances

In case of less than PPC demand shocks ($0 < \rho < 1$), given the initial increase in aggregate demand which increases outputs and prices in countries a and b, we observe the following. First, the increase in nominal outputs push up nominal rates which in turn reduces the dollar exchange rates of countries a and b. One can observe from $u_{daudbac}$, $u_{daudbni}$, and $u_{daudbri}$ in Figs. 4,7 and 8 that the higher the degree of correlation, the higher the increase in interest rates and the higher the fall of the dollar exchange rates. The higher the degree of correlation, the stronger the negative component of the conflated positive and negative effects and the lower the increase in outputs, prices and reserve stocks (See u_{daudby} , u_{daudbp} , $u_{daudbyn}$, $u_{daudbrs}$, and u_{daudbq} in Figs.1-3, and 5-6). Second, the higher the degree of indexation, the steeper the slope and the stronger the shift in the supply curve and the larger the increase in equilibrium output. Therefore, as in case of PPC demand shocks, the slopes of output and price reactions are positive and negative respectively.

3.1.6 Effect on World Economy

Now, I turn to the impact of correlated real shocks on world real output (y_w), producer prices (p_w)²¹ and nominal output (WY).

First, irrespective of the degrees of correlation and indexation, the correlated demand shocks produce *expansionary* effect on world real and nominal outputs as well as producer prices. Second, increasing the degree of correlation from minus one will reduce the expansionary effect on world economy. Third, if $-1 \leq \rho < 0$, indexation will lower the increase in real outputs. The slope of the real output reaction curve is therefore negative. As a result, the world producer price reaction curve is positive. Last, if $0 < \rho \leq 1$, indexation will reduce the change in equilibrium outputs through slope effect as well as increase them through shift effect. The net effects are upward sloping real output reaction curves. This is consistent with downward sloping price

²⁰ As a fall in the exchange rates is double in size than in case of $\rho = 0$, the shift effect would obviously dominate the slope effect.

²¹ World prices are averages of prices in countries a and b.

reaction curves. The reaction of nominal output curve is also positive as indexation approaches one.

3.2 Correlated Monetary Shocks

In this section, I analyze the effects of correlated monetary shocks on outputs, prices, exchange rates, and so on.

3.2.1 Uncorrelated Monetary Shocks

Irrespective of the degree of indexation, with zero correlation, $\rho = 0$, the effects on outputs, prices, and so on are those of an uncombined shock, that is, positive money supply shocks from countries a and b increase their outputs but lesser as the degree of indexation increases.

3.2.2 PNC Monetary Disturbances

Irrespective of the degree of indexation, the correlated monetary disturbances *completely insulate* world money stock,²² real and nominal outputs, producer and consumer prices, exchange rates, and real and nominal interest rates with reserve stocks being exceptions. Thus, we have FERs all over in the MER regime. A *complete insulation* occurs as a positive monetary shock in country a is *neutralised* by a negative monetary shock coming from country b which is exact in size but opposite in sign.

3.2.3 Less than Perfectly Correlated Monetary Shocks

If the degree of correlation between monetary shocks is $-1 < \rho < 0$, the MER regime *does not* any more provide *complete insulation* of outputs, prices, exchange rates, and so on. from correlated monetary disturbances. A positive monetary shock pushes down nominal interest rates which cause exchange rates to rise, while a negative shock pushes up nominal interest rates which cause exchange rates to fall. Thus, there are two conflicting effects on interest rates, exchange rates and so on. Given that $-1 < \rho < 0$, the impact of a positive monetary shock in country a is greater than a negative monetary stock in country b. The net effect therefore is falling nominal interest rates and rising exchange rates in countries a and b. Therefore, the higher the degree of correlation, the higher the net increase in exchange rates as well as the higher the increase in outputs and consumer and producer prices. If $0 < \rho < 1$, the two positive monetary shocks will reinforce each other depending on the degree of correlation. In other words, the higher the degree of positive correlation, the higher the fall in nominal interest rates as well as the higher the increase in exchange rates and outputs. With indexation, corresponding to a given shift in the demand curve, there is also a change in the supply of outputs via shift and slope effects.

²²The world money stock is defined as a sum of the money stocks of countries a and b.

While rising exchange rates shift the supply curve to the left, indexation steepens the slope of the supply of outputs. They increase with the degree of indexation. Thus real outputs expand lesser as the degree of indexation increases. Correspondingly, prices and nominal outputs rise more with indexation.

3.2.4 PPC Monetary Disturbances

Irrespective of the degree of indexation, the PPC monetary disturbances will have a doubling of all effects, viz. outputs, producer and consumer prices, exchange rates, and so on. That is, positive monetary shocks coming from countries a and b result in a two fold decrease in nominal interest rates and a rise in exchange rates. As a result, outputs and producer and consumer prices increase more than in the case of $-1 \leq \rho < 1$. With full indexation, *real outputs do not respond any more to the monetary shocks, regardless of the degree of correlation.*²³ This indicates that in the case of *convergent* reaction curves, the *uncertainty* about the degree of correlation between monetary shocks *loses* its importance as the degree of indexation approaches one. With full indexation, there is no change in output regardless of the degree of correlation. Since upward shifts in both demand and supply curves are observed, rising real outputs must be accompanied by increasing producer and consumer prices as the degree of correlation increases. Since the slope and shift effects of the supply of output lower the reaction of outputs to the PPC monetary disturbances, as the degree of indexation rises, they must, at the same time, increase price reaction curves as well. Since the change in the reaction of producer prices is stronger than that of real outputs, the reaction curves for nominal outputs also rise with the degree of indexation. An increase in the reaction of nominal outputs (upward sloped) must therefore be accompanied by upward sloping nominal and real interest rate reaction curves (see figures 1-3 and 6-8). The slope of exchange rates will therefore be negative.

3.2.5 Effect on World Economy

When the monetary shocks of countries a and b are correlated, the following results merit our attention. First, if $\rho = -1$, irrespective of the degree of indexation, the correlated monetary shocks *completely insulate* world real and nominal outputs and producer prices. Second, if $-1 < \rho \leq 0$, they increase real and nominal outputs as well as producer prices as long as indexation is not equal to one. Third, indexation steepens as well as shifts the supply curve to the left. Real output reaction therefore comes down as indexation approaches one. Producer prices, as a result, have positive slopes. Since the real output reaction dominates the producer price reaction, the slope of nominal output curve is negative. Last, if indexation is full, irrespective of the degree of correlation, real output does not any more respond to the correlated shocks.

²³World prices, producer prices and exchange rates in countries a and b rise to the same extent. The movements in the supply curve yield results as if it is fixed but perpendicular.

3.3 Correlated Demand and Monetary Shocks

It is clear from *udaumay*, *udaumby*, *udbumay*, *udbumby* and so on in Figs. 1-8 that correlating real shocks in country a (b) with monetary shocks in either country (a or b) produce identical effects because the impact of monetary shocks is independent of where they come from. When the shocks are uncorrelated, the results are similar to that of an independent shock reported in Läufer and Sundararajan (1993) ²⁴.

3.3.1 Own Country Effects

In this section, I first discuss the effects of the correlated shocks, *udauma(b)*, on country a's output, prices, and so on for the case of $-1 \leq \rho < 0$, and then for the cases of $0 < \rho \leq 1$. If real monetary shocks are negatively correlated ($-1 \leq \rho < 0$), real and nominal outputs (see *udauma(b)y* in Fig. 1, *udauma(b)yn* in Fig.3), consumer prices (see *udauma(b)q* in Fig.6) and producer prices (see *udauma(b)p* in Fig.2) increase less than in case of $\rho = 0$, while I find the doubling effect on nominal and real interest rates (see *udauma(b)ni* in Fig.7, *udauma(b)ri* in Fig.8) as well as exchange rates (see *udauma(b)ac* in Fig.4). Increasing the degree of indexation will, on the one hand, steepen the supply curve (slope effect) which reduces the change in equilibrium output, and will, on other hand, shift the supply curve to the right due falling exchange rates, which increases outputs. The net effects are upward sloping output curves which are consistent with downward sloping price curves. The reaction of producer prices dominates the reaction of nominal output which increases only slightly with the degree of indexation. The reactions of real and nominal interest rates, as a result, decline with the degree of indexation. Consistent with downward sloping interest rate reaction curves, exchange rate curves are sloped upwards. While the reaction of outputs (real and nominal) and prices (consumer and producer) increase, the reaction of interest rates (real and nominal) decrease as the degree of correlation increases from minus one to zero ($-1 < \rho < 0$). Therefore, the higher the degree of correlation, the lower the extent of falling exchange rates and the higher the increase in outputs and prices.

If the shocks are positively correlated ($0 < \rho \leq 1$), outputs and prices increase more, while nominal and real interest rates rising less as the degree of correlation increases. While real output and exchange rate curves have negative slopes, the slopes of (producer and consumer) prices, nominal outputs, reserve stocks and interest rates (real and nominal) are positive as the degree of indexation increases. With indexation, the supply curve is subject to three influences. While indexation produces a slope effect, at the same time, it also produces two shift effects. While falling exchange rates shift the supply curve to the right and increase the change in outputs, the rising exchange rates via the money supply shock shift it to the left and reduces the change in outputs. If $0 < \rho < 1$, the impact of rising exchange rates on outputs is less than that of falling

²⁴A positive real shock originating in Germany or France has a positive effect on its output, but due to a new third country (exchange rate) effect, produces a contractionary effect on foreign output.

exchange rates. But the combined effects of slope and shift effects (due to a rising exchange rate) is higher than that of falling exchange rate effects on outputs. Therefore, outputs decrease more as the degrees of indexation and correlation increase. Consistent with falling outputs, producer and consumer prices increase. As a result, nominal outputs rise as well. The rising nominal outputs cause interest rates to increase more and exchange rates to fall more as the degree of indexation increases.

3.3.2 Cross-Country Effects

If $-1 \leq \rho < 1$, irrespective of the degree of indexation, positively or negatively correlated money supply shocks with the demand shock of country a produces a *contractionary impact* on outputs (real and nominal), prices (producer and consumer) and reserve stocks (see $udbuma(b)y$, $udbuma(b)p$, $udbuma(b)yn$, $udbuma(b)rs$, $udbuma(b)q$ in Figs.1-3, 5, 6). The interest rates (real and nominal) rise, while exchange rates fall but lesser as the degree of correlation increases.

The demand shock of country a affects country b's output in four ways. While income and substitution effects produce expansionary effects on outputs and prices, the impact of real interest rates and exchange rates are not only contractionary but also overwhelming positive income and substitution effects²⁵. Thus the net impact is a contractionary impact of country a's demand shock on country b's outputs, prices, etc. However, the monetary shocks, irrespective of where they come from, produce positive effects on outputs and prices. When the monetary shocks are negatively correlated with the demand shock, it adds to the contractionary impact of country a's real shocks on outputs, prices and reserve stocks of country b. As the degree of correlation increases from -1 to 1, the magnitude of contractionary effect on outputs and prices gets reduced. Therefore, there exists a *varying degrees of correlation that completely offset the contractionary impact* of country a's demand shock on outputs and prices of country b. When $\rho = 1$, till a critical degree of indexation, the PPC monetary shocks with the demand shock of country a produce expansionary effects on output and prices of country b.

With indexation, the supply curve not only steepens but also shifts to the right. Therefore, the real output reaction curve slopes upwards. As the degree of correlation increases, the position of the real output reaction curve also goes up with indexation. If $\rho > 0$, with indexation, the supply curve not only steepens and shifts to the right but also shifts it to the left through rising exchange rates. Since the steepening and leftward shift of the supply curve reduce the change in outputs more with an increase in the degree of correlation, the real output reaction curve is a downward sloping one. Therefore, there exists a critical degree of correlation before which outputs contract lesser as the degree of indexation increases. After the critical degree of correlation, outputs fall more as indexation approaches one. Before the critical degree of correlation, consistent with positive real output reaction curves, producer and consumer price reaction curves are negatively sloped. As a result, nominal outputs fall as well. The falling

²⁵See Läufer and Sundararajan (1993,1994) for a detailed discussion on this.

nominal outputs cause interest rates to fall more and exchange rates to fall less as indexation increases. After the critical degree of indexation, a downward sloping real output curve would imply upward sloping price and nominal output reaction curves. The slopes of interest rates and exchange rates are therefore positive and negative respectively (see $udbuma(b)y$, $udbuma(b)p$, $udbuma(b)yn$, $udbuma(b)q$, $udbuma(b)ac$, $udbuma(b)rs$, $udbuma(b)ni$ and $udbuma(b)ri$ figures 1-8). Even the PPC money shock cannot completely offset the contractionary effect of country a's demand shock at all degrees of indexation. There exists a critical degree of indexation which *completely insulates* country b's real outputs from both demand and PPC money supply shocks. Above this critical value, the monetary shocks dominate, while the demand shock dominates below the critical level.

3.3.3 Effect on World Economy

If $-1 \leq \rho \leq -0.5$, till a critical degree of indexation, the correlated demand shock of country a with the monetary shocks of countries a and b, produce *contractionary* effect²⁶ on world outputs and prices. Therefore, there exists critical degrees of correlation where outputs and prices are *completely insulated* from correlating demand and monetary shocks. Before the critical degrees of correlation and indexation, the net effect is negative, while positive after the critical degrees. Indexation, for negative correlation, will produce upward sloping real output reaction curves. The slope of the world prices, as a result, is negative. The reaction of the nominal output is positive. For positive degrees of correlation, the shift and slope effect will reduce the reaction of real output with indexation. The reaction of world prices will therefore be positive. Since the former dominates the latter, the slope of the nominal output reaction curve is positive as well.

3.4 Correlated Demand and Country c's Shocks

I first consider the effect of correlated output shock of country c with the demand shock of country a(b) on itself (country b) before analyzing the impact of correlated demand, price and interest rate shocks.

3.4.1 Demand and Output Shocks

Irrespective of the degree of correlation and indexation, the correlated output shock with the demand shock of country a produces expansionary and contractionary effects on outputs and prices of countries a and b (see $uda(b)uycy$, $uda(b)uycp$, $uda(b)uycq$ in Figs. 1-2, 6) respectively. While demand shock of country a produces a positive (negative) effect on country a (b), output shock produces positive effect. When $-1 \leq \rho < 0$, the negatively correlated output shock increases

²⁶Although the effect of correlated demand and monetary shocks on country a is expansionary, their cross-country effect is contractionary. Since the magnitude of the negative effect is higher than that of the positive effect, they also produce negative effects on world economy.

(reduces) outputs and prices in country a (b) lesser (more) than in case of positively correlated output shocks. The real and nominal outputs as well as producer and consumer prices increase (decrease) more (lesser) as the degree of correlation rises from -1 to 1. With rising (falling) prices, nominal outputs increase (decrease) more than real outputs in country a (b). Interest rates increase, while exchange rates fall in both countries. With indexation, the slope and shift effects change the supply curve in opposite directions. The higher the degree of indexation, the lower the increase (decrease) in real outputs and interest rates as well as the increase (decrease) in exchange rates and producer and consumer prices in country a (b) are higher. If $\rho = 1$, there exists a critical degree of indexation which *completely insulates* the impact of correlated demand and output shocks on outputs of country b.

3.4.2 Demand, Price and Interest Rate Shocks

As far as the effects of correlating demand shocks with either price or interest rate shock of country c are concerned, they produce identical effects with exchange rates being exceptions²⁷. Irrespective of the degrees of correlation and indexation, the combined demand shock of country a with either price or interest rate shock of country c produces (a)n *expansionary (contractionary)* impact on outputs, prices and reserve flows of country a (b). Rising interest rates lead to falling exchange rates with country c.

While the demand shock of country a increases (decreases) outputs and prices of country a (b), price and interest rate shocks pull the demand for output of countries a and b in two opposite directions through the substitution and real interest rate effects. The results show that the combined shocks increase (decrease) outputs, prices, and interest rates more (less) as the degree of correlation rises from -1 (see the combined demand shock, $u_{da}(b)$, with the price (u_{pc}) and interest rate (u_{ic}) shocks in case of real output (y), nominal output (y_n), producer and consumer prices (p, q), exchange rates (ac) as well as nominal and real interest rates (n_i and r_i) in Figs.1-8) as long as $b < 1$.

Increasing indexation will both steepen and shift the supply curve to the left. With the former dominating the latter, till a critical degree of indexation, we find a(n) downward (upward) sloping real output curve which is consistent with (a)n upward (downward) sloping reaction curve for producer and consumer prices in country a (b). As a result, the reaction curve for nominal output is also positively (negatively) sloped.

There exists a critical degree of indexation where the correlated price or interest rate shock *completely loses its importance at all degrees of correlation* and there by giving rise to *switching reaction curves*²⁸. Below this level, real interest rate effects dominate the reaction, while relative

²⁷The total (primary and secondary) reaction for an interest rate shock in country c is equal to the exchange rate reaction for a price shock in country c plus one, which represents the primary depreciation mentioned above. See Läufer and Sundararajan (1993) for a detailed analysis

²⁸This occurs at a degree of indexation ($b \in (.78, .79)$) where u_{ic} and u_{pc} completely insulate real outputs at all

price effects influence outputs above the critical level.

3.5 Combined Monetary and Country c's Shocks

In this section, the impact of the monetary shocks with the correlated output shocks is discussed first before examining the combined effects of the money supply shocks with either price or interest rate shock of country c.

3.5.1 Monetary and Output Shocks

When the output shock of country c is negatively correlated with the money supply shocks of countries a and b, there exists *varying* degrees of indexation and correlation where real output is *completely insulated*. Above the critical levels, the combined shocks increase outputs, while *contracting* them after the critical levels as long as $-1 \leq \rho < 0$. However, the positively correlated output shock with the monetary shocks consistently produce a positive impact on outputs, prices, and exchange rates and a negative effect on interest rates (see $uma(b)uycy$, $uma(b)uycp$, $uma(b)uycyn$, $uma(b)uycac$, and so on in Figs.1-8). With indexation, the supply curve steepens as well as shifts to the right (left), which increases with the indexation. These slope and shift effects reduce real outputs and increase price expansions more as the degree of indexation increases. As a result, nominal outputs of both countries also increase more with indexation. The rising nominal outputs increase interest rates which in turn reduce rising exchange rates with indexation. With higher indexation and negative correlation, the supply curve shifts to the left more and produces a *contractionary effect* on both countries. When negative correlation turns positive, the *contractionary effect* also comes down as ρ and b approaches one. There exist *varying critical degrees of indexation and correlation* which would *completely insulate* real outputs from the combined money supply and output shocks.

3.5.2 Monetary, Price and Interest Rate Shocks

Irrespective of the degrees of correlation, the combined effects of monetary shocks with either price or interest rate shocks on outputs and prices are positive, while they are positive and negative respectively in case of interest rates and exchange rates (except for $\rho \geq 0.75$) as long as indexation is not close to one. For higher degrees of indexation, we find that the positively correlated price or interest rate shocks produce *contractionary* effects on real outputs (see $uma(b)uicy$, $uma(b)upcy$ in Fig.1), while producer and consumer prices, nominal outputs, exchange rates, (except for $\rho \geq .75$), are positive for all degrees of correlation and indexation (see combined monetary shocks (uma, umb) with interest rate (uic) or price (upc) shocks for outputs (y, yn), prices (p, q), exchange rates (ac), reserves (rs), and real and nominal interest rates (ri, ni) in Figs.1-8). Increasing indexation changes the supply curve of output via the slope and shift effects. This

degrees of correlation.

reduces outputs as indexation approaches one. While the money supply shocks lose their importance, price or interest rate shocks via the real interest rate effect leads to a *contractionary impact* on real outputs for higher degrees of indexation. Obviously, there exist various degrees of indexation which *completely insulates* real outputs, real and nominal interest rates and exchange rates from their combined shocks. Above the critical levels, the transmission effects of combined monetary, price and interest rate shocks are uniformly positive for all degrees of correlations. Below the critical value, the *transmission is negative for all positive degrees of correlation* of price or interest rate shocks with monetary shocks. The latter is through the real interest rate effect, while the former is via the relative price effect.

Consistent with the negative slopes of real outputs, prices have positive slopes which in turn produces upward sloping nominal output curves as the degree of correlation increases. The higher nominal output which has a positive slope also leads to higher interest rates (positive slopes). The positions and slopes of nominal interest rate reaction curves explain the positions and slopes of exchange rate reaction curves.

3.6 Combined Country c's Shocks

At the outset, the effects of combined output shock with price or interest rate shock is discussed before analyzing the impact of combined price and interest rate shocks.

3.6.1 Output, Price and Interest Rate Shocks

The impact of combined output shock (u_{yc}) with a price shock (u_{pc}) is identical to output and interest rate (u_{ic}) shocks because of identical effects of u_{ic} and u_{pc} with respect to outputs, prices, etc., except for exchange rates which are equalizing differences. Irrespective of the degrees of correlation and indexation, the combined country c's shocks do not have any effect on reserve stocks (see $u_{yc}u_{pc}(ic)y$, $u_{yc}u_{pc}(ic)p$, $u_{yc}u_{pc}(ic)yn$, $u_{yc}u_{pc}(ic)q$, $u_{yc}u_{pc}(ic)ac$, $u_{yc}u_{pc}(ic)rs$, $u_{yc}u_{pc}(ic)ni$ and $u_{yc}u_{pc}(ic)ri$ in figures 1-8).

While the impact of an output shock from country c on countries a's and b's outputs are positive, the effect of u_{ic} or u_{pc} can be either positive or negative because of the positive substitution and the negative real interest rate effects. When u_{ic} (u_{pc}) is negatively related to u_{yc} , the former offsets the impact of the latter. The negatively correlated u_{ic} (u_{pc}) shock (for $\rho \geq -1$) produces *contractionary effects* on outputs, prices, and interest rates as long as the indexation is not full. While exchange rates fall in response to u_{yc} , they fall (rise) in response to a negatively related u_{ic} (u_{pc}). The net effect is falling (rising) exchange rates as long as $-1 \leq \rho \leq 0.75$ ($-1 \leq \rho < 0.5$). With indexation, the steepening and shifting of the supply curves further increase outputs. When indexation approaches one, for negative correlation, the substitution effect is increasingly overruled by the real interest rate effect which in turn increases real outputs. Increasing indexation will therefore produce expansionary effects on real outputs in

countries a and b respectively. As ρ increases, the position of the real output curve also goes up with the degree of correlation. Thus there exists critical degrees of indexation and correlation where real outputs are completely insulated. Below the critical levels, the real outputs are contractionary, and above the critical levels, the real outputs are positive. Therefore, the real output reaction curves are positively sloped. As a result, the slope of price reaction curves are negative. If $-1 \leq \rho < -0.5$, since prices dominate nominal outputs, although real outputs increase with indexation, the effect of indexation on nominal outputs is contractionary. Since nominal output curves are negative, interest rate reaction curves are also negative. As a result, exchange rate reaction curves rise with indexation.

When uic (upc) is positively correlated with uyc, they produce expansionary effects on outputs, prices and interest rates. The exchange rates fall till a critical degree of correlation. If $\rho > 0.5$, exchange rates rise (fall). This reduces (reinforces) a fall of exchange rates due to a shock in uyc. As a result, outputs, prices and interest rates increase more as the degree of correlation increases. With indexation, since the slope effect dominates the shift effect, we find outputs increasing lesser as indexation reaches 100 per cent. As a result, we have negative real output and positive price reaction curves. The latter produces rising nominal outputs which in turn increases with indexation. The slope of the interest rate reaction curves, as a result, go up with indexation. The slope of the latter also explains the slope of exchange rates.

3.6.2 Price and Interest Rate Shocks

When uic is negatively correlated ($\rho = -1$) with upc, outputs, prices, reserves and interest rates are *completely insulated* from the combined upc and uic shocks. (see upcuicy, upcuicp, upcuicyn, upcuicrs, upcuicni, upcuicri, upcuicq in Fig.1-3, 5-8). The exchange rates fall which merely increases the money demand and supply. For all other degrees of correlation ($-1 < \rho \leq 1$), outputs, prices, and interest rates are increased as long as indexation is not close to one. Increasing indexation steepens the supply curve which reduces the change in equilibrium outputs, while falling exchange rates shift it to the right and increase outputs. Therefore, the higher the degree of indexation, the steeper the slope of the supply curve and the lower the increase in outputs. As a result, consumer and producer prices will increase with indexation. There exist a *unique* degree of indexation, where outputs are completely insulated from price and interest rate shocks irrespective of the degree of correlation. Above this point, the substitution effect produces an *expansionary effect*, while the real interest rate leads to a *contractionary impact* on outputs at higher degrees of indexation. Consistent with falling real output reaction curves, price reaction curves are positive followed by nominal output and interest rate reaction curves. The slope of the latter would mean a downward slope of exchange rate reaction curves.

4 Concluding Remarks

I have examined the transmission of correlated economic shocks in a three-country world where two countries have no macroeconomic impact on a third country but are large enough to influence each other in a mixed exchange rate regime. I have drawn insights from a theoretical three-country model and have discussed the consequences for small countries of a variety of combined shocks under different degrees of indexation²⁹. First, with respect to *convergent* and *switching reaction curves* (see the combinations of demand, money supply and country c's shocks in Figs.1-8), the *uncertainty about the degrees of correlation* between the shocks loses its importance as the indexation increases from zero, but remains below a critical level in case of *switching reaction curves*. If shocks from country c are involved, the critical level of indexation is around 80 per cent. At this level, the uncertainty about the degree of correlation loses its importance, although regains it later. At the points of convergence and switching, the degree of correlation does not matter at all for the outcome. Therefore, there exists a *unique* degree of indexation (b=100 per cent in case of convergent reaction curves) that minimises the impact of correlating economic shocks. This implies that indexation may be used as an instrument for minimising the impact of correlated shocks. Second, exchange rates are *completely insulated* in case of perfectly negatively correlated demand shocks. Third, real and nominal outputs, producer and consumer prices, exchange rates, and real and nominal interest rates of countries a and b as well as world economy are *completely insulated* with respect to the correlated monetary shocks ($\rho = -1$). The implication is that the degree of correlation ($\rho = -1$) can be used as stabilization instrument, if the authorities want to neutralize the impact of correlating demand (monetary) shocks on exchange rates (outputs, prices and interest rates), for coordinating policies in Europe. This not only help avoid repercussions in forex market, but also help neutralize the contractionary (expansionary) effect of correlating real (monetary) shocks on the small economies. Fourth, the reserve stock is *completely insulated* in case of perfectly positively correlated demand shocks and money supply shocks. It is also completely insulated from country c shocks at all degrees of correlation and indexation. Fifth, when price and interest rate shocks of country c are perfectly negatively correlated, all macroeconomic variables are *completely insulated* with exchange rates

²⁹Apart from the results reported in this paper, sensitivity tests were performed for the following two assumption. (i) Country a's trade is evenly balanced so that the country's trade shares, income and price elasticities are all equal with respect to countries b and c. (ii) Trade is still balanced so that $h_{12} = h_{13}$ and $\alpha_1 = \alpha_2$ but price elasticities are higher in country b than in country c. The main findings of this paper are robust because of the following reasons. A Comparison of Läufer and Sundararajan's simulation and analytical results in case of a single shock coming at a time clearly indicates that their simulation results (Läufer and Sundararajan, 1993), for the same parameter constellation, are quite consistent and robust with that of their analytical ones (Läufer and Sundararajan, 1994). Since the results of correlated shocks in this paper, if $\rho = 0$, would immediately be reduced to the case of a single shock coming at a time in Läufer and Sundararajan (1993, 1994), the results of this paper are also consistent and robust. However, several sensitivity tests were also done by changing the behavioural parameters of the model in the simulation. The results, however, do not change our main conclusions.

being exceptions. The latter is an equalizing difference, which establishes the equivalence in all other respects. Sixth, there exists various *critical degrees of correlation and indexation* where real outputs, producer and consumer prices, exchange rates and real and nominal interest rates are *completely insulated* in case of combined real and monetary shocks, and the money supply shocks with country c's shocks. In other words, there does not exist a *unique* degree of correlation and/or indexation that provides complete insulation from these shocks. Seventh, beyond the critical degrees of indexation, real outputs, consumer and producer prices, etc are *contractionary* as far as the shocks concerning country c are concerned. Eighth, the combined real shock of country a with the monetary shocks of countries a and b and output shock of country c produce *contractionary effects* on outputs (real and nominal), prices (producer and consumer), and reserve stocks of country b at all degrees of indexation as long as the degree of correlation is not close or equal to one. The results also imply that there exists varying degrees of correlation and indexation where world real and nominal outputs as well as world prices are *completely insulated*. Before and after the critical degrees, the effect of correlated demand and monetary shocks on world economy is positive and negative respectively. The results imply that country b may hope to nullify the contractionary effect of these correlating shocks only through a sufficiently sized high degree of positive correlation ($\rho > 0.75$) as long as $0.6 < b < 0.7$ in case of correlated real and monetary shocks and $b \geq 0.97$ in case of correlating real shock of country a with the output shock of country c. Therefore, in order to neutralize the contractionary effect of foreign fiscal shock, country b may follow an expansionary monetary or fiscal policy that help stabilize the economy from correlated fiscal and monetary shocks. Ninth, correlating the real shock of country a with the price or interest rate shock of country c produces *contractionary effect* on real and nominal outputs, producer and consumer prices as well as reserve stocks of country b at all degrees of indexation and correlation. Tenth, correlating the demand and monetary shocks of countries a and b as well as country c's output shock with the price or interest rate shock of country c provide either identical or minimum or no effect on outputs of countries a and b at a critical degree of indexation ($b \simeq 0.8$). At this critical level, the degree of correlation does not have any effect on small economies. Last, correlating the demand and monetary shocks individually produce *expansionary effects* on outputs and prices of countries a and b as well as on world economy. The implications of these results for coordination of monetary and fiscal policies in Europe are very clear. The degree of correlation can be considered as an instrument of coordinating policies. As such it may play a very important role in minimising the cross-country effect of a real (fiscal) shock coming from country a. Both countries stand to gain from correlating demand (fiscal) shocks. While a country's output reaction is maximized in case of perfectly negatively correlated fiscal shocks, it can stabilize the contractionary impact of a foreign fiscal shock on outputs by coordinating monetary and fiscal policies.

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Table 1:
Parameter Values

$h_b = 1.00$	$n_{xb} = 1.15$	$n_{xc} = 1.56$	$n_{mb} = 1.41$
$h_c = 1.00$	$n_{mc} = 1.67$	$h_{11} = 0.70$	$h_{12} = 0.15$
$h_{13} = 0.15$	$\theta = 0.67$	$\alpha_1 = 0.15$	$\alpha_2 = 0.15$
$\alpha_3 = 0.10$	$\alpha_4 = 0.234$	$\alpha_5 = 0.335$	$\beta_1 = 0.20$

Fig.1 Impact of Correlated Shocks on Real Outputs

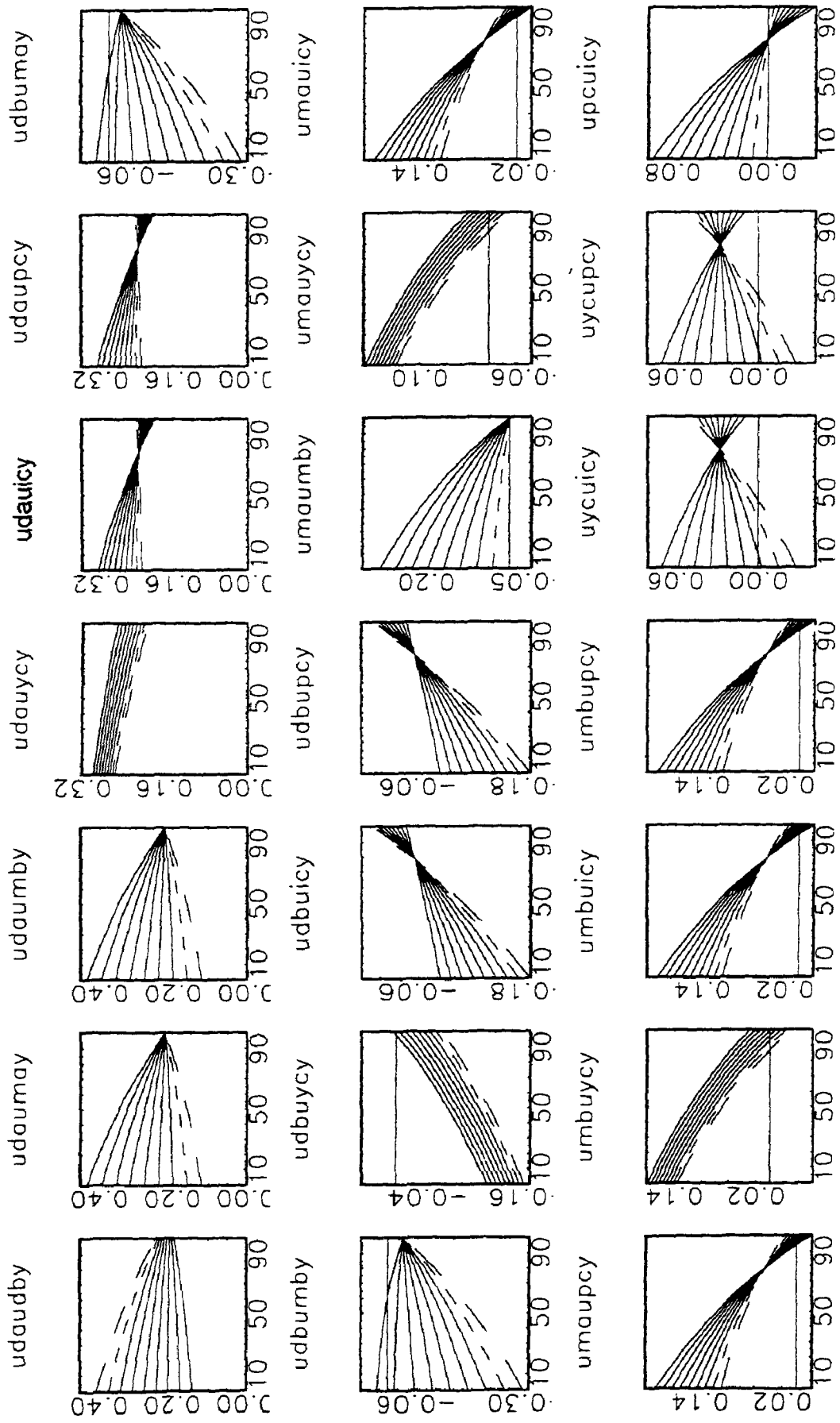


Fig.2 Impact of Correlated Shocks on Producer Prices

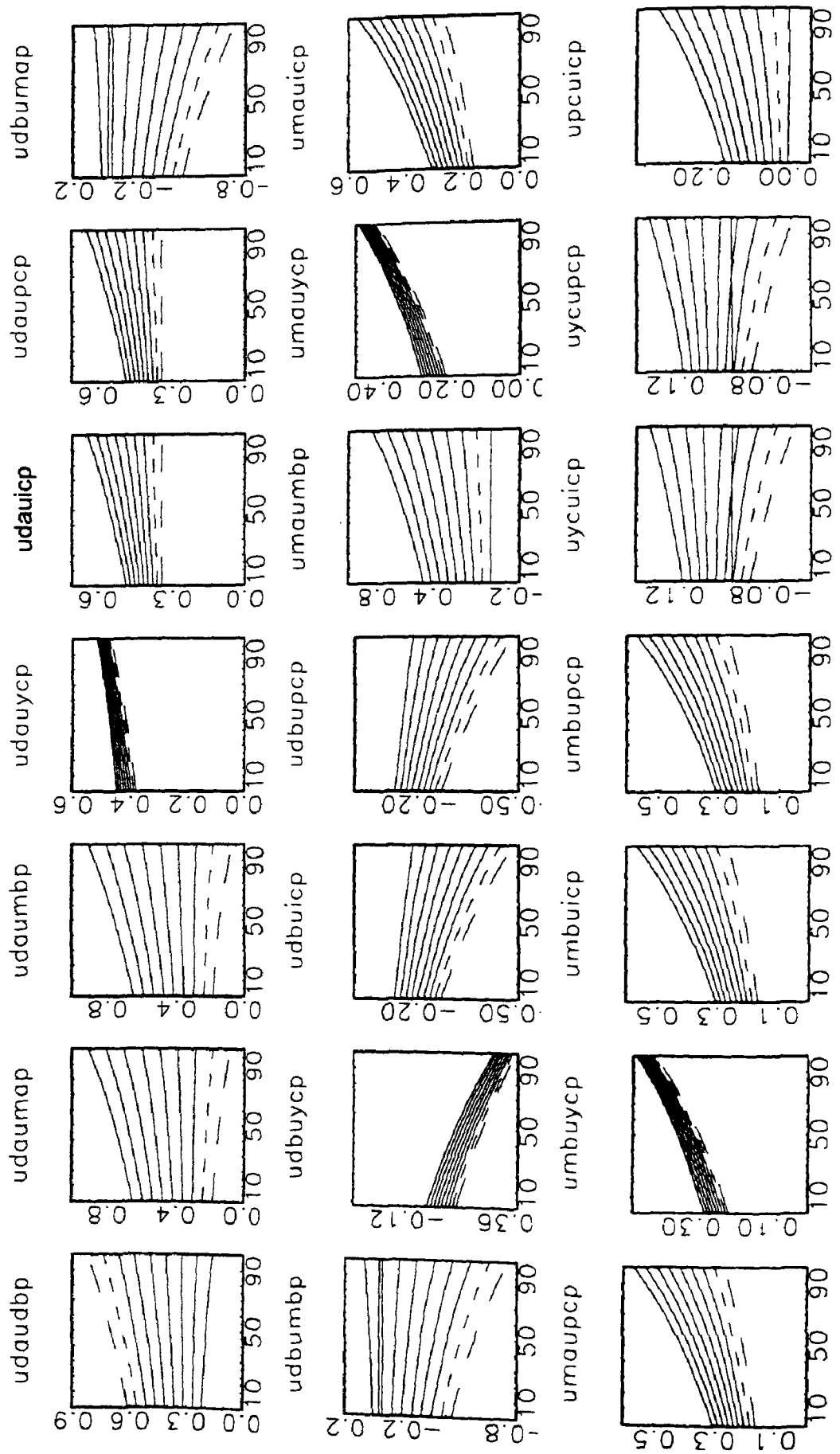


Fig.3 Impact of Correlated Shocks on Nominal Outputs

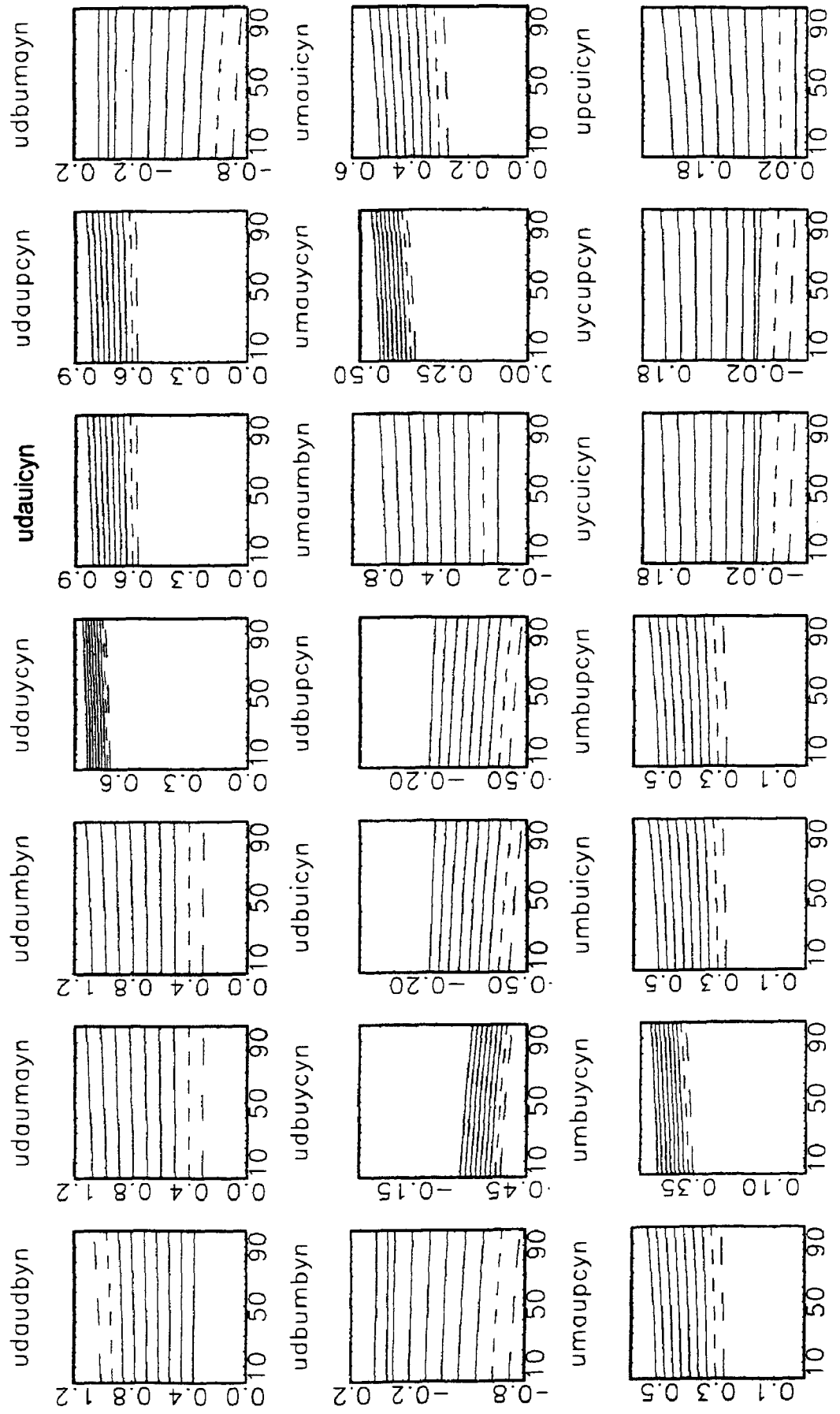


Fig.4 Impact of Correlated Shocks on Exchange Rates

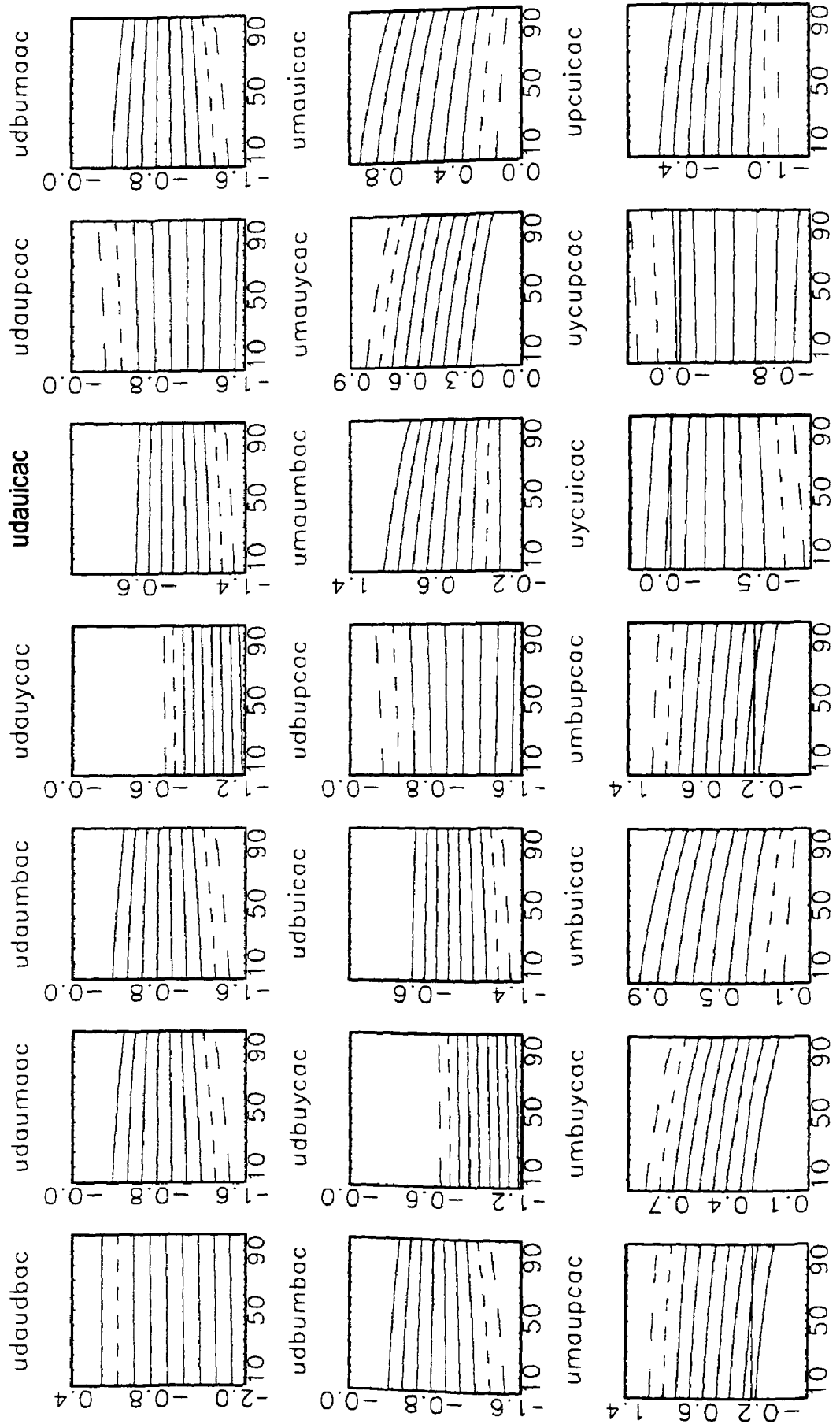


Fig.5 Impact of Correlated Shocks on Reserve Stocks

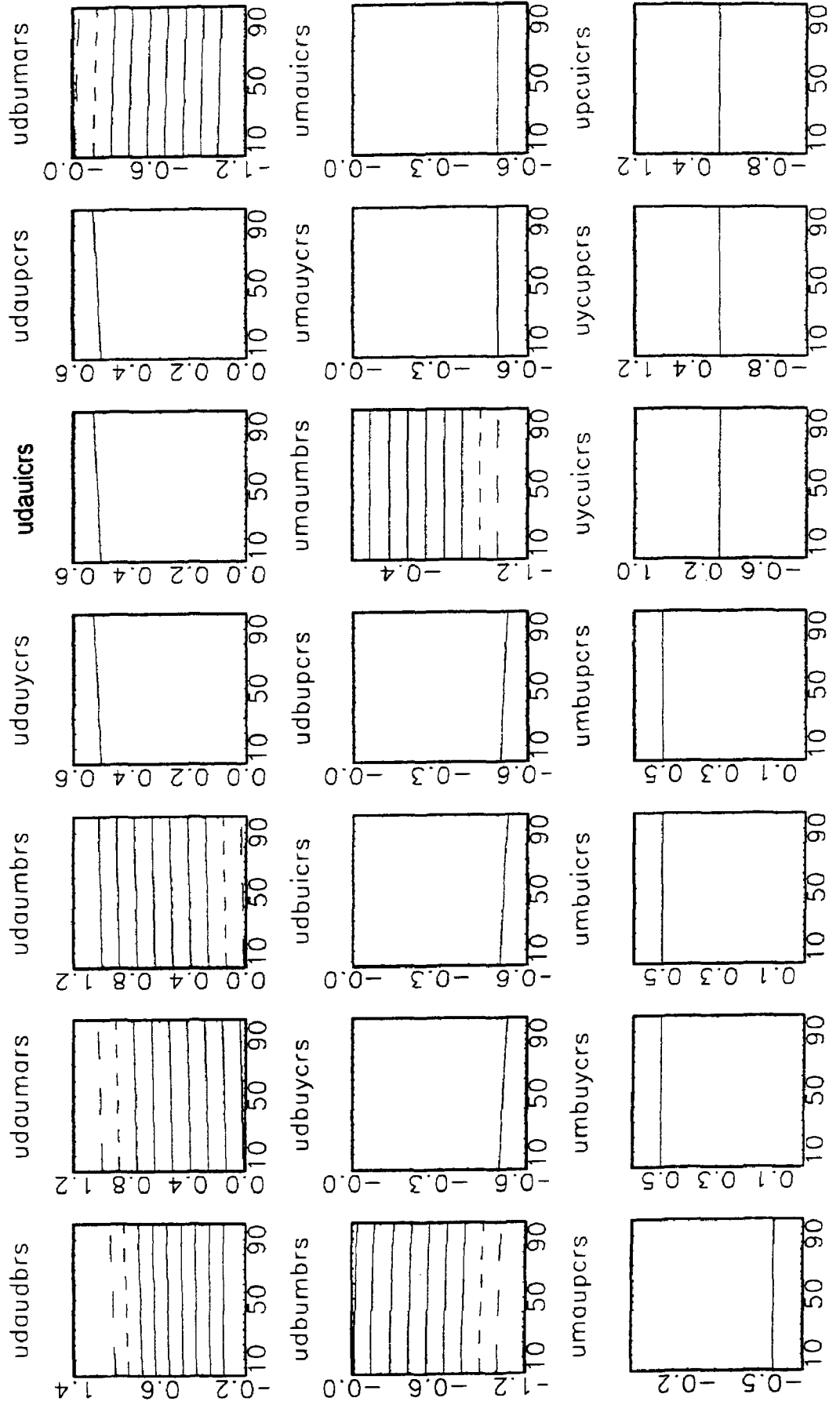


Fig.7 Impact of Correlated Shocks on Nominal Interest Rates

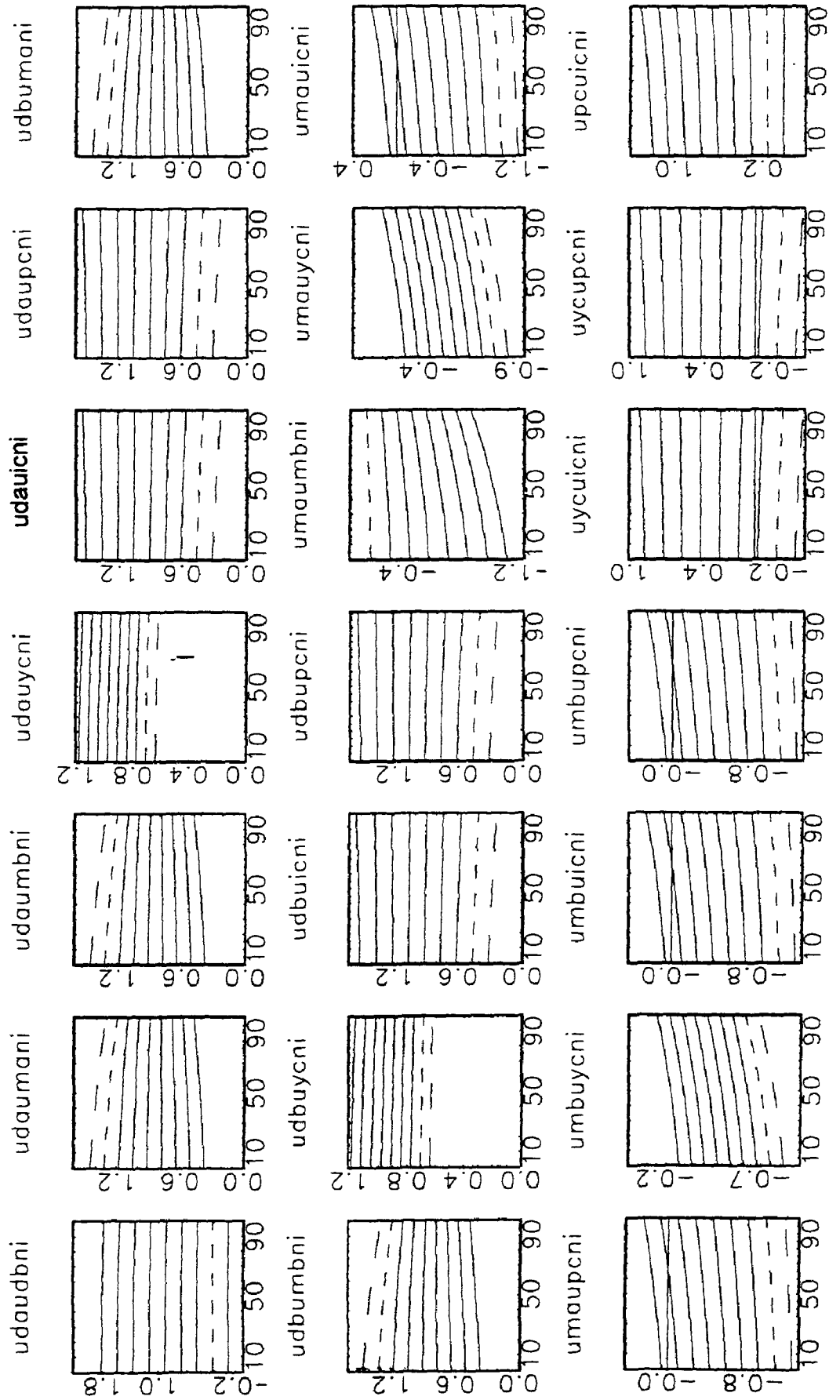


Fig.8 Impact of Correlated Shocks on Real Interest Rates

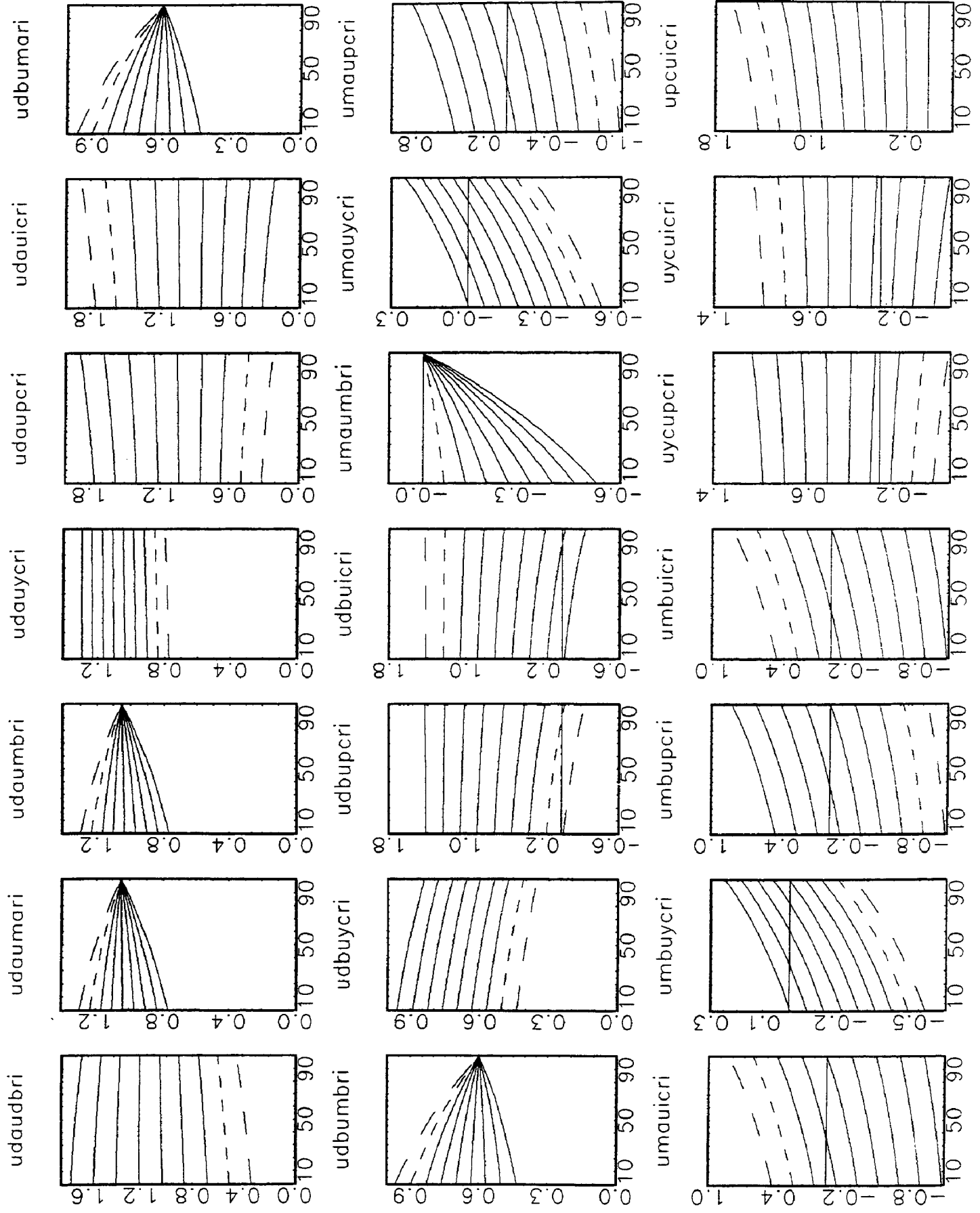
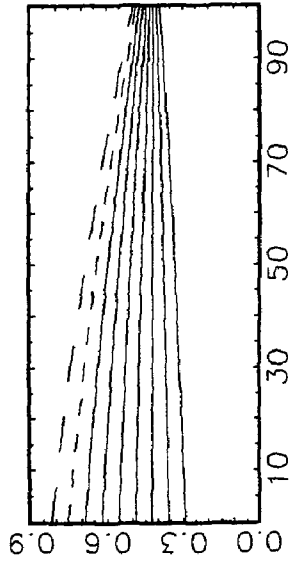
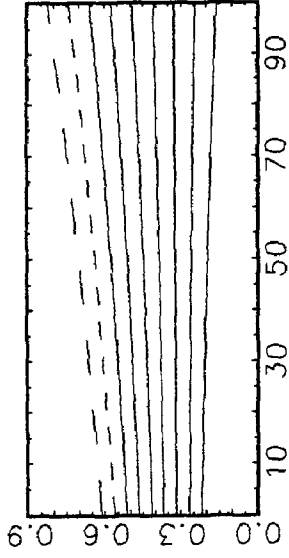


Fig.9 Impact of Correlated Shocks on World Economy

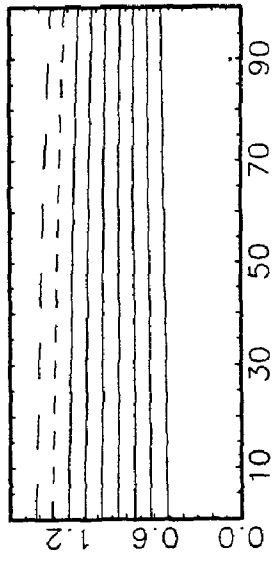
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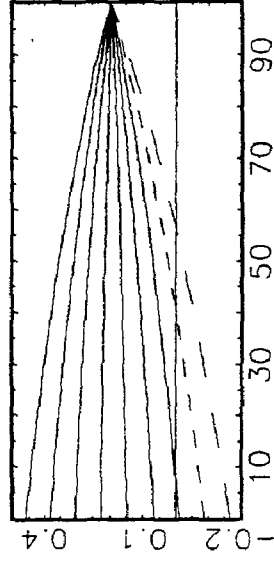
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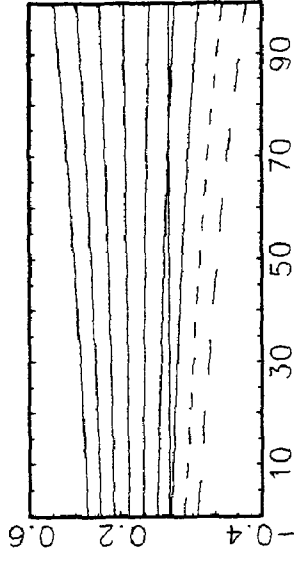
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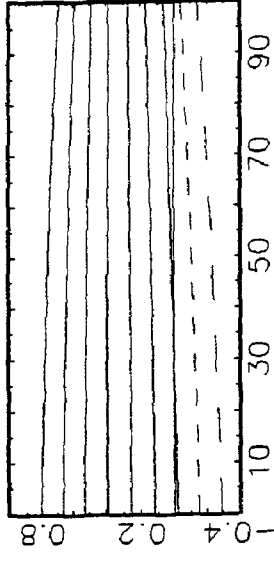
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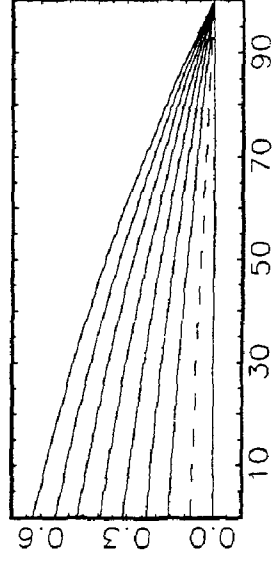
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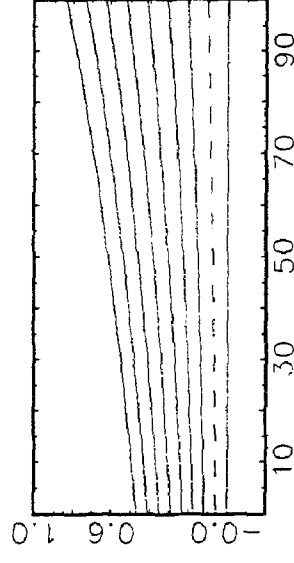
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