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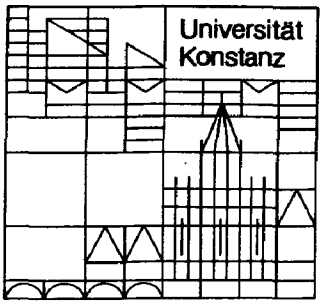

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Stabilization Policy in Multi-Country Models

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Abstract

This paper analyzes the international transmission of economic disturbances 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 fixed and flexible exchange rates. While the fixed exchange rate (FER) regime is shown to insulate the domestic economy from monetary shocks, the flexible exchange rate (FLER) regime is shown to be effective in dampening the impact of real shocks on domestic output. As far as the shocks coming from the large country are concerned, the exchange rate flexibility serves as an important tool in reducing the variability of output.

1 Introduction

Modern stochastic macroeconomic theory asserts that economic disturbances and policies are in general transmitted across countries, though the channels of transmission and the exact way in which economies respond to shocks may depend on the type of exchange rate regime. Of particular concern has been the extent to which a domestic economy is insulated from foreign disturbances under a flexible exchange rate (FLER) regime.

Long before the inception of the current system of managed exchange rates it was argued that exchange rate flexibility would greatly reduce macroeconomic interdependence across countries. Friedman (1953), for example, showed that FLER would suppress the international transmission of monetary shocks by eliminating the effects of foreign prices and allowing only the real effects to be transmitted across the countries. Meade (1950), on the other hand, in his fixed price model

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with the assumption of perfect capital mobility found that FLER would completely insulate the domestic economy from the foreign monetary disturbances. However, Mundell (1963), using perfect capital mobility, has predicted that foreign monetary disturbances would produce a negative effect in the domestic economy[1]. Alternatively, Dornbusch (1976) and Mussa (1979) showed that, with perfect capital mobility, the positive or the negative transmission of monetary shocks will depend upon the impact of the foreign monetary shocks on exchange rate expectations, and thereby on the domestic interest rate. Turnovsky and Kingston (1977), on the other hand, found a positive effect of an increase in foreign inflation on the domestic economy with a fall in the world real interest rate. Turnovsky (1981) in a rational expectations model has indicated that the domestic economy would completely be insulated from foreign price disturbances. Marston (1984) investigates how a small country which has economic ties with a large country from an exchange rate union[2] and with another large country – the rest of the world – fares by joining the exchange rate union. The results indicate that the domestic demand and monetary disturbances have an identical effect on output in the home country under the FLERs or in the union if wages are fully indexed to the general price level. Short of full indexation, the case for the union, i.e. FER, is stronger if the monetary disturbances originate at home rather than abroad and it is weaker if domestic demand disturbances are important. Similarly, the effect of foreign disturbances is also shown to be dependent on foreign wage and price behaviour as well as the respective domestic behaviour. Argy et al.'s (1989) study on the choice of an appropriate exchange rate regime showed that the floating exchange rate regime performs well in mitigating the domestic economy from real and monetary shocks. When choosing among various FER regimes, the small country is better off pegging to a basket of currencies.

Except for a few studies like Marston (1984) and Argy et al. (1989) who have analyzed the *international* transmission of real and monetary disturbances, it can be observed that researchers have analyzed specifically the transmission of foreign monetary shocks within the domestic economy. One thing which clearly emerges is that the evidence for the transmission of foreign disturbances is mixed.

[1]The interested readers are further referred to Laursen and Metzler(1950), Branson and Rotemberg (1980), Cox(1980), Schmid (1982), Corden and Turnvosky(1983) and Argy and Salop(1983) for studies of negative transmission of foreign monetary disturbances.

[2]Marston (1984) defines the exchange rate union as an arrangement in which member countries of each union maintain fixed exchange rates between member currencies, but with each country retaining its own central bank with control over its national monetary policy.

Furthermore, they have, by and large, not dealt with the case where a country from an exchange rate union is large enough to affect the other union country in a three-country world. This is especially true of Marston's (1984) treatment of a three-country world consisting of a small country facing two large countries, viz. the potential partner of the small country in an exchange rate union and another partner forming the rest of the world. The purpose of this paper is then, to extend Marston's (1984) analysis of the three-country world, to examine the international transmission of real and monetary disturbances originating at home and abroad in a three-country framework where two countries are assumed to have no macroeconomic impact on a third country but they are large enough to influence each other. Each of the disturbances has potential effects that depend on several factors like the degree of wage indexation, the type of exchange rate regime, etc.

Section 2 presents a three-country model and uses the model to derive equations for output, prices of domestic output and two exchange rates under the FLER and equations for output, prices of domestic output and one reserve stock under the FER. In section 3, we present and discuss some numerical results that are designed to illustrate the quantitative importance of the mechanisms discussed in the theoretical model. The last section presents concluding remarks.

2 The Model and its Solution

Consider a world consisting of three countries (a, b and c). For simplicity, we assume that countries a and b are identical. That is, the structural parameters in the aggregate demand and supply functions and in the financial equations are the same for both countries. We further assume that countries a and b have no macroeconomic impact on country c but they are large enough to influence each other. So, the behaviour of country c is not modelled explicitly. Following Marston's (1984) structure, the model of each country consists of three basic equations, aggregate demand and supply equations for the output produced in that country, and an equation describing equilibrium in financial behaviour. Perfect asset substitution is assumed, so there is a single interest rate that is common to the assets of all three countries.

2.1 The Model

The model is set out as follows:

Demand for Output

$$\begin{aligned} Y_t^{ad} &= \alpha_0 + \alpha_1 Y_t^{bd} + \alpha_2 Y_t^c - \alpha_3 r_t^a + \alpha_4(e_t^{ab} + P_t^b - P_t^a) \\ &\quad +\alpha_5(e_t^{ac} + P_t^c - P_t^a) + u_t^{da} \end{aligned} \tag{1}$$

$$\begin{aligned} Y_t^{bd} &= \alpha_0^* + \alpha_1^* Y_t^{ad} + \alpha_2^* Y_t^c - \alpha_3^* r_t^b + \alpha_4^*(-e_t^{ab} + P_t^a - P_t^b) \\ &\quad +\alpha_5^*(e_t^{bc} + P_t^c - P_t^b) + u_t^{db} \end{aligned} \tag{2}$$

General Price Index

$$q_t^a = h_{11} P_t^a + h_{12}(e_t^{ab} + P_t^b) + h_{13}(e_t^{ac} + P_t^c) \tag{3}$$

$$q_t^b = h_{21} P_t^b + h_{22}(-e_t^{ab} + P_t^a) + h_{23}(e_t^{bc} + P_t^c) \tag{4}$$

Supply of Output

$$Y_t^{as} = \theta(P_t^a - E_{t-1}P_t^a) - \theta b(q_t^a - E_{t-1}q_t^a) + \theta_0 \tag{5}$$

$$W_t^{a'} = E_{t-1}P_t^a + ln(1-\theta') - \theta' \overline{L}^a \tag{6}$$

$$W_t^a = W_t^{a'} + b(q_t^a - E_{t-1}q_t^a) \tag{7}$$

$$Y_t^{bs} = \theta^*(P_t^b - E_{t-1}P_t^b) - \theta^* b^*(q_t^b - E_{t-1}q_t^b) + \theta_0^* \tag{8}$$

$$W_t^{b'} = E_{t-1}P_t^b + ln(1-\theta^{*'}) - \theta^{*'} \overline{L}^b \tag{9}$$

$$W_t^b = W_t^{b'} + b^*(q_t^b - E_{t-1}q_t^b) \tag{10}$$

Money Markets

$$M_t^{ad} - q_t^a = (P_t^a + Y_t^a - q_t^a) - \beta_1 i_t^a + \beta_0 \tag{11}$$

$$M_t^{bd} - q_t^b = (P_t^b + Y_t^b - q_t^b) - \beta_1^* i_t^b + \beta_0^* \tag{12}$$

$$M_t^{as} = M_t^{afs} + M_t^{ads} + u_t^{ma} \tag{13}$$

$$M_t^{bs} = M_t^{bfs} + M_t^{bds} + u_t^{mb} \tag{14}$$

Equilibrium Conditions

$$Y_t^{ad} = Y_t^{as} = Y_t^a \tag{15}$$

$$Y_t^{bd} = Y_t^{bs} = Y_t^b \tag{16}$$

$$M_t^{ad} = M_t^{as} \tag{17}$$

$$M_t^{bd} = M_t^{bs} \tag{18}$$

Interest Rate Arbitrage Conditions

$$i_t^a = i_t^c + (E_t e_{t+1}^{ac} - e_t^{ac}) \quad (19)$$
$$i_t^b = i_t^c + (E_t e_{t+1}^{bc} - e_t^{bc}) \quad (20)$$
$$r_t^a = i_t^a - (E_t q_{t+1}^a - q_t^a) \quad (21)$$
$$r_t^b = i_t^b - (E_t q_{t+1}^b - q_t^b) \quad (22)$$

Triangular Arbitrage Condition

$$e_t^{ac} = e_t^{ab} + e_t^{bc} \quad (23)$$

FLER

$$M_t^{afs} = \overline{f}^a \quad (24)$$
$$M_t^{bfs} = \overline{f}^b \quad (25)$$

FER

$$e_t^{ab} = \overline{k}^{ab} \quad (26)$$
$$e_t^{bc} = \overline{k}^{bc} \quad (27)$$

FLER and FER

$$M_t^{ads} = \overline{M}^{ads} \quad (28)$$
$$M_t^{bds} = \overline{M}^{bds} \quad (29)$$

Rest of the World Sector

$$Y_t^c = \overline{Y}^c + u_t^{yc} \quad (30)$$
$$P_t^c = \overline{P}^c + u_t^{pc} \quad (31)$$
$$i_t^c = \overline{i}^c + u_t^{ic} \quad (32)$$

All variables are in logarithms, where superscripts d and s denote the demand and supply and $*$ denotes the foreign country b.

Y^j	output in country j, where $j = a, b, c$.
q^i	general price index in country i, where $i = a, b$, expressed as the weighted average of the domestic and foreign prices.
W^{ri}	contract wage in country i.

W^i	nominal wage in country i.
M^{id}	money demand in country i.
M^{is}	money supply in country i.
M^{ifs}	foreign component of the money supply in country i.
M^{ids}	domestic component of the money supply in country i.
i^j	nominal interest rate in country j, where $j = a, b, c$.
r^i	real interest rate in country i.
$E_t q^i_{t+1}$	expected price index of country i for period $t+1$ at t.
u^{di}	demand disturbance in country i.
e^{ab}	exchange rate of currency a per unit of currency b.
e^{bc}	exchange rate of currency b per unit of currency c.
e^{ac}	exchange rate of currency a per unit of currency c.
P^j	price of the product in country j.
$E_{t-1}P^i_t$	expected price of the product in country i for period t at time $t-1$.
$E_{t-1}q^i_t$	expected price index in country i for period t at $t-1$.
$\overline{L}^i$	inelastic labour supply in country i.
u^{mi}	monetary disturbance in country i.
$E_t e^{ab}_{t+1}$	expected exchange rate of currency a per unit of currency b for period $t+1$ at time t.
$E_t e^{ac}_{t+1}$	expected exchange rate of currency a per unit of currency c for period $t+1$ at time t.
$\overline{f}^i$	exogenous value of the international component of the money supply in country i (FLER).
$\overline{k}^{ab}$	exogenous value of exchange rate between countries a and b (FER).
$\overline{k}^{bc}$	exogenous value of exchange rate between countries b and c (FER).
$\overline{M}^{ids}$	exogenous value of the domestic component of the money supply in country i.
$\overline{Y}^c$	exogenous value of output in country c.
$\overline{P}^c$	exogenous value of prices in country c.
$\overline{i}^c$	exogenous value of rate of interest in country c.
u^{yc}_t	output disturbance in country c.
u^{pc}_t	price disturbance in country c.
u^{ic}_t	interest rate disturbance in country c.
d	sum of marginal propensities to save and to import.

α_1 , α_2	export elasticities, that is the product of the income elasticities of the demand for output of country a in the two foreign countries (h_b ,h_c) times the share of exports of country a to them as a fraction of total output of country a (ϕ_b , ϕ_c) divided by d (See Marston (1984), pp. 434-37).
α_3	real interest rate elasticity.
α_4, α_5	relative price elasticities, that is the product of the price elasticities of imports and exports minus one ($n_m + n_x - 1$) times the share of exports of country a to countries b and c as a fraction of total output of country a (ϕ_b , ϕ_c) divided by d (See Marston (1984), pp. 434-37).
h_{1k}	expenditure weight in country 1 for country k's good.
h_{2k}	expenditure weight in country 2 for country k's good.
θ	elasticity of labour share in the output supply.
b	indexation parameter.
θ_0	$(1-\theta')\overline{L}^i$, where $(1-\theta')$ is the share of labour in the production function.
β_1	nominal interest rate elasticity.

Equations (1)–(2) represent the two countries' demand for output. The demand is a function of foreign output, relative prices of foreign and domestic goods and real interest rate. In addition, each country is exposed to a real disturbance (u_t^{di}).

Equations (5)–(8) explain the supply side of the economy. The supply behaviour is based on a labour contract lag of one period with partial or complete indexation of wages to current prices. Output is responsive to nominal wages relative to domestic prices, but the former is partially or fully indexed to current changes in the price index which is a weighted average of domestic and foreign prices. The supply functions (5) and (8) are derived from the Cobb-Douglas production function, the labour market equilibrium conditions (6) and (9) determining the contract wage and the wage indexation equations (7) and (10). The contract wage, indicating expectations at $t-1$, is based on labour demand and an inelastic labour supply[3] . The actual wage is expected to differ from the contract

[3]The desired labour supply is assumed to be inelastic following Marston (1984). But once the contract is signed the amount of labour supplied is determined by the demand for labour as in Gray (1976).

wage if the indexation parameter is different from zero[4] . While domestic prices alone affect the supply of output when there is no indexation, the domestic prices as well as foreign prices via the price index influence the output supply when the wages are partially or fully indexed.

Equations (11) to (14) are the conventional money demand and supply equations. Real demand is a positive function of real income and a negative function of the nominal interest rate. The behaviour of money supply depends upon the exchange rate regime. Under the FER regime, the supply of money is assumed to be a function of an endogenously determined reserve component and an exogenously given domestic component of the money supply. In the FLER regime, both the reserve and the domestic component of the money supply are exogenously determined. Each country is also exposed to a monetary disturbance (u_t^{mi}).

Equations (15) to (18) describe the product market and the money market equilibrium conditions. The domestic interest rate is equal to the foreign interest rate plus the expected rate of depreciation of the domestic currency according to equations (19)– (20). Similarly, the real interest rates in equations (21)–(22) are explained as a function of the nominal interest rate minus the expected rate of inflation.

Equation (23) defines the exchange rate between a and c as the residual cross rate. Equations (24) to (29) describe the exogenous values of the reserve component, the domestic component of the money supply and the exchange rate under the specified exchange rate regimes.

Equations (30) to (32) explain that all the effects coming from country c are exogenously determined. They are expressed as a function of a constant and a disturbance term.

Assuming that expectations follow long-run equilibrium values, under the FLER, we can substitute equations (3), (4), (19)–(22), (24)–(25), (28)–(32) into equations (1)–(14) through equations (15)–(18) and (23), and obtain solutions for the seven endogenous variables: Y^a, Y^b, P^a, P^b, e^{ab}, e^{ac} and e^{bc}. Similarly, under the FER, the equations (3), (4) , (19)–(22), (26)–(32) are substituted into equations (1)–(14) through equations (15)–(18) and (23) to obtain solutions for the six endogenous variables: Y^a , Y^b , P^a, P^b, M^{afs} and M^{bfs} .

[4]See 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.

For convenience, the definition of coefficients used in the derivation of the model is given in the appendix.

2.2 Solutions for Real and Monetary Disturbances in Country a

Using the model and the procedure just described, the following equations show the solutions for various disturbances in the FER and the FLER regimes.

FER

$$Y_t^a - \overline{Y}^a = \frac{1}{A_{25}}\Big\{u_t^{yc}E_{10} - u_t^{ic}E_{11} - u_t^{pc}E_{12} + u_t^{da}E_{13} + u_t^{db}E_{14}\Big\} \tag{33}$$

$$P_t^a - \overline{P}^a = \frac{1}{A_{25}}\Big\{u_t^{yc}\alpha_2 A_{30} - u_t^{ic}\alpha_3 A_{30} - u_t^{pc}MA_{30} + u_t^{da}I + u_t^{db}J\Big\} \tag{34}$$

$$M_t^{afs} - \overline{M}^{afs} = \frac{1}{A_{25}}\Big\{u_t^{yc}E_{15} - u_t^{ic}D_5 - u_t^{pc}D_6 + u_t^{da}E_{16} + u_t^{db}E_{17} - u_t^{ma}A_{25}\Big\} \tag{35}$$

FLER

$$Y_t^a - \overline{Y}^a = \frac{1}{A_{24}}\Big\{u_t^{yc}D_7 + u_t^{ic}D_8 + u_t^{pc}D_9 + u_t^{da}D_{10} + u_t^{db}D_{11} + u_t^{ma}D_{12} + u_t^{mb}D_{13}\Big\} \tag{36}$$

$$P_t^a - \overline{P}^a = \frac{1}{A_{24}}\Big\{u_t^{yc}E_1 + u_t^{ic}E_2 + u_t^{pc}E_3 + u_t^{da}NC_5 + u_t^{db}NC_6 + u_t^{ma}C_7 + u_t^{mb}C_8\Big\} \tag{37}$$

$$e_t^{ab} - \overline{e}^{ab} = \frac{1}{A_{15}}\Big\{u_t^{da}E_4 + u_t^{db}E_5 + u_t^{ma}E_6 + u_t^{mb}E_7\Big\} \tag{38}$$

$$e_t^{ac} - \overline{e}^{ac} = \frac{1}{A_{15}}\Big\{u_t^{yc}\alpha_2 NA_6A_{29} + u_t^{ic}D_1A_{29} + u_t^{pc}D_2A_{29} + u_t^{da}E_8 + u_t^{db}E_9 + u_t^{ma}D_3 + u_t^{mb}D_4\Big\} \tag{39}$$

Exogenous output and price shocks coming from country c are expected to increase the output in country a both in the FER and in the FLER regimes. But the variability of output would be less in the FLER regime, depending upon the extent to which the exchange rate appreciates. As far as the effect of an increase

in country c's interest rate is concerned, in the FER regime, a rise in country c's interest rate lowers country a's output through the real interest rate effect on aggregate demand. In the FLER regime, a rise in country c's interest rate as such lowers output but the induced depreciation of country a's exchange rate increases it. Therefore, the output in country a is subject to two opposing forces in the FLER regime. As far as the effects of monetary shocks emanating from countries a and b on country a's output are concerned, the FER regime provides perfect insulation, while in the FLER output, prices and exchange rates in country a are affected. For a real disturbance, the FLER is effective in reducing the variability of country a's output, because the FLER adjusts in such a way as to dampen a change in demand.

3 Numerical Parameterization and Discussion of Results

Since the equations presented above are complex, signs are ambiguous and in order to analyze the quantitative importance of the international linkages given above, some *numerical* results are presented here. Germany, France and the United States are chosen as examples of countries a, b and c respectively[5]. In order to calibrate the model, behavioural coefficients for structural equations, as well as trade and expenditure shares are required. We assume that country a's trade is bilaterally balanced with both countries b and c so that the weights in the general price index are equal, $h_{12} = h_{13}$. This assumption is a convenience so that differences in the coefficients of an output equation reflect only the role of elasticities and not the influence of trade imbalances. For instance, country a may be more or less sensitive to real or monetary disturbances in country b, because country b's demand for its product has a relatively high or low income or price elasticity. For simplicity, we assume that trade and expenditure shares are equal. Trade shares are based on actual data of German exports in 1988 from the IMF's International Financial Statistics. Numerical values for behavioural parameters are based on our interpretation of the empirical literature. The parameter values 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

[5]Throughout the discussion, for convenience, we alternatively use the terms, "the domestic economy", "the home country" and "Germany" to refer to country a.

were assumed to be equal to one. These values are closely consistent with the elasticities used by Ueda (1984), Sachs and McKibbin (1985) and Ishii et al. (1985). The real and nominal interest rate elasticities are chosen to be 0.1 and 0.2 which correspond to Sachs and McKibbin(1985), McKibbin and Sachs (1986), Dornbusch and Fischer (1981) and Argy et al. (1989). The expenditure shares in our calculation are consistent with the high expenditure share given to the domestic economy by McKibbin and Sachs (1986), Ishii et al. (1985) and Argy et al. (1989). The elasticity of labour share in the output supply is assumed to be 0.67. This is close to the value reported by Devereux (1988). The parameter d is assumed to be equal to one. The indexation parameter is alternatively chosen to be 0, 0.5 and 1.

Using the parameterization just described, the model is solved to study the effects of real and monetary disturbances originating at home and abroad[6]. We examine the results of domestic disturbances first under the FER and the FLER and then turn to the transmission of foreign disturbances in the domestic economy under both exchange rate regimes.

As far as the domestic disturbances are concerned, following Mundell (1963), one may consider these disturbances as the deliberate instruments of fiscal and monetary policies, and therefore one may want to maximize their effect on the economy. However, given the stochastic assumption that the shocks have a mean of zero and are serially uncorrelated, these policies would have to be regarded as unanticipated and temporary (Marston, 1982). In that case the objective would be to minimize their impact on the economy. Although the real and the monetary shocks influence most of the economic variables in a country under alternate exchange rate regimes, following the literature on the choice of an appropriate exchange rate regime, we examine the effects of the shocks on output only. To put it succinctly, the analysis mainly concentrates on the transmission of real and monetary disturbances on output under both exchange rate regimes, though the response of other variables, viz. prices and exchange rates is also discussed.

[6]The partial variances reported in Tables 2-6 are calculated by using the following procedure: Let $Y_t^a - \overline{Y}^a = Ku_t^{yc}$, where K is a coefficient. Taking expectation on both sides gives $E(Y_t^a - \overline{Y}^a)^2 = E[K^2(u_t^{yc})^2] = K^2E(u_t^{yc})^2$. Replacing $E(u_t^{yc})^2$ by σ_u^2 and normalizing the variance of disturbances ($\sigma_u^2 = 1$) in the above equation yields what we call the partial variance. A similar procedure is followed with respect to other disturbances.

3.1 Disturbances Originating at Home

First we consider domestic disturbances, that is disturbances that originate in Germany, for the case when there is no wage indexation (b = 0), partial wage indexation (b = 0.5) and then full wage indexation (b = 1). When there is no wage indexation, the effects of both real and monetary disturbances correspond closely to those reported in Mundell (1963) and Marston (1984). It is clear from Tables 2 and 3 that an *aggregate demand disturbance* in country a (Germany) leads to greater changes in output in the FER regime than in the FLER regime. An increase in aggregate demand increases domestic output and prices. As a result of an incipient rise in the domestic interest rate, there is an appreciation pressure on both Mark exchange rates. But intervention in the foreign exchange market keeps the exchange rate fixed at the equilibrium level. However, under the FLER regime, an increase in the domestic interest rate leads to an appreciation of the domestic currency which reduces the increase in the aggregate demand for output. Thus there is less output variation under the FLER in Germany.

When the indexation is partial (b = 0.5) or complete (b = 1), we find that the aggregate domestic demand disturbance causes less variation in output in the FER regime than in the case without indexation. A positive demand disturbance leads to an outward shift in the aggregate demand. Indexation affects the output supply curve only. The higher the degree of indexation, the steeper the slope of the supply curve. For a given shift in the demand curve, the steeper the slope of the supply curve, the lower the increase in equilibrium output. Therefore, the higher the degree of indexation, the lower the output variation in Germany. Under the FLER, the increase in aggregate demand leads to an appreciation of the mark exchange rate. Appreciation of the exchange rate affects both the demand and the supply curve of output. It lowers the demand and therefore the demand curve shifts less to the right than in the FER case. This is a stabilizing effect of the FLERs. The output supply curve is subject to two influences. Indexation steepens the supply curve and thus lowers output variance. Appreciation shifts the supply curve to the right and thus increases output variance. The conflicting changes both depend on the degree of indexation. The results indicate that the rightward shift in the supply curve dominated.

As far as the *monetary shocks* are concerned, it is clear from Table 2 that they have no effect under the FER. An increase in the supply of money puts pressure on both mark exchange rates, but the intervention in the exchange market keeps the

exchange rates fixed and results in an offsetting capital outflow to both countries b and c (France and the United States). The resulting capital inflow from Germany drives up the money stock and pushes down the interest rate in France. With the exchange rate remaining fixed, a fall in the interest rate results in an offsetting capital outflow both to Germany and to the United States. As a result, the money stock in Germany rises again, though not as high as before. This again exercises pressure on the interest rate and on the exchange rate. With the FER, a fall in the interest rate drives out the excess money stock both to France and to the United States and so on. This process continues until equilibrium in the money market is established and the total initial excess stock of money has been completely transferred to the United States. The United States, being the large country and with its interest rate remaining fixed, simply absorbs the capital flows from both Germany and France. Our results correspond to Mundell's (1968) treatment of a small country facing a large country. Though we have two small countries and not just one small country facing a large country, the two countries put together are still too small to influence the large country, the United States. In the FLER regime, on the contrary, a monetary shock leads to a depreciation of the domestic currency and to an increase in output as well as in domestic prices. Thus as in Mundell (1963) and Marston (1982), a domestic monetary shock causes variations in output only under the FLER. As opined by Mundell (1968), it may be noted that a monetary expansion at home raises output in the domestic economy and lowers output abroad, and for this reason it is sometimes assailed as a beggar-my-neighbour policy. The depreciation of the mark exchange rate relative to the franc increases the mark prices of the foreign (French) goods. The higher foreign prices by themselves cause an increase in the demand for Germany's goods and reduce the demand for France's goods. Thus the monetary expansion in Germany produces a positive effect on its own output and a negative effect on France's output in the FLER regime.

With indexation b = 0.5 or b = 1.0, the monetary shock in Germany still leaves the aggregate demand and supply unaffected under the FER. Therefore, for all degrees of indexation output is completely insulated under the FER (Table 2). In the FLER regime, in contrast, monetary shocks do change equilibrium output and with indexation they do it both via demand and supply changes. Depreciation of the exchange rate pushes up aggregate demand because of the sensitivity of aggregate demand to relative prices and real interest rates. With indexation, there is both a steepening of the supply curve and a leftward shift in

the supply because depreciation leads to a rise in indexed nominal wages. Thus under indexation, as in the case of no indexation, the FLER regime causes both prices and output to vary (Tables 2 and 3). Prices of domestic output rise further than under no indexation. The steepening and the leftward shift in the aggregate supply curve reinforce each other. The two exchange rate regimes also clearly differ with respect to price and exchange rate behaviour, since prices and exchange rates are affected by monetary shocks only in the FLER regime and not in the FER regime.

Thus, as in Marston (1984), while the FER regime fares well in insulating the domestic economy from monetary shocks regardless of wage indexation, the FLER regime, short of full indexation, performs better in the case of aggregate demand disturbances. With full indexation, the FER regime performs well in reducing the variability of output from demand shocks.

3.2 Transmission of Disturbances from b

Foreign disturbances affect the domestic country through the changes in foreign output which directly influence domestic aggregate demand, through changes in foreign prices which will lead to substitution with the domestic good, and through changes in foreign interest rate which lead to changes in the exchange rate and hence changes in the aggregate demand.

Irrespective of the degree of wage indexation, a *monetary expansion* in France leads to pressure on France's exchange rate. Under the FER, the monetary expansion in France results in an offsetting capital outflow both to Germany and to the United States. As a result, the money stock in Germany goes up. With the exchange rate remaining fixed, a fall in the German interest rate results in an offsetting capital outflow both to France and to the United States. The money stock in France rises again. This again exerts pressure on the exchange rate. With the FER, again a fall in the interest rate drives out the excess money stock both to Germany and to the United States and so on. This process continues until the equilibrium in the money market is re-established and the total initial excess stock of money has been completely transferred to the United States. Therefore, the monetary shock in France leaves output and prices in Germany (Tables 2 and 3) unchanged.

However, the FLER regime does not provide insulation against a monetary shock coming from France. Regardless of the degree of indexation, a monetary expansion in France leads to a depreciation of France's currency as well as to an increase in output and in domestic prices in France. An increase in the French money stock leads to an appreciation of the mark exchange rate relative to the franc which lowers the mark prices of the foreign (French) goods. The lower foreign prices by themselves cause a reduction in the demand for Germany's goods. Thus, the monetary expansion in France produces a negative effect on output in Germany in the FLER regime, while there is no such effect in the FER regime. Indexation steepens the slope of the supply curve and lowers output variance. Appreciation shifts the supply curve to the right and further reduces output variance. Thus, the results on the whole indicate that, regardless of the degree of wage indexation, the FER regime is more effective in insulating German output from French monetary shocks than the FLER regime.

Consider the effect of *demand disturbances.* Irrespective of the degree of wage indexation, an increase in aggregate demand in France increases the output and the prices in that country under the FER regime. On the other hand, in the FLER regime, an appreciation of the franc exchange rate dampens the overall increase in aggregate demand in France. As far as Germany is concerned, the demand disturbance in France causes both prices and output to increase under both exchange rate regimes (Tables 2 and 3). The increased levels of output, prices and interest rates in France imply pressure on the exchange rate. In the FER regime, the increase in French output and prices causes prices and output in Germany to vary. In the FLER regime, the increased levels of French output and prices also stimulate demand for German commodities. However, the depreciation of the mark exchange rate against the franc and the appreciation of the mark exchange rate against the dollar help to reduce the variability of output and prices. Thus there are less output and price variations in case of the FLER regime (Tables 2 and 3). The results on the whole indicate that, while the FER regime offers perfect insulation from the monetary shocks coming from the union partner France, the FLER regime, with b = 0 and 0.5, is highly effective in dampening a real shock emanating from France, the union partner of Germany. When b = 1, the FER regime reduces the variability of output from real shocks. As the commentator points out, this ability of the FLER regime is lost for high degrees of indexation.

3.3 Disturbances from Country c

Since the behaviour of the United States is not modelled explicitly here, unlike the analysis presented in the preceding sections, the shocks coming from the United States are traced through output shocks, price shocks and interest rate shocks rather than through what we so far called real and monetary shocks.

Regardless of the degree of indexation at home, in the FER regime, a rise in the United States output increases the output in Germany. Indexation affects the supply curve only. An increase in the degree of indexation steepens the slope of the supply curve. As a result, the output rise in Germany is reduced. Therefore, the higher the degree of indexation, the lower the output variance in Germany. In the FLER regime, the output in Germany is increased as well. Whether the output variance is higher or lower in the FLER regime, depends on whether the mark appreciates or depreciates. The higher domestic interest rate due to an increase in domestic transactions leads to an appreciation. Hence, the output variation in Germany is less in the FLER regime than in the FER regime. With full indexation, the variability of output is identical in both regimes.

Under the FER, an increase in foreign prices raises domestic output. The variability in prices would be less in the FLER regime, if the exchange rate would appreciate in response to the increase in prices abroad. As in the case of output disturbance, with b = 0 and 0.5, the increase in output and therefore the increase of the interest rate ensures that the exchange rate appreciates with respect to the dollar, which in turn ensures that the variance in output is less in the FLER regime than in the FER regime. When b = 1, the output variation is identical in both regimes.

As far as the effect of an increase in the United States' interest rate is concerned, in the FER regime, a rise in the United States' interest rate lowers the domestic (Germany's) output through the real interest rate effect on aggregate demand. An increase in the United States' interest rate will lead to an increase in the German interest rate, reduce the demand for German output and thus reduce equilibrium output in Germany. Indexation affects the output supply only. The higher the degree of indexation, the steeper the slope of the supply curve. For a given shift in the demand curve, the higher the degree of indexation, the lower the output variance in Germany.

In the FLER regime, higher interest rates in country c raise interest rates in country a and depreciate the mark exchange rate with respect to the US dollar. Thus, under FLER, there are two opposing forces on output. The rise in domestic interest rates lowers the demand for output while the depreciation increases it. Given the present choice of parameter values, without indexation there is an increase in output. Now, indexation both steepens the supply curve and shifts it to the left. The leftward shift in the supply curve tends to reduce equilibrium output. The steepening tends to reduce a demand induced change in output. Due to the leftward shift in the supply curve, an increase in output with no indexation may turn into a decrease in output when indexation has passed a certain initial level. Beyond this critical level a higher degree of indexation makes the decrease larger. Under the present choice of parameter values, with zero and/or partial indexation, the output variation is less in the FLER regime than in the FER regime. With full indexation of wages, the variability of output is less in the FER regime than in the FLER regime.

4 Concluding Remarks

This paper has examined the international transmission of 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 both the FER and FLER regimes.[7] It has drawn insights from a theoretical three-country model and it has provided some quantitative evidence on the consequences of a variety of shocks for small countries under different exchange rate regimes and degrees of indexation. One of the important results that emerges from the analysis is the independence of exchange rates between Germany and France from shocks in the United States (Table 4). This independence is due to the assumed symmetry between Germany and France. As far as domestic disturbances are concerned, the FER is effective in insulating the economy from monetary shocks and the FLER regime, short of full indexation, performs well in case of real shocks. As far as foreign disturbances coming from France are concerned, the FER regime insulates

[7]Apart from the results reported in this paper, a sensitivity test was also performed for the following two assumptions. (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 the price elasticities are higher in country b than in country c. The results, however, do not change our main conclusions.

the domestic (German) economy from monetary shocks coming from France and the FLER regime, with zero and/or partial indexation, again dampens the impact of real disturbances in France on German output. Although both the FER as well as the FLER regimes show output variation in the small countries due to output, price and interest rate disturbances coming from the United States, the FLER regime, with b = 0 and 0.5, provides less output variation than the FER regime. With full indexation of wages, while the FER regime dampens the impact of interest rate shocks on domestic output, the effects of output and price shocks coming from the large country, the United States, on the variability of output in the small countries are identical in both regimes.

Appendix
Definition of Coefficients used in the Derivation

$$I = \alpha_1\theta^* b^* h_{22} + \alpha_3 h_{11} + \alpha_4 + \alpha_4 + \theta(1 - bh_{11}) \quad (40)$$

$$J = \alpha_1\theta^*(1 - b^* h_{21}) - h_{12}(\alpha_3 - \theta b) + \alpha_4 \quad (41)$$

$$K = \alpha_1\theta^* b^* h_{22} - (\alpha_3 - \theta b)(h_{12} + h_{12}) + \alpha_3 + \alpha_4 + \alpha_5 \quad (42)$$

$$L = \alpha_1\theta^* b^* h_{23} - \alpha_3 + h_{13}(\alpha_3 - \theta b) - \alpha_5 \quad (43)$$

$$M = \alpha_1\theta^* b^* h_{23} + h_{13}(\alpha_3 - \theta b) - \alpha_5 \quad (44)$$

$$N = \beta_1 - \theta b(h_{12} + h_{13}) \quad (45)$$

$$Q = 1 + \theta - \theta b h_{11} \quad (46)$$

$$R = \theta b h_{12} \quad (47)$$

$$S = \theta b h_{13} \quad (48)$$

$$T = S - \beta_1 \quad (49)$$

$$XY = NI + QK \quad (50)$$

$$YZ = JN + RK \quad (51)$$

$$XY_1 = (XY.XY - YZ.YZ)N \quad (52)$$

$$A_4 = XYQ - YZR \quad (53)$$

$$A_2 = A_4(TK - LN) \quad (54)$$

$$YZ_1 = A_2 - T(XY.XY - YZ.YZ) \quad (55)$$

$$A_3 = YZQ - XYR \quad (56)$$

$$A_1 = A_3(TK - LN) \quad (57)$$

$$A_5 = SK - MN \quad (58)$$

$$A_6 = Q(YZ + XY) - R(XY + YZ) \quad (59)$$

$$A_7 = \alpha_3 N - \theta b N - \theta b K \quad (60)$$

$$A_8 = \alpha_1 N - K - N \quad (61)$$

$$A_9 = \beta_1 K - \alpha_1 N \quad (62)$$

$$XY_2 = XY_1(XY_1 - YZ_1) \quad (63)$$

$$YZ_2 = (A_1 + XY_1)^2 + YZ_1(XY_1 - YZ_1) \quad (64)$$

$$A_{10} = \alpha_1 N A_3 - (K + N)A_4 \quad (65)$$

$$A_{11} = \alpha_1 N A_4 - (K + N)A_3 \quad (66)$$

$$A_{12} = A_1 + XY_1 \quad (67)$$

$$A_{13} = XY_1 - YZ_1 \quad (68)$$

$$A_{14} = TK - LN \tag{69}$$

$$A_{15} = XY_2 - YZ_2 \tag{70}$$

$$A_{16} = \alpha_1 NYZ - XY(K+N) \tag{71}$$

$$A_{17} = XY\alpha_1 N - YZ(K+N) \tag{72}$$

$$A_{18} = XY_1 + A_1 + A_{13} \tag{73}$$

$$A_{19} = \alpha_1 \theta bNA_3 + A_7 A_4 \tag{74}$$

$$A_{20} = \alpha_1 \theta bNA_4 + A_7 A_3 \tag{75}$$

$$A_{21} = YZ(\alpha_1 \theta bN) + XYA_7 \tag{76}$$

$$A_{22} = XY(\alpha_1 \theta bN) + YZA_7 \tag{77}$$

$$A_{23} = (XY.XY - YZ.YZ) \tag{78}$$

$$A_{24} = A_{15}A_{23} \tag{79}$$

$$A_{25} = (II - JJ) \tag{80}$$

$$A_{26} = (YZ + XY)\theta(1 - bh_{11}) - (XY + YZ)\theta bh_{12} \tag{81}$$

$$A_{27} = \theta(1 - bh_{11}) \tag{82}$$

$$A_{29} = 2XY_1 + A_1 - YZ_1 \tag{83}$$

$$A_{30} = (J + I) \tag{84}$$

$$B_1 = A_{14}A_{26} - SA_{23} \tag{85}$$

$$B_2 = A_6 A_{18} B_1 \tag{86}$$

$$B_3 = A_{18}(A_9 A_6 - \beta_1 A_{23}) \tag{87}$$

$$B_4 = A_{18}(A_5 A_6 - SA_{23}) \tag{88}$$

$$B_5 = A_{14}(A_{12} + A_{13})(YZ + XY)(A_4 + A_3)(A_{27} - R) \tag{89}$$

$$B_6 = A_{15}(XYA_{27} - YZR) - [(A_4 - A_3)(A_1 + YZ_1)(RA_{23})] \tag{90}$$

$$B_7 = (A_4 A_{12} + A_3 A_{13})SA_{23} \tag{91}$$

$$B_8 = A_{15}(YZA_{27} - XYR) - [(A_3 - A_4)(A_1 + YZ_1)(RA_{23})] \tag{92}$$

$$B_9 = (A_3 A_{12} + A_4 A_{13})SA_{23} \tag{93}$$

$$B_{10} = A_{14}(A_{12} + A_{13})(YZ + XY)[(KA_4 - A_{23} + KA_3)(A_{27} - R)] \tag{94}$$

$$B_{11} = KA_{15}(XYA_{27} - YZR) - [K(A_4 - A_3) - A_{23}](A_1 + YZ_1)RA_{23} \tag{95}$$

$$B_{12} = [KA_4 A_{12} + KA_3 A_{13} - (A_{23}A_{12})]SA_{23} \tag{96}$$

$$B_{13} = KA_{15}(YZA_{27} - XYR) \tag{97}$$

$$-[K(A_3 - A_4) + A_{23}](A_1 + YZ_1)RA_{23}$$

$$B_{14} = [KA_3A_{12} + KA_4A_{13} - (A_{23}A_{13})]SA_{23} \quad (98)$$

$$C_1 = A_6A_{14}(YZ + XY)A_{18} \quad (99)$$

$$C_2 = A_{15}(YZ + XY) \quad (100)$$

$$C_3 = A_{14}(YZ + XY)B_3 \quad (101)$$

$$C_4 = A_{14}(YZ + XY)B_4 \quad (102)$$

$$C_5 = A_{14}[A_4(YZA_{12} + XYA_{13}) + A_3(XYA_{12} + YZA_{13})] + XYA_{15} \quad (103)$$

$$C_6 = A_{14}[A_3(YZA_{12} + XYA_{13}) + A_4(XYA_{12} + YZA_{13})] + YZA_{15} \quad (104)$$

$$C_7 = A_{14}[(KA_4 - A_{23})(YZA_{12} + XYA_{13}) + KA_3(XYA_{12} + YZA_{13})] + XYKA_{15} \quad (105)$$

$$C_8 = A_{14}[KA_3(YZA_{12} + XYA_{13}) + (KA_4 - A_{23})(XYA_{12} + YZA_{13})] + YZKA_{15} \quad (106)$$

$$D_1 = A_9A_6 - \beta_1A_{23} \quad (107)$$

$$D_2 = A_5A_6 - SA_{23} \quad (108)$$

$$D_3 = K(A_4A_{12} + A_3A_{13}) - A_{12}A_{23} \quad (109)$$

$$D_4 = K(A_3A_{12} + A_4A_{13}) - A_{12}A_{23} \quad (110)$$

$$D_5 = \alpha_3A_{30}(Q - R) + \beta_1(II - JJ) \quad (111)$$

$$D_6 = MA_{30}(Q - R) + S(II - JJ) \quad (112)$$

$$D_7 = \alpha_2N(B_2 + A_{15}A_{26}) \quad (113)$$

$$D_8 = B_3B_1 + A_9A_{15}A_{26} \quad (114)$$

$$D_9 = B_4B_1 + A_5A_{15}A_{26} - A_{15}SA_{23} \quad (115)$$

$$D_{10} = N(B_5 + B_6 - B_7) \quad (116)$$

$$D_{11} = N(B_5 + B_8 - B_9) \quad (117)$$

$$D_{12} = (B_{10} + B_{11} - B_{12}) \quad (118)$$

$$D_{13} = (B_{10} + B_{13} + B_{14}) \quad (119)$$

$$E_1 = \alpha_2N(C_1 + C_2) \quad (120)$$

$$E_2 = C_3 + A_9C_2 \quad (121)$$

$$E_3 = C_4 + A_5C_2 \quad (122)$$

$$E_4 = N(A_4 - A_3)A_{12} \quad (123)$$

$$E_5 = N(A_3 - A_4)A_{12} \quad (124)$$

$$E_6 = [K(A_4 - A_3) - A_{23}]A_{12} \quad (125)$$

$$E_7 = [K(A_3 - A_4) + A_{23}]A_{12} \quad (126)$$

$$E_8 = N(A_4A_{12} + A_3A_{13}) \quad (127)$$

$$E_9 = N(A_3A_{12} + A_4A_{13}) \quad (128)$$

$$E_{10} = \alpha_2 A_{30}(A_{27} - R) \quad (129)$$

$$E_{11} = \alpha_3 A_{30}(A_{27} - R) \quad (130)$$

$$E_{12} = MA_{30}(A_{27} - R) + SA_{25} \quad (131)$$

$$E_{13} = IA_{27} - JR \quad (132)$$

$$E_{14} = JA_{27} - IR \quad (133)$$

$$E_{15} = \alpha_2 A_{30}(Q - R) \quad (134)$$

$$E_{16} = IQ - JR \quad (135)$$

$$E_{17} = JQ - IR \quad (136)$$

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Table 1:

Parameter Values

$h_b = 1.00$	$n_{xb} = 1.15$	$n_{xc} = 1.56$	$n_{mb} = 1.41$
$h_c = 1.00$	$n_{mc} = 1.67$	$h_{11} = 0.70$	$h_{12} = 0.15$
$h_{13} = 0.15$	$\theta = 0.67$	$\alpha_1 = 0.15$	$\alpha_2 = 0.15$
$\alpha_3 = 0.10$	$\alpha_4 = 0.234$	$\alpha_5 = 0.345$	$\beta_1 = 0.20$

Table 2:

The Effects of Shocks on Germany's Output

Disturbance	Indexation					
	FER			FLER		
	0.0	0.5	1.0	0.0	0.5	1.0
u_t^{yc}	0.01011	0.00582	0.00086	0.00048	0.00062	0.00086
u_t^{ic}	0.00449	0.00259	0.00038	0.00167	0.00016	0.00086
u_t^{pc}	0.04893	0.01941	0.00038	0.00232	0.00044	0.00038
u_t^{da}	0.29119	0.18024	0.04910	0.01995	0.03673	0.05765
u_t^{db}	0.01709	0.00707	0.00071	0.00214	0.00023	0.00083
u_t^{ma}	0.0	0.0	0.0	0.08910	0.02599	0.00018
u_t^{mb}	0.0	0.0	0.0	0.00009	0.00002	0.00003

The figures reported are partial variances.

Table 3:

The Effects of Shocks on Germany's Prices

Disturbance	Indexation					
	FER			FLER		
	0.0	0.5	1.0	0.0	0.5	1.0
u_t^{yc}	0.02252	0.03922	0.08469	0.00107	0.00085	0.00058
u_t^{ic}	0.01001	0.01743	0.03764	0.00372	0.00880	0.02032
u_t^{pc}	0.10901	0.24212	0.64961	0.00517	0.01073	0.02267
u_t^{da}	0.64868	1.02127	1.90906	0.02729	0.01270	0.00208
u_t^{db}	0.03806	0.09586	0.31187	0.00277	0.00676	0.01328
u_t^{ma}	0.0	0.0	0.0	0.22887	0.39635	0.69444
u_t^{mb}	0.0	0.0	0.0	0.00010	0.00020	0.00000

The figures reported are partial variances.

Table 4:
The Effects of Shocks on the Exchange Rate
between Germany and France

	Indexation		
Disturbance	0.0	0.5	1.0
u_t^{yc}	0.0	0.0	0.0
u_t^{ic}	0.0	0.0	0.0
u_t^{pc}	0.0	0.0	0.0
u_t^{da}	0.88294	0.84377	0.79720
u_t^{db}	0.88294	0.84377	0.79720
u_t^{ma}	0.84995	0.77793	0.69444
u_t^{mb}	0.84995	0.77793	0.69444

The figures reported are partial variances.

Table 5:
The Effects of Shocks on the Exchange Rate
between Germany and the United States

	Indexation		
Disturbance	0.0	0.5	1.0
u_t^{yc}	0.07446	0.07315	0.07123
u_t^{ic}	0.24072	0.21870	0.18797
u_t^{pc}	0.36039	0.38750	0.42956
u_t^{da}	1.90277	1.85188	1.78508
u_t^{db}	0.19339	0.19561	0.19643
u_t^{ma}	1.01073	0.87232	0.69444
u_t^{mb}	0.00696	0.00270	0.00000

The figures reported are partial variances.

Table 6:
The Effects of Shocks on Reserve Flows in Germany

	Indexation		
Disturbance	0.0	0.5	1.0
u_t^{yc}	0.06281	0.07525	0.10257
u_t^{ic}	0.13475	0.14660	0.17099
u_t^{pc}	0.30402	0.39863	0.61856
u_t^{da}	1.80911	2.05959	2.57052
u_t^{db}	0.10615	0.15498	0.28286
u_t^{ma}	1.00000	1.00000	1.00000
u_t^{mb}	0.0	0.0	0.0

The figures reported are partial variances.