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Real Exchange Rates in the 1970s

Louka T. Katseli

ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

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Introduction

There is by now a substantive literature and a growing consensus on the failure of the Purchasing Power Parity (PPP) doctrine to explain exchange rate movements in the 1970s. With the advent of floating exchange rates PPP was rediscovered and presented as a simple and potentially powerful theory of exchange rate determination only to be reburied under a strong wave of criticism. The main objections were equivalent to those which had been raised in the 1920s[1] and included the tenuous empirical validity of perfect commodity arbitrage and the non-comparability of general price indices due to weighting and/or productivity differences; they pointed to the predominance of non-monetary disturbances that can substantially alter the equilibrium terms of trade among countries; they finally highlighted the role of expectations, and potentially asymmetric behavior of governments and/or private market participants in asset and good markets whose actions can produce "overshooting" phenomena.[2]

This latest round of debate on the theoretical and empirical validity of PPP has raised a number of interesting and still unresolved questions that focus explicitly on the role of the real exchange rate in macroeconomic adjustment.

Real exchange rates have moved differently across countries both as a consequence of structural differences and policy responses. The origin of the shocks has also varied. In some cases the predominant shocks originated in the home country: increases in domestic costs of production due to growing government budget deficits adversely affected international competitiveness through real appreciation of the exchange rate. Careful management of the nominal exchange rate through a policy of mini-devaluations has in some instances mitigated these effects. Alternatively, in countries with open financial markets, the real appreciation of the currency has occasionally been dampened due to actions of private market participants who diversified internationally in light of ; expected nominal depreciation of the currency.[3]

In other cases the origin of the disturbance was external to the particular economy: confronted with rising foreign prices some Central Banks appreciated their effective nominal exchange rates in an attempt to insulate the domestic economy from external inflationary pressures. Nominal appreciation of the exchange rate in the face of external price increases could also be consistent with private market behaviour where agents perceive the deterioration of the terms of trade as a permanent improvement in international competitiveness. More often, however, at least among smaller European countries, increases in foreign prices have been transmitted to domestic prices through substitution and income effects in consumption or production. This process could even be accompanied by exchange rate depreciation if the rise of internal prices exceeds that of traded goods.[4] Finally, changes in nominal exchange rates among hard currencies have led to changes in effective exchange rates which have in turn been transmitted to domestic prices and, in the case of countries with market power, to the foreign currency price of exports.[5]

Thus real exchange rate movements reflect different economic processes which result from the interaction of private market participants and policy authorities. Even in those cases where real exchange rates have remained roughly constant, it is interesting to analyze the economic forces behind the process of real exchange rate determination. Such analysis can highlight the effectiveness of exchange rate policy and can potentially illuminate the fundamental reasons for alternative targets in the exercise of exchange rate policy. Thus in a country where nominal exchange rate devaluation quickly raises domestic prices by the full extent of the devaluation, an active exchange rate policy can only become an instrument of anti-inflation policy rather than balance-of-payments adjustment. Alternatively, if the speed of adjustment is low, nominal exchange rate policy can potentially become a useful instrument of external balance.

In countries where nominal exchange rates are market determined, the transmission from nominal exchange rate movements to relative prices and from prices to exchange rates can highlight the role of the current account in the process of exchange rate determination. In a rational expectations framework, the instantaneous adjustment of the nominal exchange rate following a given disturbance will critically depend on expectations about the movement of relative prices. Similarly the dynamic path of the nominal exchange rate to its new equilibrium level will depend on the actual and expected movement of the real exchange rate which determines the current account and hence the rate of accumulation of foreign assets.[6]

In light of these considerations, this paper presents a comparative analysis of the implied linkages between nominal exchange rates and relative prices for thirteen industrialized countries during the 1974-1980 period of floating rates. Section 1 highlights the theoretical differences between two commonly-used indices of real exchange rate movements, namely the terms of trade and the relative price of traded to non-traded goods. This is done in a pure two-country, four-good trade model following the work by Bruno

(1976), Jones (1979), Katseli (1980) and more recently Srinivasan (1982). The model is solved for the equilibrium terms of trade and relative price of nontraded goods in response to a number of disturbances in the home or foreign country. Even in the context of this stark framework, it can be readily seen that the movement of the two indices is not analytically equivalent so that the choice of index becomes crucially important for empirical work.

Section 2 provides a comparative study of the two relative price indices for thirteen OECD countries during the period of floating rates and analyzes their time series properties for that same period. The lack of any systematic correspondence in the movement of the two indices which is suggested in the theoretical analysis of Section 1 is also evident in the empirical findings of this section.

In Section 3 movements in the real exchange rate defined now as the relative price of nontraded to traded goods, are decomposed into movements of the nominal exchange rate, a foreign price and a domestic price component. The analysis of their time-series properties supports the view that in the floating-rate period there has not been a one to one correspondence between movements in exchange rates and prices as a simple PPP-view would maintain. Instead exchange rates have generally followed an AR1 process while prices all followed cyclical AR2 processes. This provides partial support to the theoretical argument that the process of exchange rate determination is qualitatively different from the process of relative price determination, and does not contradict the conventional hypothesis that exchange rates are determined in asset markets which clear faster than goods markets. Statistical exogeneity however, is harder to ascertain.

Section 4 investigates different patterns of statistical exogeneity among nominal exchange rates, domestic and foreign prices and simulates the implied adjustment to unexpected shocks in each of these variables for the OECD countries in the sample. The analysis highlights some of the observed differences of behavior and the appearance of vicious circles.

The last section of the paper summarizes the results.

1. The Equilibrium Real Exchange Rate: Alternative Interpretations

In static trade theory long-run equilibrium is usually identified with balance on current account.[7] The equilibrium real exchange rate is thus identified with the vector of relative prices that balances the current account (Katseli 1979a).

Depending on the object of the analysis most models of real exchange rate determination have focused either on the terms of trade or the relative price of traded to nontraded goods. In traditional two-country, two good models, the equilibrium real exchange rate has almost always been identified with the terms of trade.[8] Alternatively in models where non-traded goods play an important role in balance-of-payments adjustment, the terms of trade are usually assumed to be determined exogenously and traded goods are assumed to be perfect substitutes and thus aggregated into a composite good (Dornbusch 1973; Bruno 1976). Given the importance of nontraded goods and trade in differentiated products in most OECD countries (Krugman 1980), such restrictive assumptions are not necessarily warranted except for analytical purposes. It is important to realize that in the process of adjustment both relative prices are involved, i.e. the terms of trade and the relative price of traded to nontraded goods. This fundamental insight goes back to Pearce (1961) if not still earlier to Keynes (1930) and Ohlin (1929a; 1929b). Introduction of nontraded goods into a simple two-country model where each country is completely specialized in the production of a traded commodity, allows the relationship between the two-relative price indices in both flow and stock equilibrium[9] to be demonstrated clearly. The effects of different shifts such as technological change in either sector on both equilibrium relative prices can then be easily derived.

This is the structure of the theoretical model that is presented in this section. It is a static trade model where all goods are final and where there is only one tradeable private asset, money, that can be accumulated through the trade balance. All these assumptions could in turn be relaxed along the lines of recent papers (Katseli and Marion 1982; Obstfeld 1981; Giavazzi 1980). The objective here is not to present a complete list of factors that could affect the real exchange rate but rather to highlight the differences between the equilibrium properties of the two relative indices in the simplest general equilibrium model.

Each country is assumed to produce a nontraded good (H and H^*, where a "*" indicates the foreign country) using a fixed amount of sector-specific capital ($\bar{K}_h$ and $\bar{K}_h^*$) and labor (N) which is free to move between the nontraded and traded good sector in each country but not internationally. The two trading countries are assumed to be completely specialized with the home country producing an exportable commodity (X) and importing the foreign country's traded good (M). The assumption of complete specialization can be justified on grounds that the major OECD countries each produces a different bundle of products. It also makes the model solvable as it reduces the number of relative prices that need to be endogenously determined to three. Using the home country's exportable price as the numeraire[10] the relevant relative prices are the home and foreign country's relative prices of non-traded goods (P_h and P_h^*) and the terms of trade (P_m) between the two countries.

The exogenous shifts that are analyzed in the comparative-static exercises are increases in the stock of capital used by different sectors, representing capital-augmenting technical progress, increases in the desired real wage that could be attributed to rising degrees of unionization, changes in the marginal propensity to save which could result either from shifts in intertemporal preferences or from policy, and finally a money transfer from one country to the other. Money is assumed to be the only asset that constitutes private wealth.[11] Thus saving, which is equal to the trade balance, is also equal to the flow excess demand for money by the private sector. The effects of all disturbances on relative prices will be presented both on impact when the stock of money is given, but there is positive saving or dissaving in each country through the balance of payments, and the long-run where the actual money holdings equal their desired level and hence saving and the trade balance are zero.

The full model is set out and described below and a more detailed explanation of the workings of the labor and goods-markets follows.[12] A complete list of symbols is presented in Table 1.

Table 1: Notation

Asterisks refer to foreign variables denominated in foreign exchange.

Subscripts s and d attached to quantities refer to supplies or demands of goods, while subscript $i = x,m,h,h^*$ refers to sector-specific variables.

H - nontraded (home) good.

X - home country's exportable good.

M - foreign country's exportable (home-oountry's importable).

P_h - price of home country's non-traded good relative to exportable.

P_m - terms of trade (An increase in P_m is equivalent to a deterioration in the terms of trade of the home country).

K_i, $i = x,m,h,h^*$ - sector-specific capital used in each sector i.

A - shift parameter of labor supply function in each country.

W - real wage in terms of the exportable commodity.

N_i, $i = x,m,h,h^*$ - employment in each sector.

C - desired real consumption expenditures in terms of the home country's exportable.

λ - speed of adjustment of actual to desired money holdings.

k - inverse of velocity of circulation

$\lambda k = s$ - marginal propensity to save.

Y - real income in terms of the home country's exportable.

M - real money supply in terms of the home country's exportable.

The Model

$$H_s\,[P_h, P_m, K_h, A] - H_d[P_h, P_m, C] = 0 \tag{1}$$

$$H_s^*\,[P_h^*, P_m, K_h^*, A^*] - H_d^*\,[P_h^*, P_m, C^*] = 0 \tag{2}$$

$$X_s\,[P_h, P_m, K_x, A] - X_d\,[P_h, P_m, C] - X_d^*\,[P_h^*, P_m, C^*] = 0 \tag{3}$$

$$M_s^*\,[P_h^*, P_m, K_m^*, A^*] - M_d^*\,[P_h^*, P_m, C^*] - M_d[P_h, P_m, C] = 0 \tag{4}$$

$$C = Y - S \tag{5}$$

$$C^* = Y^* - S^* \tag{6}$$

$$Y = P_h H_s + X_s \tag{7}$$

$$Y^* = P_h^* H_s^* + P_m M_s^* \tag{8}$$

$$S = \lambda[kY - M] \tag{9}$$

$$S^* = \lambda^*[k^* Y^* - M^*] \tag{10}$$

Stock Equilibrium

$$X_s[P_h, P_m, K_x, A] - X_d[P_h, P_m, C] - P_m M_d\,[P_h, P_m, C] = 0 \tag{11}$$

As in Katseli (1980), equations (1) and (2) specify the equilibrium condition in the nontraded good markets of both countries, while equations (3) and (4) impose the overall equilibrium clearing conditions in the international market for the traded commodities X and M.

Equations (3) and (4) together imply that in flow equilibrium one country's deficit should be the other country's surplus.

The specification of the labor markets follows the work by Argy and Salop (1979) and Katseli and Marion (1982), where firms determine the demand for labor by equating the nominal wage to the value of the own marginal product of labor while the supply of labor in each sector is assumed to depend on the nominal wage divided by the expected price level ($\frac{W}{P^e}$); the expected price level (P^e) is assumed to be a function of the consumer price index. It is due to this assumption that the terms of trade enter the supply function of the nontraded goods. The shift parameter A represents exogenous movements in the supply of labor schedule. Appendix 1 gives a derivation of the functional forms for the supply curves presented in equations (1) and (2) and by extension (3) and (4).

Demand for home goods depends on the own relative price, the terms of trade and real consumption expenditures which is defined by equations (5) and (6). All goods are assumed to be gross substitutes and indifference curves homothetic.

Finally real output or income in terms of commodity X, is defined in equations (7) and (8) and real saving in equations (9) and (10). Desired saving is equal to the flow excess demand for money. In the absence of government debt or domestic money creation, the private sector accumulates money through the balance of payments.

A condition for stock equilibrium, characterized by a zero rate of asset accumulation, is equation (11).

By appropriate substitution of equations (5) to (10) in equations (1)-(4) and by invoking Walras law the model can be reduced to a system of three equations in three unknowns, namely the two relative prices of nontraded goods, P_h and P_h^*, and the relative price of imports, P_m. Table 1 reports the comparative static effects of **percentage changes in** each of the exogenous variables, K_h, K_x, K_h^*, K_m^*, A, A^* on P_h and P_m, holding the stock of money fixed. Table 2 also reports the effects on relative prices of a money transfer from the foreign country to the home country (i.e. when $\hat{M}^* = -\hat{M}$) and the effects of a change in the marginal propensities to save in both countries.

Table 2: Effects of Various Disturbances on Relative Prices Holding the **Real Money Stock, M, Fixed**

Disturbance	$\hat{K}_h$	$\hat{K}_x$	$\hat{K}_h^*$	$\hat{K}_m^*$	$\hat{A}$	$\hat{A}^*$	$\hat{M}^* = -\hat{M}$	ds	ds^*
$\hat{P}_h$	-	+	?	-	?	?	?	?	+
$\hat{P}_m$	?	?	?	-	?	?	?	+	+

In Appendix 2 it is shown that sufficient condition for local stability of the system is that the reduction in the labor supply due to increases in the expected **consumer price relative to the price of the exportable is adequately low.**

It can be seen from Table 2 that with few exceptions the movement of the two relative prices is hard to sign unambiguously. The results depend on the relative size of the structural parameters in the two countries such as the relative own and cross price elasticities of demand and supply for each good and the relative marginal propensities to consume. For convenience of the reader, Appendix 3 gives a complete listing of the solutions so that the existing ambiguities can be more easily interpreted.

A few general conclusions can be drawn which can be related to known results:

a. An increase in the capital stock used by the home country's non-traded good sector unambiguously lowers the relative price of nontraded goods. This result is well known from the growth and trade literature and is also derived in Bruno (1976). The opposite can be said for expansion of the capital stock in the home country's traded good sector. The effects of these disturbances however, on the equilibrium terms of trade are ambiguous depending on the relative size of the income and substitution effects in the demand for the three available goods.

b. Increases in the capital stock of the trading partner's nontraded good have ambiguous effects on P_h and P_m. The reason for this is that the ensuing decrease in the foreign country's relative price of nontraded goods causes substitution away from the traded goods at the same time that foreign income probably increases. It is not clear therefore if overall demand by foreigners for the two traded goods increases or not.

c. Contrary to the previous case, growth of the capital stock in the foreign country's traded good reduces the home country's relative price of non-traded goods and the relative price of importables. Expansion of supply of importables unambiguously reduces their price causing substitution away from the home country's nontraded and traded goods. Thus if we define the real exchange rate as the relative price of traded goods and the terms of trade as the relative price of exportables (that is the inverse of $\hat{P}_h$ and $\hat{P}_m$ respectively), it follows that trade-biased growth in the foreign country causes the home country's real exchange to depreciate and its terms of trade to improve.

d. A push for higher real wages in either country has as one would expect ambiguous effects on the relative price of goods. The outcome will depend once again on the relative size of the supply and demand elasticities.

e. The results from the transfer experiment are interesting in light of the Ohlin-Keynes insights and can be looked in conjunction with the ds experiment. If the home country's money supply is increased by the same amount as the reduction in the money supply of the trading partner, saving is reduced. As in the case of a reduction in the marginal propensity to save, the ensuing change on P_h depends on the marginal propensities to consume the home and exportable commodities. If m_h is sufficiently larger than m_x then P_h unambiguously increases. The effects on P_m are harder to ascertain. A reduction in saving unambiguously reduces P_m as consumption of both the nontraded good and the exportable rises in the home country. The effects however of a transfer which increases M in the home country depend not only on the home country's reaction but also on the foreign country. Hence as it is shown in Appendix 3 the relative size of both the home and foreign marginal propensities to consume is important.

The ambiguities that characterize the flow equilibrium solutions reappear in the stock equilibrium version which is characterized by a balanced current account and an endogenous money supply. In stock equilibrium the system consists of four equations in four unknowns and can be solved recursively as is shown in Appendix 4.

From the above it is evident that both the origin of any given disturbance and the choice of the relative index will determine the effects of any given real shock to what is called the "equilibrium real exchange rate." In the empirical section that follows the two indices will be approximated (a) by the relative price of foreign to domestic wholesale prices, a proxy for the relative price of traded goods between countries and hence the terms of trade and (b) by the price of traded goods relative to the value added deflator, a proxy for the relative price of traded to non-traded goods.[13]

2. Indices of Real Exchange Rates

An index usually used to describe the real exchange rate in empirical studies is the ratio of foreign to domestic wholesale prices expressed in a common currency (Branson, 1981). As wholesale prices exclude services, a major component of nontraded goods, they can be considered proxies of relative traded good prices and thus the terms of trade. Data for the construction of this index (R^w) come from the IMF[14] and are based on quarterly observations.

The R^{tn} index, i.e. the relative price of traded to nontraded goods, is constructed by deflating the home currency price of traded goods by the value added deflator which is used as a proxy for the price of nontraded goods. The home currency price of traded goods is calculated by taking a weighted average of export and import unit value indices for each country as these are given by the IMF, International Financial Statistics.

Figures 1 to 5 plot the two relevant indices for five major industrialized countries, namely the United States (A), Japan (J), Germany (G), United Kingdom (E) and France (F).

The United States is the only country which has experienced a continuous depreciation of its real exchange rate almost for the whole period regardless of the index which is used. The other countries' experience can be roughly subdivided into three sub-periods. During the first period which ends around the second quarter of 1974 the relative price of traded to nontraded goods increased while domestic wholesale prices rose fast. This trend is especially characteristic of Japan and Germany. The second period roughly extending from 1974 to 1978 is quite dissimilar across

Figure 1. Alternative Measures of Real Exchange Rates--United States

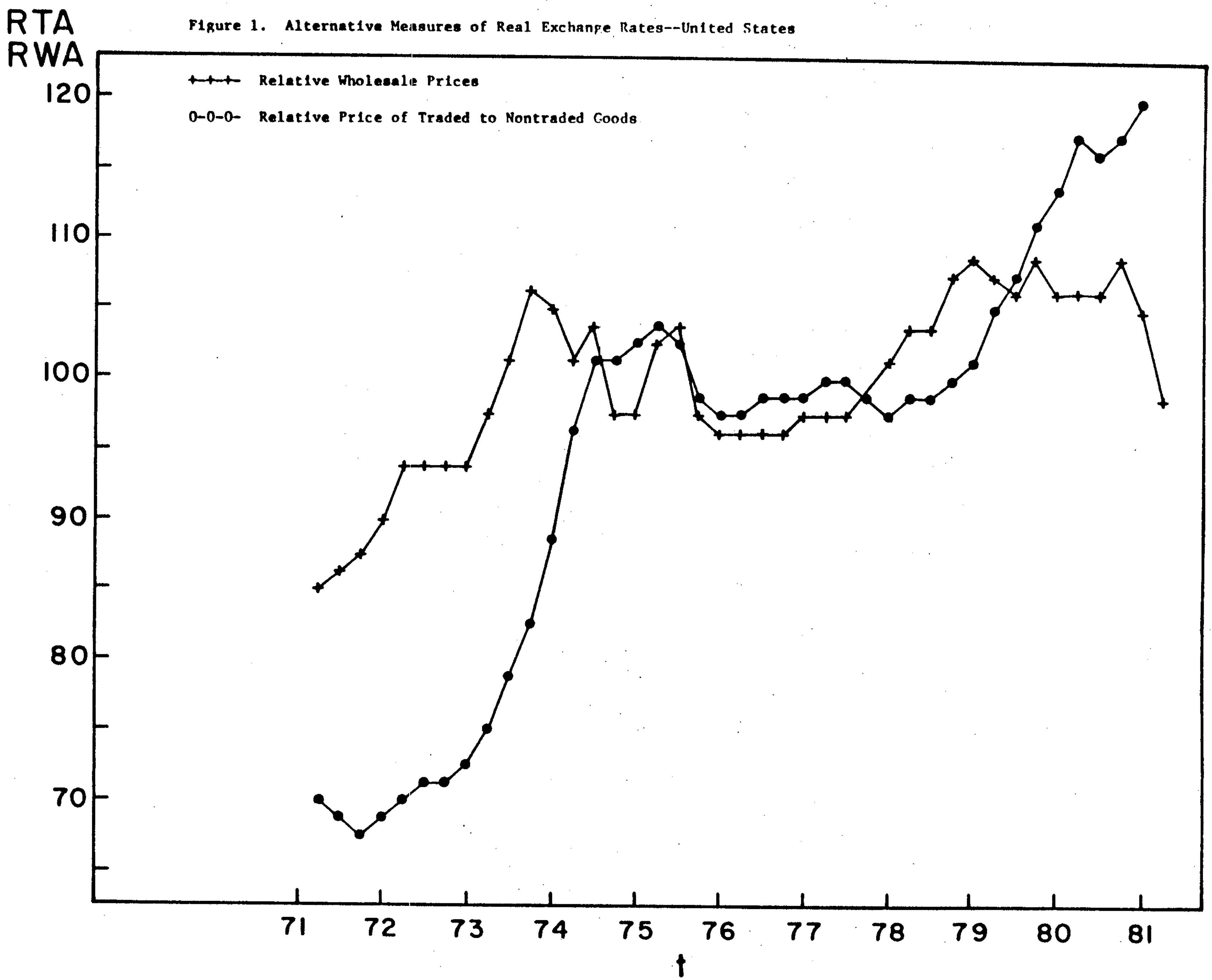


Figure 2. Alternative Measures of Real Exchange Rates--Japan

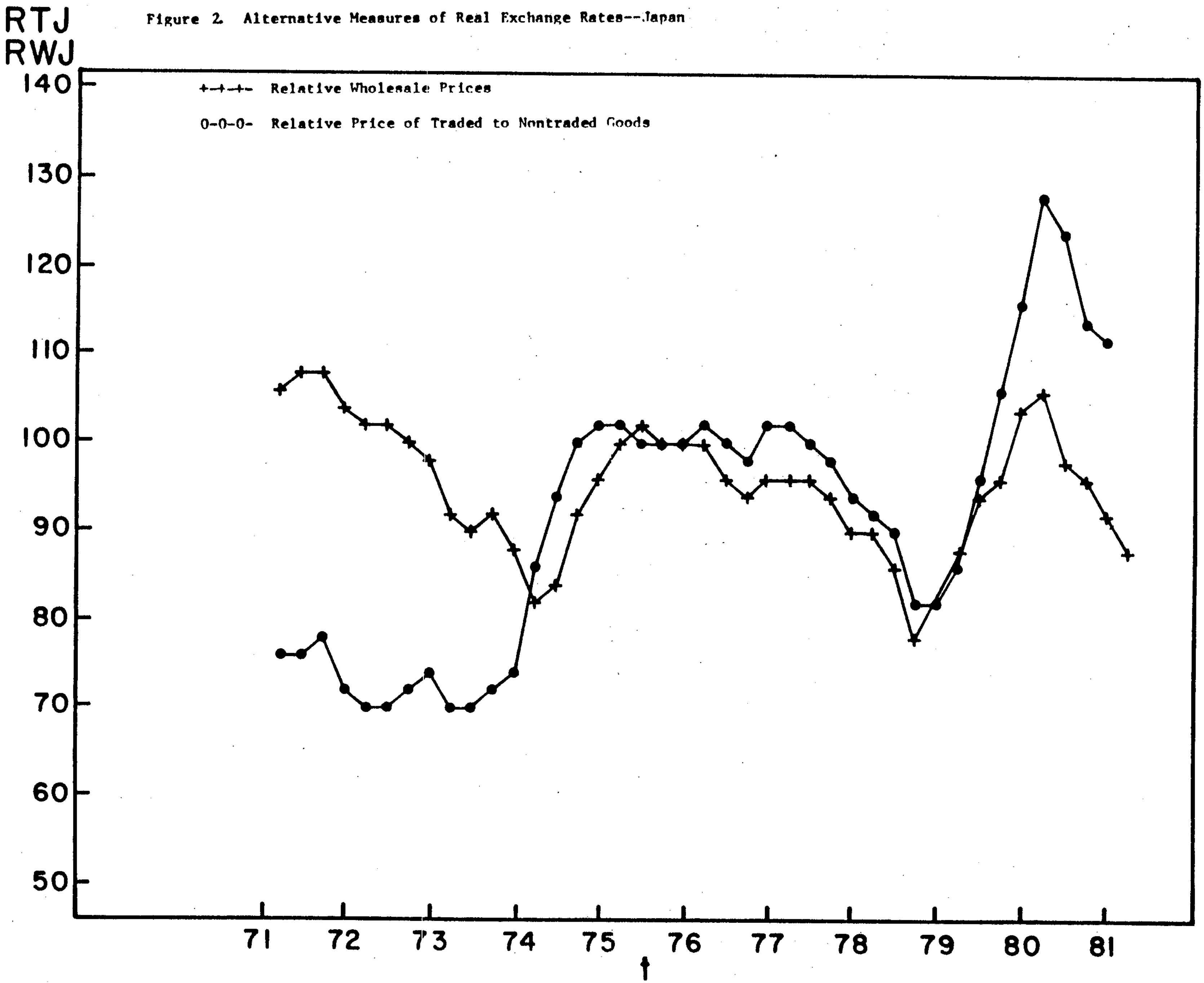


Figure 3. Alternative Measures of Real Exchange Rates--Germany

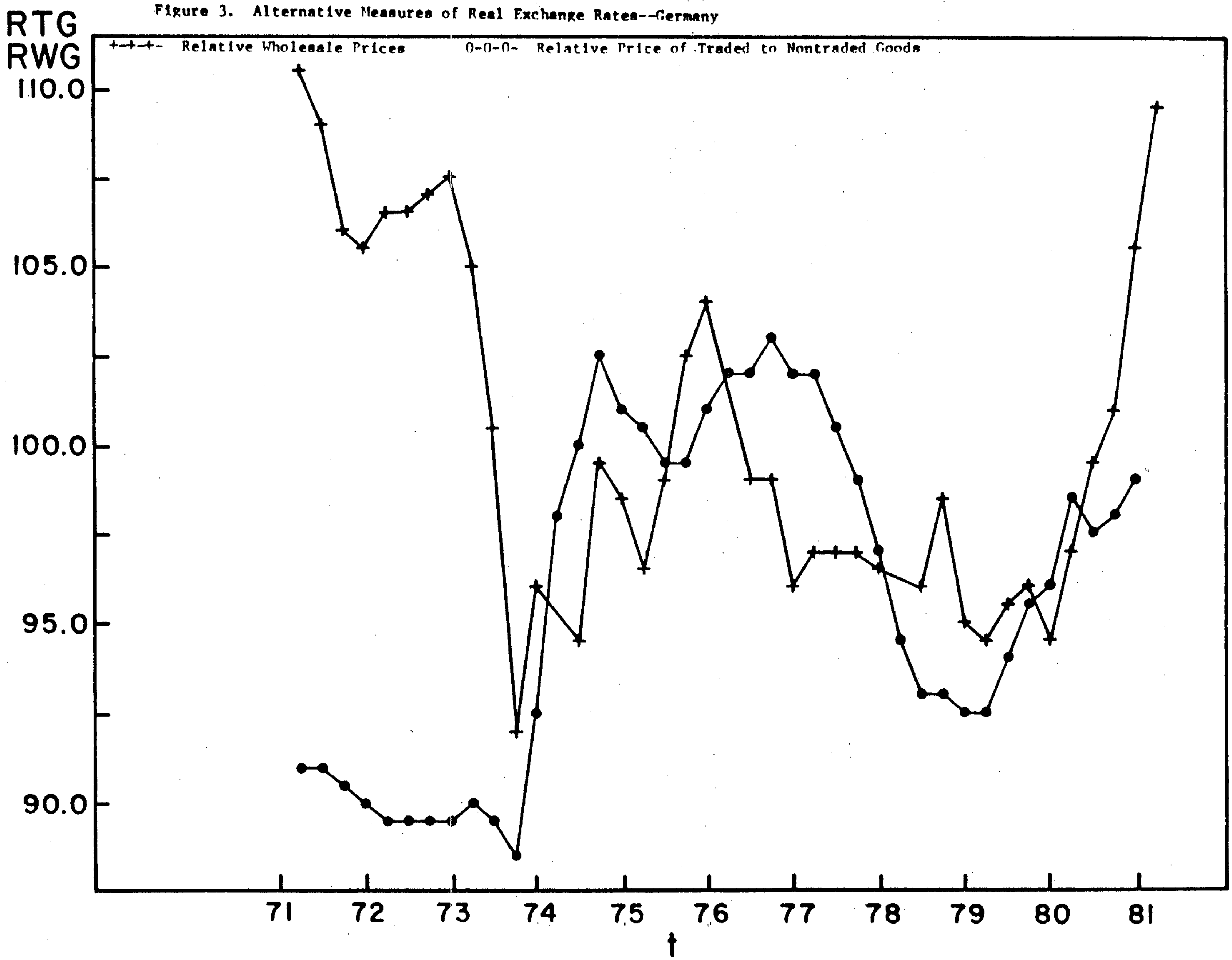


Figure 4. Alternative Measures of Real Exchange Rates--United Kingdom

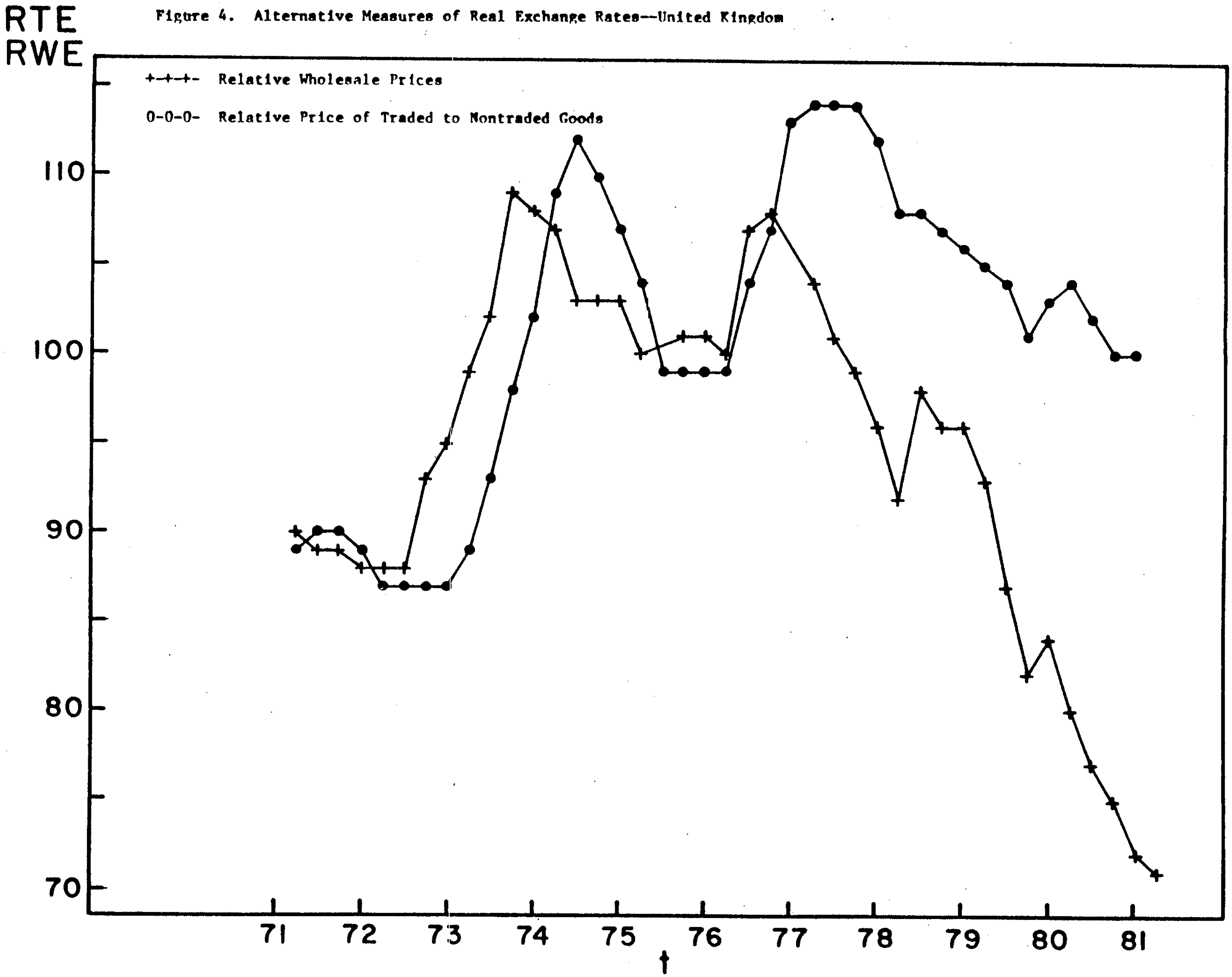
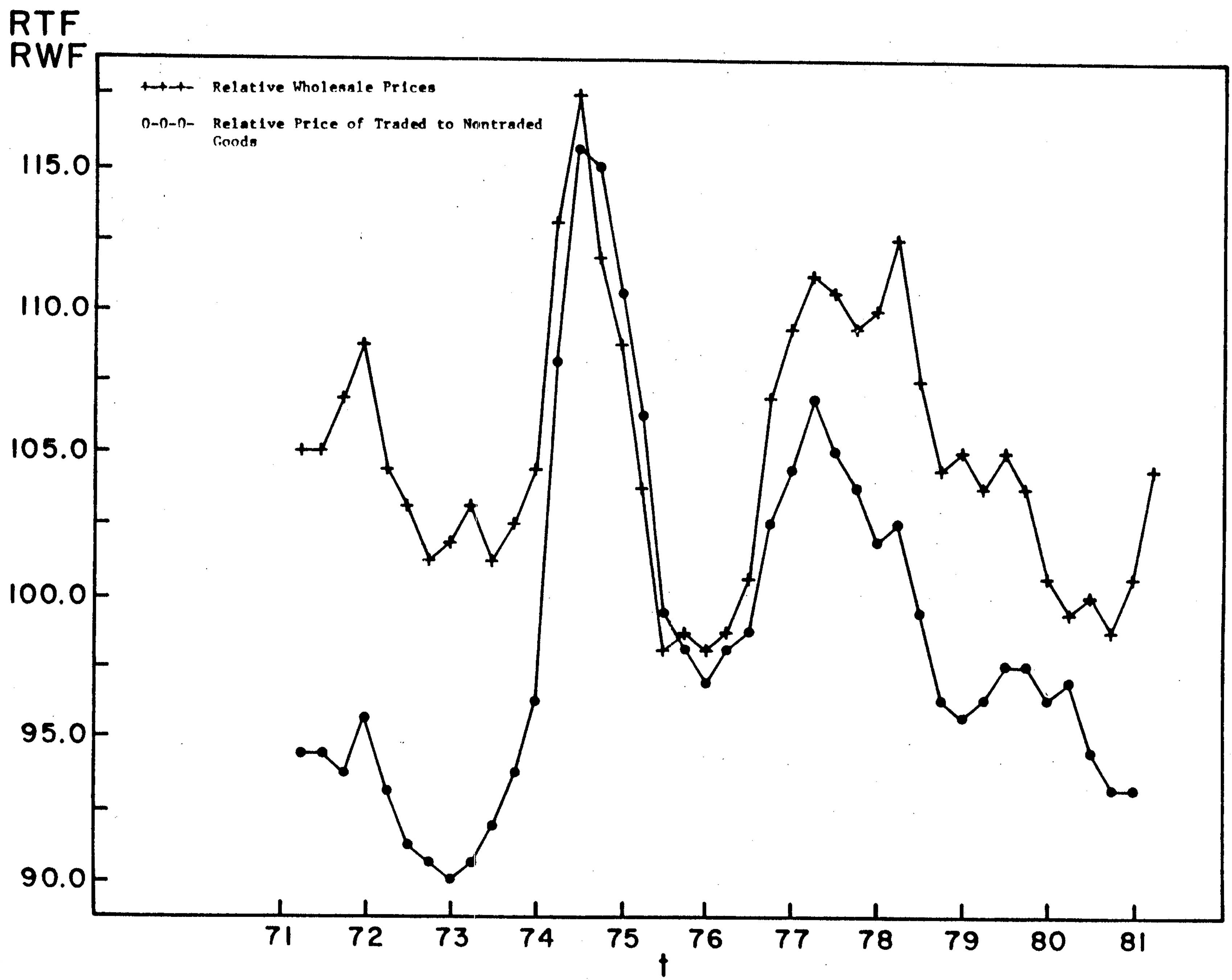


Figure 5. Alternative Measures of Real Exchange Rates--France



countries. The two real price indices stayed roughly constant in the case of the United States and Japan, while they exhibited substantial fluctuations in the other countries. After 1978, France and England experienced real appreciations and the United States and Germany real depreciations. The evidence on Japan is mixed.

Table 3 provides some information on the stochastic properties of the two real exchange rate indices for the whole period of the 1970s by comparing the variability of each index around trend and the correlation coefficient between the two for each country. The correlation coefficient between each index and the current account balance is also included even though this study will stop short of investigating the properties of current account adjustment. It is interesting to note, however, that ρ is in most cases negative, probably reflecting strong J curve effects.

Comparing the standard deviations of the two indices which are used as measures of variability around trend it is interesting to note that experiences are different across countries even though the underlying reasons are not apparent in such aggregate analysis. In terms of variability of the R^{tn} index during the floating rate period, Japan has clearly the lead followed by the United States, Italy and England. In terms of R^{w}, the United Kingdom and Japan are the two leading countries. Germany and countries in the DM currency area have experienced considerably less real exchange rate variability regardless of the index. In all cases, these developments could be attributed either to private market behavior, or policy or even to differences in structural characteristics which account for different transmission processes. It is evident, however, that whatever the reason, the real exchange rates of most countries moved sufficiently to contradict a PPP view of exchange rate determination. This is consistent with most

Table 3: Comparison of Real Exchange Rate Variability and Correlations (1971.1-1980.4)

	Real Exchange Rates (R)		Correlations		
Countries	$\sigma_R{}^{tn}$	$\sigma_R{}^{w}$	$\rho(R_t^{tn}, R_t^{w})$	$\rho(CA_t, R_t^{tn})$	$\rho(CA_t, R_t^{w})$
United States	7.7	4.3	0.307	0.559	0.258
Canada	3.2	3.6	0.141	-0.043	0.140
Japan	11.1	7.2	0.561	-0.443	-0.239
United Kingdom	6.7	10.3	0.784	-0.491	-0.537
West Germany	4.4	6.4	-0.116	0.287	-0.642
Austria	2.0	3.1	0.259	-0.069	-0.015
Netherlands	5.5	3.3	0.420	0.103	-0.301
Denmark	5.4	5.8	0.194	-0.177	-0.079
Belgium	4.7	4.4	0.112	-0.330	-0.653
France	6.3	4.4	0.738	-0.417	-0.204
Italy	7.7	3.8	0.334	-0.542	0.041
Norway	5.6	5.8	-0.124	0.351	0.639
Sweden	2.4	5.1	-0.334	-0.518	0.383

Notes:

1. Data are detrended and deseasonalized.
2. Source of all data is the IMF.
3. Both indices are defined as relative prices of foreign to domestic variables; $R^{tn} = \dfrac{E\cdot(w_1P^x+w_2P^m)}{P^v}$ and $R^w = \dfrac{E\cdot(FP^w)}{P^w}$.

available empirical findings (Frenkel, 1981). Section 3 below will pursue this line of inquiry further.

The correlation coefficient between the two relative-price indices (detrended and deseasonalized) is highest in the case of the United Kingdom (.784) but low and sometimes negative in most other cases. Thus, the choice of the real exchange rate index becomes crucial.

This becomes clearer if the time series properties of the two indices are compared more closely. Given the instability of the international system during the first three years of the 1970s which is evident in Figures 1-5, 1974II was chosen as the base period of the empirical investigation.

Table 4 presents the autoregressive structure of the two quarterly time series where each variable is regressed on its own past lags. In each regression and in all subsequent tables, a constant and seasonal dummy variables are included while a log-linear trend has been removed. All variables in this and subsequent tables are stated as natural logarithms. Significance at the 5% and 10% levels is indicated by one or two asterisks respectively.

For each of the thirteen countries in the sample, the fourth-order univariate autoregression (AR4) obtained by least squares fit over the 1974.2-1980.4 period, is presented. The lags are subsequently shortened and the results of the appropriate second-order or first-order autoregressive structures are also reported. In all cases the standard errors increase only slightly.

Table 4: Cross Country Univariate Regressions of the Real Exchange Rate[1] (1974:2 - 1980:4)

	R^{tn}_{t-i}							R^{w}_{t-i}						
	t-1	t-2	t-3	t-4	R^2	SSE	DW	t-1	t-2	t-3	t-4	R^2	SSE	DW
United States	1.49*[2]	-.39	-.26	.10	.98	.002	2.0	.66*	-.12	.35	-.21	.76	.012	1.9
	1.56*	-.64*			.98	.002	2.3	.61*	.08			.74	.014	1.8
Canada	1.18*	.03	-.50	.05	.96	.002	1.8	1.20*	-.60**	.47	-.35	.96	.005	1.5
	1.49*	-.67*			.94	.003	2.3	1.23*	-.43*			.95	.006	1.9
Japan	1.41*	-.56**	-.03	-.04	.92	.025	1.8	1.07*	-.37	.17	-.35	.85	.020	2.1
	1.49*	-.69*			.91	.026	1.9	1.24*	-.54*			.81	.026	2.2
United Kingdom	1.34*	-.51	-.04	-.02	.87	.007	1.9	1.00*	-.04	-.03	-.01	.93	.025	1.9
	1.39*	-.59*			.87	.007	1.9	1.01*	-.08			.93	.025	1.9
West Germany	1.35*	-.41	-.04	-.04	.92	.002	1.8	.96*	-.14	.30	-.48	.67	.008	1.6
	1.45*	-.56*			.92	.002	2.0	.80*	.05			.52	.011	1.6
Austria	.77*	-.03	.13	-.17	.89	.003	2.5	.89*	-.27	.22	-.18	.72	.006	1.5
	.77*	.02			.88	.003	2.4	.79*	-.10			.71	.006	1.6
Netherlands	1.14*	-.24	.07	-.16	.88	.006	2.0	.84*	.20	.31	-.43*	.84	.005	2.0
	1.27*	-.38*			.86	.006	2.2	.79*	.22			.80	.006	2.1
Denmark	1.34*	-.62	.28	-.17	.93	.007	1.7	.97*	-.18	.31	-.23	.85	.007	2.0
	1.31*	-.44*			.93	.007	1.8	.92*	-.00			.85	.008	2.1
Belgium	1.11*	-.28	.32	-.45	.92	.007	1.6	1.05*	-.35	.39	-.51*	.95	.004	1.9
	1.36*	-.47*			.90	.008	2.1	1.18*	-.37			.93	.005	2.1
France	1.18*	-.60*	.05	-.11	.96	.004	2.2	1.14*	-.54**	.32	-.36	.85	.010	2.1
	1.32*	-.69*			.96	.004	2.5	1.24*	-.52*			.82	.012	2.4
Italy	.49*	.05	-.01	-.32*	.74	.013	1.8	.93*	-.35	.23	-.28	.65	.013	1.9
	.91*	-.30**			.61	.020	2.4	.92*	-.26			.63	.014	2.0
Norway	.74*	.31	-.12	-.28	.85	.014	1.9	.89*	-.15	.02	-.15	.89	.009	2.0
	.99*	-.10			.81	.018	2.3	.97*	-.30			.89	.010	2.1
Sweden	.57*	.09	-.34	-.03	.79	.002	1.9	1.13*	-.25	-.16	-.06	.89	.008	1.8
	.76*	-.25						1.26*	-.53*			.88	.009	2.1

Notes: 1. All regressions include a time trend and seasonal dummies.
2. One asterisk implies that the coefficient is significant at the five percent confidence level. Two asterisks imply that the coefficient is significant at the ten percent confidence level.

As it was expected, the two time series have quite different properties. R^{tn} exhibits,in all countries except Austria, Norway and Sweden, AR2 properties with convergent cyclical responses to disturbances,[15] while R^{w} is in most cases an AR1 stable process. Exceptions are Canada, Japan, France and Sweden where R^{w} is a stable AR2 process and the United Kingdom where the system could be considered explosive. These differences in the properties of the two time-series can be attributed to the relative sluggishness of domestic nontraded good prices which causes a lengthier adjustment process. It should also be noted that the coefficient of R^{w}_{t-1} is in some cases over .90 and in the United Kingdom, Denmark, Norway, and Italy not significantly different from unity. This would make the R^{w} close to a random walk process in which a given disturbance to the system is sustained indefinitely. It is thus evident both from the theoretical analysis of Section 1 and the empirical evidence provided so far that the two indices do not exhibit similar time series properties.

The analysis of the remaining two sections will be cast in terms of R^{tn}. The choice of the index is influenced by the fact that the properties of R^{w} have received relatively more attention in the recent literature (Branson 1981) and that in the presence of non-traded goods, R^{tn} is a better proxy of overall competitiveness.

Given the choice of R^{tn} as the relevant real exchange rate index, Sections 3 and 4 below investigate further the movements of nominal effective exchange rates, foreign prices of traded goods and domestic prices and their interaction.

3. Decomposition of R^{tn} and Analysis of Time Series Properties of its Components.

Variability of the real exchange rate, R^{tn}, around trend can be decomposed further. Determination of the principal source of variability, if at all possible, can illuminate the importance and effects of "news" relative to the long-run movement of R^{tn} which is determined by expected changes in competitiveness due to technological innovations, decreasing money illusion or other factors.

Table 5 shows that for most countries much of the R^{tn} variability can be attributed to the detrended foreign price of tradeables index. Its standard deviation is considerably higher than that of either the nominal effective exchange rate or the value added deflator with the exception of the United Kingdom where nominal exchange rate variability is dominant. This is not surprising given the fact that the time period under consideration in Table 5 includes 1973 and hence the dramatic increase in the prices of all imported intermediate goods, most notably oil. The second point to be noted is that for most countries the standard deviation of the value added deflator is the lowest. Austria, Netherlands, and Belgium whose exchange rates have been tied to the DM are the only exceptions. Low variability of P^{v} probably reflects countercyclical policies that have been pursued during the period. Finally, contrasting the results of Tables 3 and 5, real exchange rate variability is consistently higher than nominal exchange rate variability in all countries except Canada, the United Kingdom, Austria and Sweden. The result runs counter to existing perceptions about real exchange rates which in a PPP world are assumed to stay roughly constant, and at least not to exhibit greater variability than nominal exchange rates.

Table 5: Comparison of Price and Nominal Exchange Rate Variability and Corelation Analysis (1971.1-1980.4)

$$R_t^{tn} = E(w_1 P^x + w_2 P^m)/P^v$$

	Effective Exchange Rate (E)	Prices (P)		Correlation Analysis				
	σ_E (x 100)	σ_{P^v}	σ_{FP^T}	$\rho(E_t, R_t^{tn})$	$\rho(P_t^v, R_t^{tn})$	$\rho(P_t^v, FP^t)$	$\rho(E, FP^t)$	$\rho(E, P^v)$
United States	4.6	2.7	9.0	0.255	0.040	0.566	-0.425	-0.487
Canada	4.5	3.2	7.4	0.131	0.456	0.791	-0.667	-0.247
Japan	8.2	5.0	8.6	0.938	0.581	0.909	0.538	0.469
United Kingdom	10.6	4.7	7.0	0.680	0.001	0.296	-0.571	0.307
West Germany	4.0	1.5	6.7	-0.088	0.693	0.698	-0.564	0.017
Austria	2.9	3.2	5.8	-0.111	0.333	0.901	-0.771	-0.505
Netherlands	2.5	2.8	8.1	-0.283	0.333	0.708	-0.618	-0.366
Denmark	4.7	2.9	7.8	0.200	-0.138	0.674	-0.670	-0.731
Belgium	2.2	3.4	6.1	0.474	0.286	0.774	0.053	-0.140
France	4.1	3.4	7.3	0.116	-0.223	0.297	-0.486	0.024
Italy	4.8	3.7	9.4	0.268	0.412	0.562	-0.152	0.347
Norway	5.1	3.0	9.1	-0.001	-0.130	0.629	-0.789	-0.701
Sweden	5.0	3.3	8.9	-0.214	0.765	0.847	-0.814	-0.428

Notes:

1. Data are detrended and deseasonalized.

2. Source of all data is the IMF; P^x and P^m series come from the IMF's International Financial Statistics.

3. Exchange rates are effective rates, defined as home currency per foriegn exchange.

The correlation analysis presented in Table 5 sheds some light on the process underlying the variability in the real exchange rate index. Once again, experience is quite varied across countries. Foreign and domestic prices have moved closely together in all countries especially in Japan (ρ = .909), but the nominal exchange rate has moved in most cases in the opposite direction of foreign and domestic prices. A notable exception is Japan. The Scandinavian countries (Denmark, Norway, Sweden) and Austria exhibit the highest negative correlations between exchange rates and each of the two price indices.

With the exception of Japan and the United Kingdom where the correlation coefficient between nominal and real exchange rates is relatively high, in most other countries it is relatively small. This could be the outcome (a) of a PPP market view of nominal exchange rate determination which is probably unlikely given the high variability of the real exchange rates in most countries or, (b) policy-enforced correlations (positive and negative respectively) between the nominal exchange rate, domestic and foreign prices. As it was argued in the introduction, causality can run either way. With respect to domestic prices, a nominal devaluation could be passed on rapidly to domestic prices or alternatively domestic inflationary pressures could influence authorities or the market to depreciate the nominal exchange rate. This process will be consistent with the evidence on Japan, United Kingdom and Italy where the correlation coefficient between E and P^V is positive.

With respect to foreign prices, a nominal devaluation can induce a decline in the foreign currency price of traded goods if countries possess market power in traded good markets. Alternatively, an increase in foreign prices might lead monetary authorities to appreciate the nominal exchange rate to insulate the economy from external inflationary pressures.

This would be consistent with the evidence on most other industrialized countries and especially the Scandinavian countries. Given the observed high variability of the real exchange rate and foreign prices and the relatively low variability of the domestic price index, intervention by the monetary authorities is suspected. Section 4 investigates more thoroughly the evidence on causality and the adjustment process of individual countries.

Before proceeding with the analysis, however, a few more points should be raised. Table 6 describes the dynamic time-series properties of the three indices, namely the nominal effective exchange rate, the value added deflator and the foreign price of traded goods for the period 1974.2-1980.4 after the 1973 major realignment of nominal parities. As with the real exchange rate indices, each variable is regressed against past values of itself in a regression which includes a constant, a time trend and seasonal dummies. Lags are subsequently eliminated successively and the final choice is based on the significance level of the estimated coefficient and the standard error of the restricted equation. The F test of the joint elimination of the third and fourth period lags shows that the three indices generally demonstrate properties of an AR1 or AR2 autoregressive process with the exception of West Germany and the United Kingdom.

With the exception of Canada, Japan, France and Sweden, the exchange rate can be described as an AR1 process. The process is generally stable except in the cases of the United Kingdom and Italy where the estimated coefficients of E_{t-1} exceed unity while the second lag coefficient is not significantly different from zero; also in one of the smaller European countries, namely Norway, the respective estimates

Table 3: Cross Country Univariate Regressions of Exchange Rates and Prices (1974.2 - 1980.4)

E

	-1	-2	-3	-4	R^2	SEE	DW	F(3,4)
United States	.88*	-.06	.33	-.34	.88	.012	1.6	1.5(.24)
	.82	.03			.86	.014	1.5	
Canada	1.39*	-.75**	.41	-.25	.98	.005	1.6	0.7(.49)
	1.36*	-.52*			.98	.006	1.8	
Japan	1.16*	-.19	-.12	-.21	.95	.002	2.1	2.0(.17)
	1.45*	-.69*			.94	.027	2.4	
United Kingdom	1.13*	-.04	-.02	-.09	.93	.023	1.9	0.2(.85)
	1.16*	-.15			.93	.023	2.0	
West Germany	.94*	-.11	.24	-.48*	.97	.009	1.5	3.3(.06)
	.80*	.01			.96	.012	1.5	
Austria	.84*	-.37	.18	-.42*	.97	.004	1.4	2.7(.09)
	.76*	-.27			.96	.005	1.6	
Netherlands	.69*	-.13	.24	-.44	.93	.004	1.5	2.0(.16)
	.67*	-.09			.91	.005	1.7	
Denmark	.94*	-.18	.32	-.24	.83	.007	1.8	0.6(.56)
	.88*	-.00			.82	.007	1.9	
Belgium	.75*	-.05	.25	-.35	.90	.005	1.6	1.0(.39)
	.78*	-.01			.89	.006	1.7	
France	1.05*	-.44	.29	-.37**	.86	.009	2.3	2.0(.16)
	1.13*	-.44*			.82	.010	2.4	
Italy	1.13*	-.43	.24	-.22	.98	.017	1.9	0.4(.65)
	1.11*	-.33			.98	.018	2.0	
Norway	.99*	.00	-.13	-.10	.88	.005	2.0	0.9(.44)
	1.12*	-.32			.87	.006	2.2	
Sweden	1.25*	-.44	.01	-.09	.94	.008	1.8	0.3(.78)
	1.32*	-.55*			.94	.008	2.0	

P

	-1	-2	-3	-4	R^2	SEE	DW	F(3,4)
United States	1.30*	-.62	.00	.00	.99	.001	2.0	0.0(.99)
	1.30*	-.61*			.99	.001	1.9	
Canada	1.49*	-.61**	.16	-.21	1.00	.001	2.2	0.7(.49)
	1.67*	-.78*			1.00	.001	2.3	
Japan	1.19*	-.52**	.49**	-.26	.94	.002	1.4	1.6(.23)
	1.03*	-.16			.93	.002	1.4	
United Kingdom	.90*	-.00	.24	.40*	1.00	.001	1.9	5.7(.01)
	1.37*	-.54*			1.00	.002	2.4	
West Germany	.96*	.08	-.05	-.29**	1.00	.000	1.8	6.4(.01)
	1.45*	-.55*			1.00	.000	2.2	
Austria	1.12*	-.73*	.66**	-.39**	.99	.001	1.9	2.1(.15)
	1.03*	-.37*			.99	.001	2.0	
Netherlands	1.00*	-.26	-.02	-.12	.99	.002	2.0	0.4(.65)
	1.11*	-.43*			.99	.002	2.2	
Denmark	1.16*	-.18	-.25	.08	1.00	.001	2.4	0.3(.73)
	1.26*	-.44*			1.00	.001	2.4	
Belgium	1.01*	-.20	-.16	.14	1.00	.001	2.6	0.8(.47)
	1.02	-.23**			1.00	.001	2.2	
France	1.32*	-.14	-.32	-.06	1.00	.002	2.1	1.6(.23)
	1.59*	-.70*			1.00	.002	2.5	
Italy	1.42*	-.97*	.32	-.08	1.00	.002	2.0	0.5(.61)
	1.23*	-.58*			1.00	.002	1.7	
Norway	1.17*	-.45	.17	-.16	1.00	.001	2.3	0.4(.65)
	1.23*	-.47*			1.00	.001	2.4	
Sweden	.94*	-.12	-.23	-.01	1.00	.002	2.0	0.9(.44)
	1.12*	-.47*			1.00	.003	2.3	

	-1	-2	-3	-4	R^2	SEE	DW	F(3,4)
United States	1.00*	-.18	.27	-.32*	.98	.013	1.5	2.8(.08)
	1.18*	-.30**			.97	.017	1.8	
Canada	1.38*	-.45	-.05	-.04	.98	.006	2.1	0.2(.81)
	1.49*	-.63*			.98	.007	2.3	
Japan	.89*	-.24	.23	-.27**	.98	.015	2.1	1.9(.18)
	1.04*	-.23**			.97	.018	2.4	
United Kingdom	1.15*	-.19	.05	-.24	.98	.017	2.0	1.1(.35)
	1.34*	-.43*			.98	.019	2.3	
West Germany	.85*	-.30	.13	-.28*	.99	.005	1.5	3.1(.07)
	1.09*	-.54*			.99	.007	2.1	
Austria	.90*	-.19	-.12	-.10	.99	.005	1.8	1.0(.38)
	1.18*	-.54*			.99	.005	2.0	
Netherlands	1.26*	-.51**	.05	-.09	.99	.005	1.9	0.3(.78)
	1.37*	-.53*			.99	.005	2.2	
Denmark	1.02*	-.09	-.14	-.05	.99	.003	1.9	0.8(.46)
	1.20*	-.42*			.99	.004	2.3	
Belgium	1.01*	-.39	.02	-.17	.99	.006	1.8	1.0(.39)
	1.26*	-.64*			.99	.007	2.4	
France	1.06*	-.13	-.06	-.16	.99	.006	1.9	1.4(.26)
	1.32	-.53*			.98	.007	2.4	
Italy	.95*	.04	-.08	-.17	.97	.017	2.0	2.0(.17)
	1.23*	-.36			.96	.021	2.4	
Norway	.83*	.26	-.22	-.22	.98	.015	1.7	4.3(.03)
	1.27*	-.45*			.97	.022	2.5	
Sweden	1.52*	-.86*	.30	-.15	.98	.006	1.7	0.3(.76)
	1.47*	-.66*			.98	.006	1.8	

Notes: [1] All regressions include a constant, seasonal dummies and a time trend.

[2] A "*" indicates the coefficient is significant at the 5% level.

A "**" indicates the coefficient is significant at the 10% level.

[3] The source of data is the IMF. FP^t was computed by division of the P^t index by the effective exchange rate.

[4] The F test is conducted under the null hypothesis that the 3rd and 4th-lag coefficient is equal to zero; the number in parenthesis is the significance level at which the null hypothesis can be accepted. Germany and Austria are the only countries for which the F-test on the E and P autoregressions point to an AR3 or AR4 structure.

[5] The behavior of the stochastic equations is stable in all cases.

[6] For Sweden the FP^t autoregression was estimated for the period 1974.2-1979.4

in the restricted equation are 1.12 and -.32. The coefficients in some of the other small European countries especially the Scandinavian countries are close enough to unity that the nominal exchange rate can be effectively characterized as a random walk. This probably explains why the nominal exchange rate in most of these countries has not been allowed to vary much (see Table 5).

The two prices can be described effectively on the other hand as AR2 processes. According to the reported F tests, P^v, in the United Kingdom and Germany exhibit even higher order autoregressive properties. This underlines the sluggishness of the domestic price index which is probably the outcome of pricing or stabilization policies. FP^t is generally an AR2 process with possible exceptions West Germany and Norway.

The observed differences between the properties of nominal exchange rate time series data and those of relative prices, which have also been noted elsewhere, (Frenkel, 1981; Branson, 1981), would be again consistent with the hypothesis that exchange rates are determined in asset markets which clear markedly faster than goods markets. Since adjustment in prices is generally more sluggish than that of exchange rates, nominal exchange rates tend to overshoot their equilibrium value as private market participants respond to new information. This would also be consistent with the observed high real exchange rate variability and would apply particularly well to the United States, the United Kingdom and Germany among the major hard currency countries. The interaction of exchange rates and prices in the other floating countries, namely Japan, Canada and France is harder to ascertain at least from the evidence presented in Table 6. Section 4 provides some further insights into these cases and into the underlying process of real exchange rate determination in the smaller European countries.

4. Statistical Exogeneity and Responses to Unexpected Shocks

Following the work by Sargent (1979), Sims (1980), Taylor (1980) and more recently Ashenfelter and Card (1981), the stochastic dynamics of the nominal exchange rate and relative price series is investigated further in this section. The objective here is two-fold: to estimate the observed adjustment of current nominal exchange rates (and prices) to lagged known values of relative prices (and exchange rates) but more importantly to investigate the response of each time-series to unanticipated disturbances. The failure of most well-known models of exchange rate determination to explain the variability of nominal exchange rates in the 1970s points to the important role of "news" as the main explanatory variable of the observed large swings in exchange rates. "News" are captured by the error term in vector autoregression systems which include as independent variables lagged values of all the relevant dependent variables.

In the context of real exchange rate determination, "news" about the current account position, the money supply or output will affect both nominal exchange rates and prices. Thus, residuals in vector autoregressions which include as independent variables only lagged values of nominal exchange rates and prices will capture unanticipated movements in these two variables due to such "news". A high negative correlation coefficient among residuals therefore could imply either that agents move nominal exchange rates and prices in opposite directions as a response to a particular source of "news" or that nominal exchange rates and prices respond to different sets of news which are themselves negatively correlated.

In light of these considerations a second order vector autoregression system is estimated for each country in the sample where the two variables are the nominal effective exchange rate and relative prices defined as the ratio of the value added deflator to the foreign price of traded goods. Each of the two variables is regressed against lagged values of both variables. All regressions are run on quarterly observations and include a constant, a linear trend and seasonal dummies. Given the analysis of Section 3, two lags are used for each variable. The only exception is Germany for which the vector autoregression is also run with three lags on exchange rates and relative prices.

Each of the estimated equations can be interpreted as a forecasting equation. To determine whether or not inclusion of the other variable improves its explanatory power F tests are conducted under the null hypothesis that (a) the two lagged relative price terms in the exchange rate equation are zero or (b) the two lagged exchange rate terms in the relative price equation are zero. The results are reported in Table 7 with significance levels in parentheses. Table 7 also reports the correlation between the residuals of the two estimated equations which can be interpreted as the correlation between "innovations". Subject to our previous interpretation, a strong positive correlation between the two residuals would imply that the two series respond similarly to a given source of news (e.g. money supply news) or to different sets of news (e.g. money supply and current account) that are positively correlated.

The results of Table 7 support the intuitive arguments so far. At a 10 percent significance level it is shown that the exchange rate can be considered statistically exogenous or predetermined vis-a-vis relative prices in all cases except the United Kingdom and possibly Denmark, Austria

Table 7: Correlation of Residuals and Granger Exogeneity Tests in Vector Autoregression System of Exchange Rates and Relative Prices.[1] (1974.2-1980.4)

Countries	$\rho(\hat{V}_E, \hat{V}_{P^v/FP^t})$	$F(P^v/FP^t)^2$	$F(E)^2$
United States	0.92	1.09 (.36)	1.82 (.19)
Canada	0.73	1.63 (.22)	0.95 (.41)
Japan	0.62	0.25 (.78)	4.80 (.02)*
United Kingdom	0.83	3.59 (.05)*	6.99 (.57)
West Germany	0.92	0.66 (.53)	1.96 (.17)
	0.93	0.45 (.72)	0.81 (.51)
Austria	0.72	3.21 (.06)**	0.04 (.96)
Netherlands	0.16	1.66 (.22)	1.44 (.26)
Denmark	0.36	2.75 (.09)**	0.70 (.51)
Belgium	0.31	2.69 (.09)**	3.95 (.04)*
France	0.79	1.23 (.32)	1.77 (.20)
Italy	0.45	0.66 (.53)	0.44 (.65)
Norway	0.33	0.52 (.60)	2.68 (.09)**
Sweden[3]	0.77	0.31 (.74)	0.46 (.64)

Notes:

[1]For all countries the vector autoregressions include two lags on all relevant variables, with the sole exception of Germany where the results of the vector autoregression with three lags on E, P^v and hence P^v/FP^t are also reported.

[2]$F(P^v/FP^t)$ is the F-test under the null hypothesis that $(P^v/FP^t)_{t-1}$ and $(P^v/FP^t)_{t-2}$ are zero in the E equation. Similarly, F(E) is the F-test under the null hypothesis that E_{t-1} and E_{t-2} are zero in the relative price equation. Significance levels are given in parentheses. An asterisk indicates that the null hypothesis can be rejected within a 10% confidence interval.

[3]Sample period: 1974.2-1979.4.

and Belgium. Past movements of the exchange rate are important expected determinants of the relative price ratio in Japan, Belgium and Norway. This supports the previous findings of differential speed of adjustment in asset and goods markets and the stronger expected transmission linkages in the smaller and more open economies.

The correlation among residuals is positive in all cases but around .80 only in the case of the United States, the United Kingdom, West Germany and France. This finding is consistent with the hypothesis that despite relatively low expected transmission from exchange rates to prices and from prices to exchange rates in the hard-currency industrialized countries as compared to smaller and more open economies (Tables 5 and 7), innovations affect both nominal exchange rates and domestic prices in a similar manner. In the other smaller countries, relative price and exchange rate movements seem to respond independently to innovations.

Based on the underlying estimation of the vector autoregression system (VAR) Figures 6 and 7 plot the response of each of the two independent variables to one standard deviation shock in the residual of the cross equation for France, Germany, Japan and the United States.[16] It is interesting to note that the impulse reaction functions presented in these figures reveal substantial cross-country differences in the dynamic path of adjustment to an unexpected disturbance.

In all four countries "news" that cause an unexpected nominal depreciation induce a decrease in the relative price of nontraded to traded goods. The drop is largest and the adjustment slowest in the case of the United States which is the least open country in the sample and which possesses a high degree of market power. The system in all cases converges roughly after fifty quarters.

Figure 6: Response of Relative Prices, Non-Traded to Traded Goods, to Shock in Exchange Rate. **(Period of Estimation 1974.2-1980.4)**

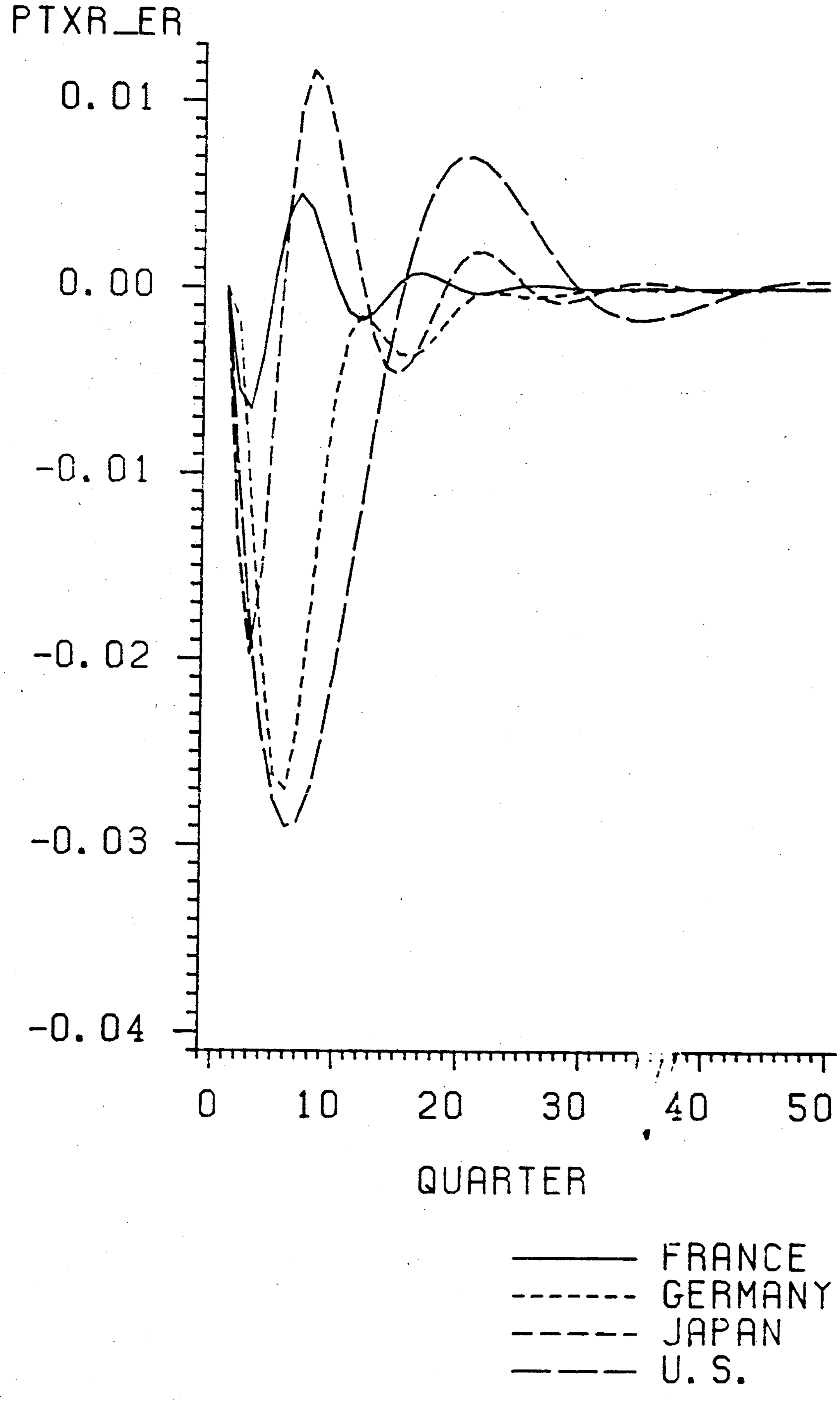
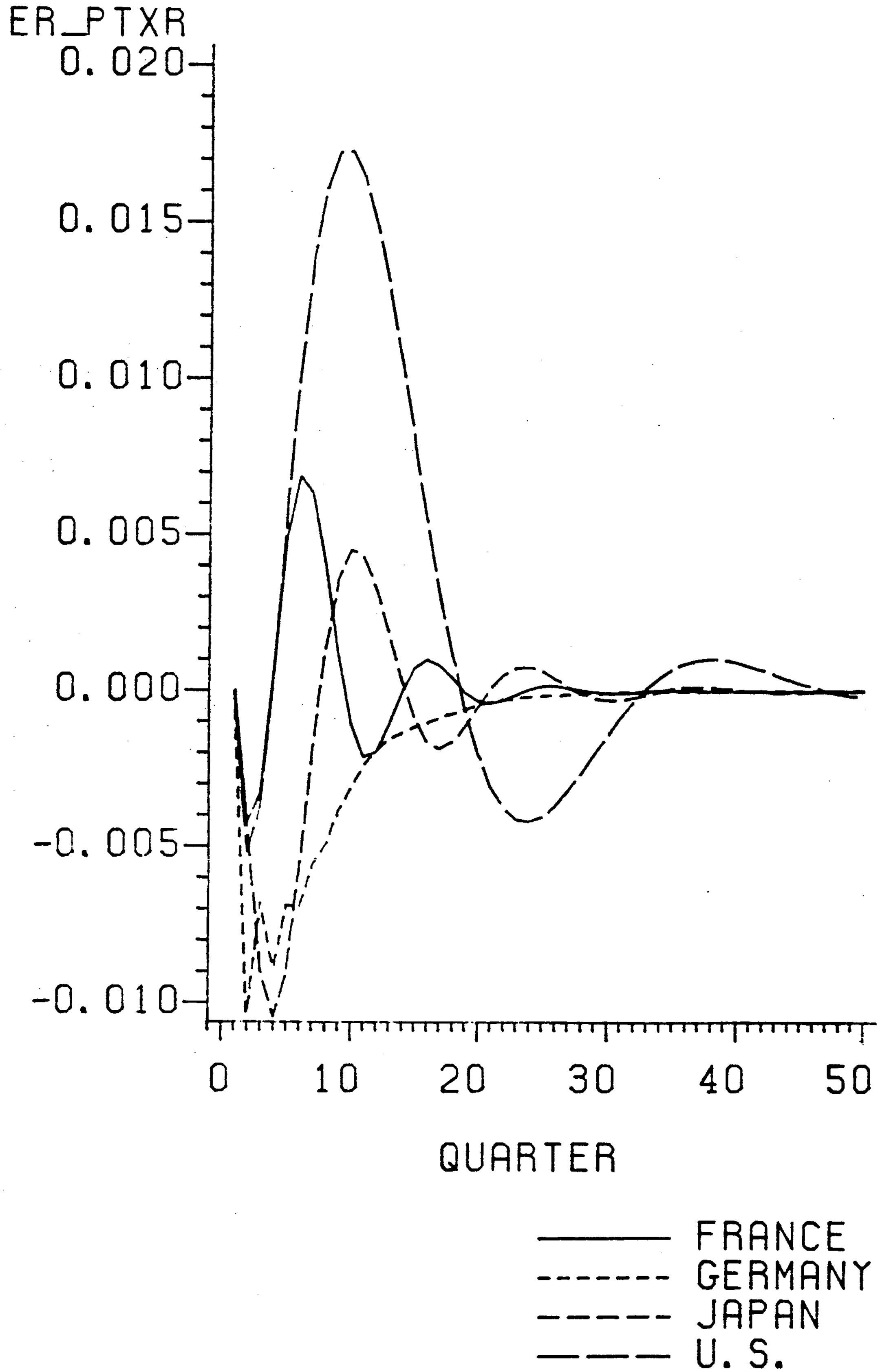


Figure 7: Response of Exchange Rate to Shock in Relative Prices, Non-Traded to Traded Goods. (Period of Estimation 1974.2-1980.4)



Oscillations of nominal exchange rates in response to an unexpected shock in relative prices are once again larger and more prolonged in the case of the United States. The nominal exchange rate depreciates in value after a short period of small appreciation (2 quarters). After fifty quarters it did not converge to its equilibrium value. The dynamic path of adjustment is quite different in the other countries with adjustment almost monotonic in the case of Germany. The exchange rate converges approximately after 35 quarters. The pronouned nominal and real-appreciations probably reflect anti-inflationary policies and possibly, in the case of the European countries, the sluggishness in nominal exchange rate adjustment imposed by monetary arrangements.

In conclusion the evidence in Table 7 and Figures 6-7 suggest that even though "innovations" affect nominal exchange rates and relative prices symmetrically in the large countries as opposed to the smaller countries, the impulse reaction functions even for these countries are not identical due to differences in structure and policy behavior.

Movements in the relative price index can now be decomposed further into movements of the domestic and foreign price component and the properties of the system can be analyzed further. Here again each variable in the trivariate autoregression system is regressed against lagged values of all three variables. As with the bivariate VAR, two lags are used in the autoregressive structure.

Tables 8, 9 and 10 present estimates of each of the forecasting equations as well as the results of F tests on the successive elimination of cross variables. The numbers in parentheses under the estimated coefficients report the t-statistics.

Table 8 generally confirms the hypothesis of exogeneity of the nominal exchange rate that was postulated in Table 7 with the exception of Germany. While in Table 7 it was reported that current values of the exchange rate do not seem to depend on lagged values of relative prices, the results here indicate that lagged values of P^v do affect independently the nominal exchange rate. Furthermore, in the case of Belgium, joint elimination of the two lags on P^v is hard to justify. This gives partial justification for the preoccupation with vicious circles by Belgian economists.

Table 9 presents the forecasting equation for P^v. Based on the F test, the domestic price ratio is clearly responsive to past exchange rate movements only in the case of the United States with an insignificant first period lag and a significantly positive second period lag. Based on the estimated equation, the first period lag (E_{t-1}) has a significantly positive sign in Germany and Italy. The second period lag is significantly negative in Germany alone.

Past values of the foreign price index for the post 1973-74 oil price increase period are significant determinants of the domestic price index only in the United States, Japan, Germany and Denmark. The first period lag is significantly positive also in France and Sweden and surprisingly negative in the case of Denmark. The second period lag is significantly negative in Germany, and France and positive in Denmark and the United States. In general it can be concluded that current values for P^v do not seem to be affected by lagged values of E and FP^t as much as one would expect. This limited backward-looking linkage could be the outcome of domestic price stabilization policies during the 1970s.

Table 8: Responsiveness of E to Lagged E, P^v and FP^t (1974.2-1980.4)

	E_{t-1}	E_{t-2}	E_{t-3}	P^v_{t-1}	P^v_{t-2}	P^v_{t-3}	FP^t_{t-1}	FP^t_{t-2}	FP^t_{t-3}	R^2	DW	$F(P^v)$	$F(FP^t)$
United States	0.97	-0.50		1.76	-0.73		0.12	-0.58		0.92	2.3	2.5	2.2
	(2.3)[1]	(0.9)		(2.2)	(2.2)		(0.3)	(1.0)				(0.11)[3]	(0.15)
Canada	1.24	-0.35		-0.49	-0.25		0.30	0.30		0.99	2.1	3.0	2.1
	(4.3)	(1.2)		(0.9)	(0.4)		(1.2)	(0.1)				(0.08)	(0.15)
Japan	1.42	-0.68		-0.41	0.59		0.29	-0.17		0.94	2.4	0.2	0.3
	(7.0)	(3.4)		(0.5)	(0.5)		(0.8)	(0.5)				(0.84)	(0.70)
United Kingdom	0.68	0.27		0.86	-0.38		-0.27	0.15		0.96	1.9	3.0	0.2
	(1.6)	(0.8)		(1.2)	(0.6)		(0.7)	(0.5)			(0.7)	(0.08)	(0.80)
West Germany	0.71	-0.36		-0.50	2.11		0.41	-0.32		0.98	1.6	6.4	0.7
	(2.1)	(0.8)		(0.5)	(1.9)		(1.2)	(1.1)				(0.01)*	(0.50)
	1.43	-1.03	0.21	-2.81	6.17	-2.89	0.82	-1.01	0.44	0.99	2.4	7.2	1.1
	(3.3)	(1.5)	(0.4)	(2.0)	(3.4)	(2.3)	(1.7)	(1.3)	(1.0)			(0.00)*	(0.30)
Austria	0.91	0.25		-0.39	-0.05		-0.14	0.56		0.98	1.8	0.9	3.6
	(3.0)	(0.9)		(0.8)	(0.1)		(0.6)	(2.6)				(0.42)	(0.52)
Netherlands	0.44	0.08		0.16	-0.62		-0.21	0.30		0.93	1.9	1.9	2.8
	(1.6)	(0.3)		(0.4)	(1.5)		(1.2)	(2.0)				(0.18)	(0.09)
Denmark	0.74	0.05		-0.45	0.12		0.17	0.11		0.86	2.1	0.6	1.8
	(2.7)	(0.2)		(0.7)	(0.2)		(0.5)	(0.3)				(0.55)	(0.19)
Belgium	0.49	0.35		-0.93	0.17		-0.21	0.29		0.94	2.4	4.4	1.6
	(1.8)	(1.3)		(1.6)	(0.3)		(1.3)	(1.7)				(0.03)*	(0.23)
France	1.03	-0.41		-0.80	0.84		0.38	-0.44		0.85	2.4	0.8	1.2
	(4.6)	(1.9)		(1.2)	(1.1)		(1.1)	(1.5)				(0.47)	(0.34)
Italy	1.05	-0.30		-0.43	0.30		-0.16	0.15		0.98	2.0	0.2	0.3
	(4.1)	(1.2)		(0.7)	(0.6)		(0.7)	(0.7)				(0.74)	(0.74)
Norway	0.91	-0.28		0.21	-0.41		-0.17	0.11		0.89	2.4	1.2	1.0
	(3.4)	(1.1)		(0.6)	(1.2)		(1.4)	(0.9)				(0.32)	(0.38)
Sweden[2]	1.10	-0.36		0.12	-0.12		-0.28	0.23		0.94	1.9	0.0	0.2
	(2.5)	(0.8)		(0.2)	(0.2)		(0.6)	(0.6)				(0.98)	(0.78)

Notes:
1. t-statistics in parentheses.
2. Sample period 1974.2-1979.4
3. **Significance level for F-test under null hypothesis that the coefficients of relevant variable are zero. An asterisk indicates that the null hypothesis can be rejected within a 5% confidence interval.**

Table 9: Responsiveness of P^v to Lagged P^v, E and FP^t (1974.2-1980.4)

	E_{t-1}	E_{t-2}	E_{t-3}	P^v_{t-1}	P^v_{t-2}	P^v_{t-3}	FP^t_{t-1}	FP^t_{t-2}	FP^t_{t-3}	R^2	DW	F(E)	$F(FP^t)$
United States	-0.70	0.25		0.73	-0.70		-0.10	0.32		1.00	2.1	8.6	9.1
	(0.7)[1]	(2.0)		(4.0)	(3.8)		(1.0)	(2.5)				(0.00)*	(0.00)*
Canada	0.09	-0.01		1.45	-0.57		0.05	-0.03		1.00	2.1	0.8	0.1
	(0.6)	(0.1)		(5.1)	(1.8)		(0.4)	(0.2)				(0.48)	(0.91)
Japan	0.03	0.01		0.66	-0.22		0.16	0.04		0.97	1.8	1.4	5.0
	(0.6)	(0.2)		(3.7)	(1.0)		(2.1)	(0.6)				(0.27)	(0.02)*
United Kingdom	-0.11	0.04		1.18	-0.35		-0.13	-0.07		1.00	2.2	0.8	0.5
	(0.8)	(0.3)		(5.3)	(1.6)		(1.0)	(0.7)				(0.47)	(0.60)
West Germany	0.05	-0.15		1.07	-0.10		0.17	-0.13		1.00	1.9	2.1	3.6
	(0.9)	(1.9)		(5.2)	(0.5)		(2.7)	(2.3)				(0.15)	(0.05)*
	0.19	-0.30	0.12	0.86	0.52	-0.61	0.22	-0.28	0.10	0.99	2.3	1.9	2.1
	(2.2)	(2.3)	(1.2)	(3.1)	(1.6)	(2.5)	(2.4)	(1.8)	(1.2)			(0.18)	(0.15)
Austria	-0.01	0.19		0.79	-0.30		0.10	0.07		0.99	2.1	0.7	1.0
	(0.0)	(1.1)		(3.0)	(1.4)		(0.8)	(0.6)				(0.51)	(0.41)
Netherlands	0.39	-0.21		0.85	-0.12		0.20	-0.09		0.99	1.9	1.8	1.7
	(1.9)	(1.1)		(3.3)	(0.4)		(1.5)	(0.8)				(0.20)	(0.21)
Denmark	-0.11	0.14		0.65	-0.07		-0.25	0.37		1.00	2.3	1.4	8.7
	(1.3)	(1.6)		(3.2)	(0.4)		(2.5)	(3.7)				(0.28)	(0.00)*
Belgium	0.03	0.09		0.81	-0.02		-0.00	0.05		1.00	2.4	1.7	1.4
	(0.3)	(0.9)		(3.5)	(0.1)		(0.1)	(0.7)				(0.21)	(0.27)
France	0.06	-0.02		1.16	-0.20		0.29	-0.25		1.00	2.6	0.2	2.7
	(0.6)	(0.2)		(4.6)	(0.7)		(2.1)	(2.2)				(0.79)	(0.10)
Italy	0.17	-0.12		0.99	-0.49		0.05	0.06		1.00	1.8	2.2	1.2
	(2.1)	(1.5)		(4.8)	(3.2)		(0.6)	(0.9)				(0.14)	(0.32)
Norway	-0.10	0.20		1.12	-0.36		-0.06	0.09		0.99	2.3	1.5	1.3
	(0.8)	(1.6)		(6.4)	(2.2)		(1.0)	(1.5)				(0.25)	(0.30)
Sweden[2]	0.25	0.12		0.32	-0.21		0.44	-0.12		1.00	2.1	2.0	2.3
	(1.4)	(0.6)		(1.0)	(0.9)		(2.1)	(0.8)				(0.18)	(0.14)

Notes: 1. t-statistics in parentheses.
2. Sample period 1974.2-1979.4.

Table 10: Responsiveness of FP^t to Lagged FP^t, E and P^v (1974.2-1980.4)

	E_{t-1}	E_{t-2}	E_{t-3}	P^v_{t-1}	P^v_{t-2}	P^v_{t-3}	FP^t_{t-1}	FP^t_{t-2}	FP^t_{t-3}	R^2	DW	F(E)	F(P^v)
United States	0.43	0.15		-2.17	0.63		1.34	0.12		0.98	1.7	5.8	3.4
	(0.9)[1]	(0.2)		(2.5)	(0.7)		(2.7)	(0.2)				(0.01)*	(0.06)
Canada	0.06	-0.07		0.77	-0.07		1.11	-0.62		0.98	2.9	0.0	2.7
	(0.2)	(0.2)		(1.3)	(0.1)		(4.0)	(2.0)				(0.98)	(0.10)
Japan	0.42	-0.34		0.50	0.02		0.90	-0.32		0.99	2.2	5.6	0.6
	(3.3)	(2.6)		(0.9)	(0.0)		(4.0)	(1.5)				(0.01)*	(0.55)
United Kingdom	0.33	-0.61		-1.24	0.95		1.29	-0.55		0.99	1.7	5.5	3.5
	(1.0)	(2.3)		(2.3)	(1.8)		(4.2)	(2.2)				(0.02)*	(0.06)
West Germany	0.74	-0.32		-0.24	-0.81		1.32	-0.55		0.99	1.8	5.2	3.7
	(2.7)	(0.9)		(0.3)	(0.9)		(4.8)	(2.3)				(0.02)*	(0.05)*
	0.06	0.54	-0.45	1.30	-4.03	2.55	0.79	0.44	-0.62	0.99	2.3	1.3	5.0
	(0.2)	(1.0)	(1.0)	(1.1)	(2.9)	(2.5)	(2.03)	(0.7)	(1.7)			(0.32)	(0.02)*
Austria	-0.29	0.12		0.83	-0.60		0.90	-0.47		0.99	2.2	0.3	1.4
	(0.8)	(0.4)		(1.6)	(1.5)		(3.6)	(1.9)				(0.71)	(0.28)
Netherlands	0.53	-0.08		-0.61	0.37		1.53	-0.63		0.99	2.1	2.3	1.9
	(1.9)	(0.3)		(1.8)	(0.9)		(9.1)	(4.5)				(0.13)	(0.18)
Denmark	0.22	-0.24		0.05	-0.01		1.29	-0.51		0.99	2.1	0.7	0.0
	(1.0)	(1.1)		(0.1)	(0.0)		(5.1)	(2.0)				(0.53)	(0.98)
Belgium	0.39	-0.17		0.86	-0.83		1.14	-0.44		0.99	2.2	0.9	1.0
	(1.2)	(0.5)		(1.2)	(1.4)		(5.8)	(2.2)				(0.40)	(0.38)
France	0.30	-0.27		0.31	-0.13		1.30	-0.53		0.99	2.3	1.5	0.2
	(1.6)	(1.5)		(0.6)	(0.2)		(4.4)	(2.2)				(0.26)	(0.79)
Italy	0.10	-0.28		0.47	-0.70		0.99	-0.19		0.96	2.1	0.7	1.3
	(0.4)	(1.1)		(0.7)	(1.5)		(4.4)	(0.8)				(0.51)	(0.31)
Norway	-0.94	1.21		-0.28	0.23		0.95	-0.07		0.98	2.4	3.5	0.1
	(1.9)	(2.6)		(0.4)	(0.4)		(4.3)	(0.3)				(0.06)	(0.90)
Sweden[2]	-0.0	0.08		-0.38	0.21		1.57	-0.69		0.98	2.0	0.0	0.2
	(0.0)	(0.2)		(0.5)	(0.3)		(3.4)	(2.0)				(0.97)	(0.86)

Notes: 1. t - statistics in parentheses
2. Sample period 1974.2-1979.4.

Finally Table 10 presents the forecasting equation for the price of traded goods in units of foreign exchange. There are two reasons why one could expect past exchange rate and domestic price movements to affect the foreign currency price of traded goods: this is possession of market power and a dominant position in international trade. Thus it is not surprising that in the case of the leading countries i.e. the United States, Japan, England and Germany, lagged values of exchange rates if not domestic prices are important determinants of the foreign price index. This kind of international linkage can work in many directions. An effective nominal devaluation of the dollar for example as we have seen in Table 9 would raise U.S. domestic prices of both home and exported goods. Inflation in the U.S. will be transmitted to its trading partners and induce an increase in their domestic price despite the initial nominal appreciation of their currency. Eventually it could raise the United State's effective foreign price of traded goods (FP^t). On the other hand possession of market power on the export and import markets could lower the foreign price of traded goods, at least in the short run. Finally an increase in the domestic price of any of the leading countries might induce restrictive policies in the rest of the world to insulate their respective economies from the negative transmission effects. The results in Table 10 are hard to interpret further without reference to other macroeconomic variables. However they support the view that there exist sufficiently important negative transmission links between the most developed of the industrialized countries and the rest of the world to require a more careful analysis.

The major findings so far are quite supportive of established theories: (a) in most cases (with possible exceptions the United States, and Belgium), the exchange rate can be considered a predetermined variable in domestic price determination; (b) relative prices of nontraded to traded goods are affected by lagged values of exchange rates only in the case of Japan among "large" countries and Belgium and Norway among "small" countries. In the other large countries, "news" seem to affect exchange rates and prices in similar patterns even though there are cross-country differences in the speed of adjustment to innovations;(c) again in the case of "large" countries (United States, Japan, United Kingdom, Germany) the foreign price of traded goods cannot be considered exogenous as it is affected by past exchange rates and domestic prices; (d) the domestic price vector, P^v, does not seem to depend on lagged exchange rates and/or foreign prices in almost all countries probably due to stabilization policies.

The correlations of residuals among all pairs in the autoregressive system are presented in Table 11. For all countries, an innovation in the exchange rate, the predominantly exogenous variable, is associated with a negative innovation in the foreign price index. Once again for the large countries (United States, United Kingdom and Germany) the correlation coefficient is highly significant (over -.70). This high negative ρ in the countries with open and developed financial markets would be consistent with a rational expectations asset-market view of exchange rate determination where an unexpected increase in foreign prices induces expectations of a current account surplus and thus an immediate appreciation of the exchange rate. In the case of the other countries the negative correlation probably reflects intervention by authorities in the exchange market.

Table 11: Correlation of Residuals in Vector Autoregression System of Exchange Rates, Value Added Deflator and Foreign Price of Traded Goods. (1974.2-1980.4)

Countries	$\rho(\hat{V}_E,\hat{V}_P v)$	$\rho(\hat{V}_E,\hat{V}_{FP} t)$	$\rho(\hat{V}_P v,\hat{V}_{FP} t)$
United States	-0.52	-0.91	0.55
Canada	-0.04	-0.58	0.53
Japan	-0.36	-0.73	0.39
United Kingdom	-0.33	-0.87	0.47
West Germany[1]	0.47	-0.83	-0.28
	0.23[1]	-0.75	0.07
Austria	0.15	-0.59	0.28
Netherlands	-0.20	-0.39	0.51
Denmark	-0.54	-0.56	0.22
Belgium	0.44	-0.25	0.17
France	-0.52	-0.88	0.62
Italy	0.13	-0.36	0.34
Norway	-0.49	-0.45	0.25
Sweden	-0.16	-0.79	0.40

Notes:

1. Correlation of residuals in system of equations estimated with three lags on each independent variable.

The correlation coefficient between innovations in the domestic and foreign price indices is positive, as expected, but relatively low. Given all the empirical findings so far, and the low overall variability of the P^V index it should be concluded that during the 1970s the focus of stabilization policies was on domestic inflation. This is also consistent with the mixed evidence on the correlation coefficient between the exchange rate and domestic price residuals. It is positive only in the cases of Germany, Austria, Belgium and Italy, and negative for all other countries. The results for Belgium and Italy, once again give some empirical support to the vicious circle theorizing in connection with these two countries (Basevi and de Grauwe, 1977), and sharply contrasts their experience with that of the Scandinavian small and open economies.

In general it can be concluded that innovations in the two price indices move generally together with causality running from foreign prices to domestic prices in the smaller countries and usually in both directions in the larger countries. Innovations in exchange rates and foreign prices are negatively correlated. In the case of small countries with managed nominal exchange rates the negative correlation would be consistent with contemporaneous intervention in the exchange market as a result of innovations in the foreign price level. In the large countries where both the nominal exchange rate and foreign price level are market determined, the high negative correlation would be consistent with opposite impact responses of the two indices to the same set of news or responses to different set ofnews which are negatively correlated. Finally, the evidence on the correlation in innovations between the exchange rate and the domestic price vector is mixed, with positive correlations in the most open economies (Germany, Austria, Belgium and Italy) and negative correlations elsewhere probably due to stabilization policies.

These results are only indicative of the complicated nature of the adjustment process and differences across countries which can have their origin in the nature of the unexpected shock, the structural responses to the disturbance or finally the policy reaction of the authorities. What is in fact striking is that some systematic patterns have indeed emerged.

It could be said that the process of adjustment in the smaller European countries is perhaps the most varied and complicated despite the "smallness" of the economy. As an example of differences in behavior, Figures 8 and 9 plot the response of the value-added deflator to unexpected shocks in foreign prices and the exchange rate for three small European countries which follow the DM closely, namely Belgium, the Netherlands and Norway. Here again substantial differences emerge in the dynamic path of adjustment of the domestic price index. Differences occur not only in the magnitude of oscillations, the oscillatory path itself and the speed of convergence but also in the direction of the short-run impulse response to distrubances.

The response of domestic prices to unexpected shocks in foreign prices for the three countries is presented in Figure 8. Adjustment is quite varied with an initial decrease in P^V in Belgium and Norway and a sharp increase in Netherlands and subsequent oscillations which are damped relatively fast in the first two countries (in less than thirty quarters) but slowly in the case of Netherlands. Figure 9 demonstrates the cross-country differences in the response of P^V to innovations

Figure 8: Response of Value Added Deflator to Shock in Foreign Prices of Traded Goods.

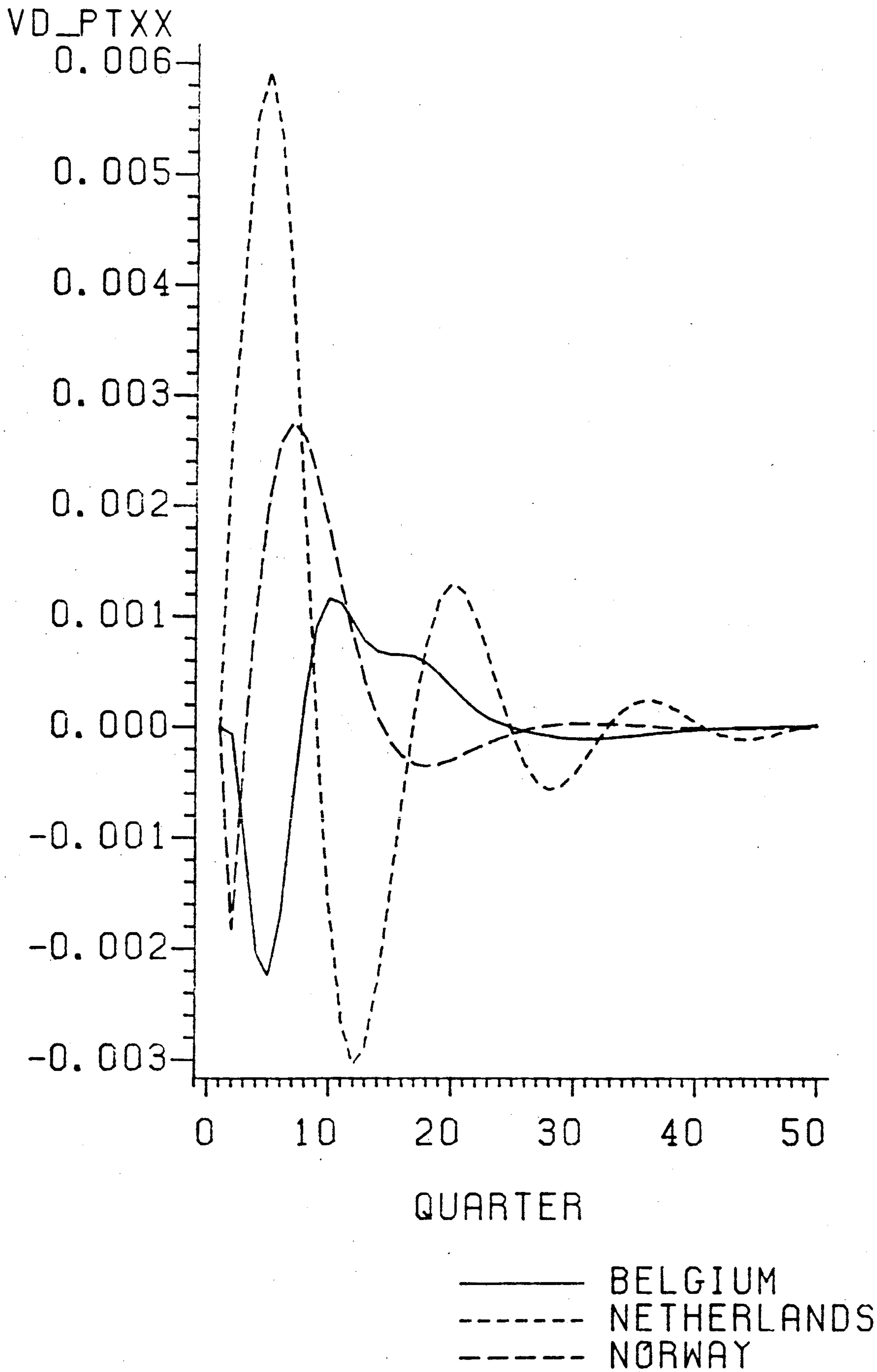
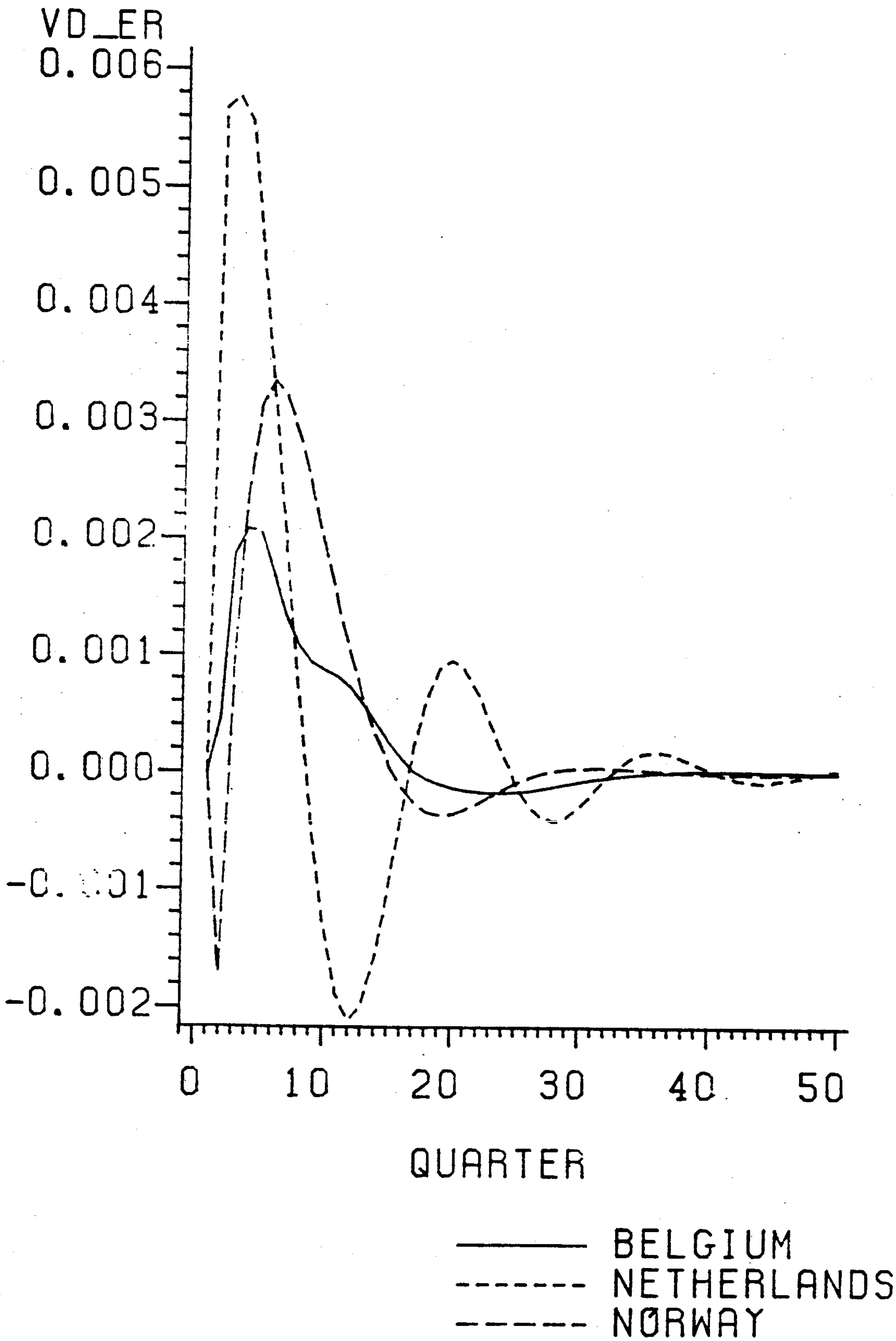


Figure 9: Response of Value Added Deflator to Shock in Exchange Rate.



in E. The Norwegian response where the value added deflator decreases following an unexpected depreciation, could have its origin to the importance of intermediate goods (Katseli 1980) or to the role of policy; any hypothesis, however, would be only a guess unless one possesses knowledge of the specific institutional and economic characteristics of the country.

The negative response of domestic prices following an unexpected nominal depreciation induces a larger depreciation of the real exchange rate relative to the nominal exchange rate. Interestingly enough the same pattern is observed in another Scandinavian country, namely Denmark, and is also characteristic of Austria. This pattern of response to innovations in exchange rates is quite different in the case of the other small European countries as can be seen in Table 12. It can be concluded that the induced movement in domestic prices following an unexpected depreciation makes real exchange rate adjustment probably easier in the case of the Scandinavian countries and Austria than in the other small countries of Europe. Given that current account adjustment is dependent on movements in the real rather than nominal exchange rate, this tentative conclusion would seem to indicate that the attainment of external balance requires a greater nominal devaluation in the case of the smaller countries of central Europe rather than in the case of their Northern neighbors.

Table 12: Impulse Reaction Functions: Responses of P^V to One Standard Deviation Shock in E (20 quarters)

Quarter \ Country	Denmark	Sweden[2]	Norway	Austria	Netherlands	Belgium	Italy
1	.0	.0	.0	.0	.0	.0	.0
2	-.20 D-02[1]	.59 D-02	-.17 D-02	-.13 D-03	.56 D-02	.45 D-03	.53 D-02
3	-.13	.11 D-01	.84 D-03	.21 D-02	.57	.19 D-02	.71
4	.43 D-03	.11	.24 D-02	.31	.56	.21	.45
5	.17 D-02	.66 D-02	.31	.39	.43	.21	.33 D-04
6	.23	.33 D-02	.33	.44	.32	.17	-.35 D-02
7	.23	.17	.32	.46	.19	.13	-.51
8	.20	.11	.28	.46	.70 D-03	.11	-.51
9	.14	.76 D-03	.24	.44	-.40	.94 D-03	-.43
10	.70 D-03	.43	.19	.41	-.13 D-02	.88	-.34
11	.94 D-04	.12	.14	.38	-.19	.82	-.26
12	-.38 D-03	-.11	.10	.35	-.21	.73	-.20
13	-.70	-.24	.64 D-03	.33	-.20	.58	-.15
14	-.85	-.29	.32	.32	-.16	.42	-.10
15	-.86	-.28	.62 D-04	.30	-.10	.26	-.60 D-03
16	-.77	-.23	-.13 D-03	.29	-.38 D-03	.12	-.27
17	-.62	-.15	-.26	.28	.19	.16 D-04	-.32 D-04
18	-.44	-.71 D-04	-.33	.26	.62	-.52	.13 D-03
19	-.25	-.11 D-05	-.36	.25	.88	-.95	.21
20	-.96 D-04	.47 D-04	-.35	.24	.95	-.12 D-03	.25

Notes:

1. Divided by 100; D-02 applies to all numbers below it. Same for D-01, D-03, D-04.

2. Sample period of estimation 1974.2-1979.4.

5. Conclusions

The objective of this paper was to study the movements of real exchange rates in the 1970s and to explore some of the inherent complications in the process of real exchange rate determination.

Real factors such as technological change, decreasing money illusion and changes in intertemporal preferences were shown to affect differently the equilibrium terms of trade and the relative price of traded to nontraded goods. Given the latter definition of the real exchange rate deviations around trend were shown to be quite varied across countries. So were the economic processes that dictated them.

Three rough country groupings emerged: the large industrialized countries with the possible exception of Japan, the Scandinavian countries and the smaller European countries.

In the major industrialized countries exchange rates can be considered predetermined with respect to relative prices. Past movements of nominal exchange rates, however, influence foreign prices in a way that is consistent with these countries' possession of market power. There is a strong positive correlation among residuals of nominal exchange rates and relative prices. This would be consistent with economic theorizing where unexpected increases in the money supply or other news cause a depreciation of the nominal exchange rate and an increase in the price of nontraded goods relative to the foreign currency price of traded goods. However, the strong positive correlation between innovations in E and P^v/FP^t cannot be accounted for by a strong positive correlation between innovations in E and P^v. The evidence is rather mixed (Table 11) but it seems to suggest that it is rather the outcome of strong negative correlations between innovations in E and FP^t, negative correlations between innovations in E and P^v and strong positive correlations between innovations in P^v and FP^t. This suggests that one should look more closely at patterns of interdependence among major industrialized countries.

The evidence presented so far also suggests that a non-discriminatory application of the "small-country" model to European experiences will be problematic unless one understands internal targets of policy and differences in structural characteristics.

In all small countries with the exception of Belgium, the nominal exchange rate does not seem to be affected by lagged values of domestic or foreign prices. The foreign price level of traded goods can be considered similarly predetermined. The domestic value added deflator, however, is strongly influenced by lagged values of foreign prices (Tables 8, 9, 10).

Differences across countries come with respect to their adjustment to innovations. "News" that affect nominal exchange rates and domestic prices are positively correlated in Austria, Belgium and Italy and negatively in the Netherlands and the Scandinavian countries. There is similarly a strong negative correlation of the $\bar{E}$ and $\overline{FP}^t$ residuals in the Scandinavian countries as opposed to the other smaller European countries. This could be the outoome of more independent nominal exchange rate policies in the Northern countries as opposed to the countries in the European Monetary System. There are also substantial differences in the path of adjustment as a response to innovations. The fundamental economic processes behind these systematic differences are not well understood. They merit closer attention and more careful analysis.

Appendix 1

In each country each sector uses a fixed stock of capital $\bar{K}_i$, and labor N_i which is free to move between sectors. The overall stock of labor is given and there is full employment. In each sector profit maximizing behavior would imply that the nominal wage is equated to the value of the own marginal product of labor. Thus, taking the nontraded goods sector as an example, and using again the exportable as a numeraire,

$$W = P_h \cdot f(\bar{K}_h, N_h);\ f_N < 0,\ f_K > 0 \qquad (1')$$

where, W = the real wage in terms of the exportable commodity.

The supply of labor is assumed to depend on the expected real wage $(\frac{W}{P^e})$ where the expected price level is itself a function of the consumer price index, and a shift parameter A. Thus,

$$W = P^e . g(\bar{N}, A);\ g_N > 0;\ g_A > 0 \qquad (2')$$

$$\text{where, } P^e = h(P);\ 1 \geq h' \geq 0 \qquad (3')$$

$$\text{and, } P = \alpha_1 P_h + \alpha_2 + \alpha_3 P_m \qquad (4')$$

Substituting (3') and (4') in (2') and equating the demand and supply of labor in each sector it follows that

$$W = P_h . f(\bar{K}_h, N_h) = h(\alpha_1 P_h + \alpha_2 + \alpha_3 P_m) \cdot g(\bar{N}, A) \qquad (5')$$

Assuming that all initial prices and hence $g(\bar{N}, A)$, $h(P)$ and $f(\bar{K}_h, N_h)$ are set equal to unity, equation (5') can be differentiated totally and solved for dN_h. Then,

$$f_N dN_h = (h'\alpha_1 - 1)dP_h + h'\alpha_3 dP_m + g_A dA - f_K dK_h. \qquad (6')$$

From (6') it follows that employment and hence output in the non-traded good sector is a positive function of P_h and K_h and a negative function of A and P_m. These are the assumed signs of the partial derivatives in the supply functions of the model. This is the most general specification of the labor markets that allows explicit consideration of different types of wage rigidities or degrees of money illusion.

Appendix 2

Local stability of a three by three system requires that the trace is negative and the determinant is negative. In the present case, sign ambiguities arise in elements a_{32}, a_{13} and a_{33} which are defined below. If a_{13} is positive and a_{32} and a_{33} are negative, then stability is guaranteed. This is equivalent to assuming that the cross elasticities of supply, i.e. E^*_{mh}, E_{hm}, and E_{xm} are sufficiently low. In other words, the determinant of the system can be described as follows:

$$|D| = \begin{bmatrix} a_{11} & 0 & a_{13} \\ 0 & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

where:

$$a_{11} = -(B_h - 1) - (1 + E_{hh})(1 - m_h(1-s)) - (1-s)m_h \frac{X_s}{P_h H_d} E_{xh} < 0$$

$$a_{21} = 0$$

$$a_{31} = -E_{xh}X_s(1 - m_x \frac{1}{P_x}(1-s)) - B_{xh}X_d - m_x \frac{1}{P_x} P_h H_s (1+E_{hh}) < 0$$

$$a_{22} = -(B^*_h - 1) - (1 + E^*_{hh})(1-m^*_h(1-s^*)) - m^*_h(1-s^*) \frac{P_m M^*_s}{P_h H^*_d} E^*_{mh} < 0$$

$$a_{32} = -B^*_{xh}X^*_d - m^*_h \frac{1}{P_x}(1-s*)[P_h H^*_s(1+E^*_{hh}) - P_m M^*_s E^*_{mh}] \; ?$$

$$a_{13} = E_{hm} + B_{hm} - m_h(1-s)[E_{hm} + \frac{X_s}{P_h H_d} E_{xm}] \; ?$$

$$a_{23} = E^*_{hm}(1-m^*_h(1-s^*)) + B^*_{hm} + m^*_h\ (1-s^*)\ \frac{P_m M^*_s}{P^*_h H^*_d}\ (1 + E_{mm}) > 0$$

$$a_{33} = - E_{xm}X_s - B_{xm}X_d - B^*_{xm}X^*_d + m_x \frac{1}{P_x}(1-s)(P_h H_s E_{hm} + X_s E_{xm}) + m^*_x \frac{1}{P^*_x}(1-s^*)$$
$$[P^*_h H^*_s E^*_{hm} - P_m M^*_s(1+E^*_{mm})]\ ?$$

The elasticities used in the solutions, all converted to be positive numbers are defined below:

B_h - own price elasticity of demand for home goods

B_{ij} - cross price elasticities of demand where i is the relevant sector and j the relevant price vector.

E_{ii} - own price elasticity of supply

E_{ij} - cross price elasticities of supply

m_i - marginal propensity to consume goods of sector i.

Appendix 3

Two sets of solutions are presented below. Holding M constant, P_h and P_m can be expressed as functions of all the exogenous variables. The first term in parenthesis is the numerator and its sign is given above it. Elements from the determinant matrix are presented as elements a_{ij} and their sign is specified in Appendix 2. The determinant, D, is assumed to be negative as required for stability. A complete listing of the elasticity terms is presented in Appendix 2.

+

$$\hat{P}_h = [(1-m_h(1-s))E_{h,K_h}(a_{22}a_{33} - a_{32}a_{23}) + m_x \frac{1}{P_x}(1-s)\, P_h H_s E_{h,K_h}(-a_{22}a_{13})]D^{-1}\hat{K}_h < 0$$

?

$$= [-(1-m_h^*(1-s^*))E^*_{h,K_h}(-a_{32}a_{13})) + m_x^* \frac{1}{P_x}(1-s^*)P_h^* H_s^* E^*_{h,K_h}(-a_{22}a_{13})]D^{-1}\hat{K}_h^*$$

−

$$= [-\frac{X_s}{P_h H_d} m_h (1-s)E_{x,K_x}(a_{22}a_{33}-a_{32}a_{23}) - E_{x,K_x} X_s (1-m_x \frac{1}{P_x}(1-s))(-a_{22}a_{13})]D^{-1}\hat{K}_x > 0$$

+

$$= [-\frac{P_m M_s^*}{P_h^* H_d^*} m_h^* (1-s^*)E^*_{m,K_m}(-a_{32}a_{13}) + m_x^* \frac{1}{P_x}(1-s^*)P_m M_s^* E^*_{m,K_m}(-a_{22}a_{13})]D^{-1}\hat{K}_m^* < 0$$

?

$$= [(-(1-m_h(1-s))E_{h,A} + m_h \frac{(1-s)}{P_h H_d} X^s E_{x,A})(a_{22}a_{33}-a_{32}a_{23}) + (E_{x,A} X_s (1-m_x \frac{1}{P_x}(1-s)) - P_h H_s E_{h,A} m_x \frac{1}{P_x}(1-s)).(-a_{22}a_{13})]D^{-1}\hat{A}$$

?

$$= [((1-m_h^*(1-s^*))E^*_{h,A} - m_h^*(1-s^*)\frac{P_m M_s^*}{P_h^* H_d^*} E^*_{m,A})(-a_{32}a_{13}) - m_x^* \frac{1}{P_x}(1-s^*)(P_h^* H_s^* E^*_{h,A} + P_m M_s^* E^*_{m,A})(-a_{22}a_{13})]D^{-1}\hat{A}^*$$

?

$$= [m_h \frac{Y}{P_h H_d}(a_{22}a_{33}-a_{32}a_{23}) - m_x \frac{Y}{P_x}(-a_{22}a_{13})]D^{-1}d_s$$

$$= [-m_h^* \frac{Y^*}{P_h^* H_d^*} (-a_{32}a_{13}) \overset{-}{-} m_x^* \frac{Y^*}{P_x} (-a_{22}a_{13})]D^{-1}\, ds^* \gtrless 0$$

$$= [-m_h \frac{1}{P_h H_d} \lambda M(a_{22}a_{33}-a_{32}a_{23})-m_h^* \frac{1}{P_h^* H_d^*} \lambda M^*(-a_{32}a_{13})+ (m_x \frac{1}{P_y} \lambda M-m_x^* \frac{1}{P_x} \lambda^* M^*)$$

$$(-a_{22}a_{13})]D^{-1}\hat{M}$$

$$\hat{P}_m = [(1-m_h(1-s))E_{h,K_h}(-a_{31}a_{22})\overset{?}{+}m_x \frac{1}{P_x} (1-s)P_h H_s E_{h,K_h}(a_{11}a_{22})]D^{-1}\, \hat{K}_h$$

$$= [-(1-m_h^*(1-s^*)E_{h,K_h}^*(a_{11}a_{32}) + m_x^* \frac{1}{P_x} (1-s^*)P_h^* H_s^* E_{h,K_h}^*(a_{11}a_{22})]D^{-1}\, \hat{K}_h^*$$

$$= [- \frac{X_s}{P_h H_d} m_h(1-s)E_{x,K_x}(-a_{31}a_{22}) \overset{?}{-} E_{x,K_x} X_s (1-m_x \frac{1}{P_x}(1-s))(a_{11}a_{22})]D^{-1}\hat{K}_x$$

$$= [\frac{P_m M_s^*}{P_h^* H_d^*} m_h^*(1-s^*)E_{m,K_m}^*(a_{11}a_{32}) \overset{+}{+} m_x^* \frac{1}{P_x}(1-s^*)P_m M_s^* E_{m,K_m}^*(a_{11}a_{22})]D^{-1}\hat{K}_m^* < 0$$

$$= [(-(1-m_h(1-s))E_{h,A} + m_h\frac{(1-s)}{P_h H_d} X^s E_{x,A})(-a_{31}a_{22})\overset{?}{+}(E_{x,A}X_s(1-m_x \frac{1}{P_x} (1-s))-m_x \frac{1}{P_x} (1-s)P_h$$
$$H_s E_{h,A}) \cdot (a_{11}a_{22})]D^{-1}\hat{A}$$

$$=[(1-m_h^*(1-s^*))E_{h,A}^*-m_h^*(1-s^*) \frac{P_m M_s^*}{P_h^* H_d^*} E_{m,A}^*)(a_{11}a_{32}) \overset{?}{-}m_x^* \frac{1}{P_x} (1-s^*)(P_h^* H_s^* E_{h,A}^* + P_m M_s^* E_{m,A}^*).$$

$$.(a_{11}a_{22})]D^{-1}\hat{A}^*$$

$$=[m_h \frac{Y}{P_h H_d} (-a_{31}a_{22})\overset{-}{-}m_x \frac{Y}{P_x} (a_{11}a_{22})]D^{-1}ds > 0$$

$$=[-m_h^* \frac{Y^*}{P_h^* H_d^*} (a_{11}a_{32}) \overset{-}{-} m_x^* \frac{Y^*}{P_x} (a_{11}a_{22})]D^{-1}ds^* > 0$$

$$=[-m_h \frac{1}{P_h H_d} \lambda M(-a_{31}a_{22})-m_h^* \frac{1}{P_h^* H_d^*} \lambda M^*(a_{11}a_{32}) + (m_x \frac{1}{P_x} \lambda M - m_x^* \frac{1}{P_x} \lambda^* M^*)(a_{11}a_{22})]D^{-1}\hat{M}$$

Appendix 4

Total differentiation of equation (11) yields the following expression:

$$\gamma_1\hat{P}_h + \gamma_2\hat{P}_m - \gamma_3\hat{M} = \delta_1\hat{K}_x + \delta_2\hat{K}_h + \delta_3\hat{A} + \delta_4 ds \qquad (1'')$$

where,

$$\gamma_1 = - E_{xh}X_s - B_{xh}X_d - B_{mh}P_mM_d - (m_x+m_m)(1-s)(P_hH_s(1+E_{hh})-X_sE_{xh}) < 0$$

$$\gamma_2 = -E_{xm}X_s - B_{xm}X_d - P_mM_d(1-B_{mm}) + (m_x + m_m)(1-s)(P_hH_sE_{hm} + X_sE_{xm}) ?$$

$$\gamma_3 = - (m_x + m_m)\lambda M \qquad < 0$$

$$\delta_1 = - E_{x,K_x}X_s(1-(m_x+m_m)X_s(1-s)) \qquad < 0$$

$$\delta_2 = (m_x + m_m)(1-s)P_hH_sE_{h,K_h} \qquad > 0$$

$$\delta_3 = E_{x,A}X_s - (m_x + m_m)(1-\lambda k)(P_hH_sE_{h,A} + X_sE_{x,A}) \qquad ?$$

$$\delta_4 = -(m_x + m_m)Y \qquad < 0$$

Substituting the flow equilibrium solutions for $\hat{P}_h$ and $\hat{P}_m$ with respect to each of the disturbances (see Appendix 3), equation (1") can be solved for $\hat{M}$ as a function of each of the exogenous variables. The effects on the relative prices can then be inferred from the $\hat{P}_h/\hat{M}$ and $\hat{P}_m/\hat{M}$ flow equilibrium solutions. Given the ambiguity of γ_2 and the noted ambiguities in Appendix 3 the relative movements of the two prices are hard to ascertain.

Footnotes

[1]For a review of the most recent round of debates on PPP see Katseli-Papaefstratiou (1979) and Frenkel (1981).

[2]This point was first raised and elaborated by Dornbusch (1976).

[3]Increases in domestic cost conditions could also be associated with a drop in foreign prices due to labor market behavior in the foreign country (Branson and Rotemberg, 1980) or the presence of intermediate goods (Katseli and Marion, 1982).

[4]For a discussion of overshooting of internal prices of home goods see Corden and Jones (1976) and Katseli-Papaefstratiou (1979b).

[5]If the demand elasticity for exports is not inifinite, devaluation by the home country reduces the foreign price of exports.

[6]Whether or not news about the current account affects nominal exchange rate movements will depend on the market's expectations about real exchange rate movements (Branson, 1977 and 1981).

[7]Most analyses at least in the finance literature abstract from long-run structural imbalances that may be planned especially in the context of developing economies with substantial foreign borrowings. Most notable exceptions are the works by Bruno (1976) and Bardhan (1970).

[8]Besides most trade theory models one should include in that tradition the work by Krugman (1981), Sachs (1981) and Branson (1981).

[9]In the flow equilibrium solutions, the stock of money is held fixed while in stock equilibrium it becomes endogenous as the current account is assumed to be balanced.

[10]The choice of the numeraire turns out to be important and linked to the homogeneity postulates of the demand functions.

[11]The capital stock is assumed to be held by the public sector and profits earned by the government are returned to the public in a lump-sum transfer.

[12]The exchange rate is assumed to be held constant or at least to be determined separately in asset markets (Katseli and Marion 1982). This will be shown to be consistent with the empirical findings later on. The model could be significantly enriched, if financial markets are introduced and expectations explicitly modelled.

[13]The relevant wholesale price index was also used in subsequent tests as a proxy for traded good prices. The results are not reported here but are available upon request.

[14]The weights used in these calculations are based on trade in manufacturing commodities between fourteen countries all of which are included in our sample with the sole exception of Switzerland. They can be readily obtained from the author.

[15]In a second order difference equation with complex roots convergence requires that the modulus $R(= \sqrt{a_2})$ is smaller than unity.

[16]The impulse reaction functions are run under the assumption that the variance-covariance matrix of the disturbances is in fact diagonal. This assumption is hard to justify in the case of the large industrialized countries where the correlation coefficient of residuals is high.
Three factors prompted this choice however: (a) there is no unique way of orthogonalizing the disturbances and thus the only acceptable alternative

would have been to investigate all possible orthogonalizations; (b) the impulse reactions could be interpreted as a shock to the distinct part of each residual in the VAR system; and (c) since there is no *a priori* reason why the appropriate orthogonalization is different across the chosen subset of countries, cross country comparisons of impulse reactions are still informative.

Bibliography

Argy, V. and J. Salop, 1979. "Price and Output Effects of Monetary and Fiscal Expansion in a Two-Country World Under Flexible Exchange Rates", IMF, mimeo.

Ashenfelter, O. and D. Card, 1981. "Time-Series Representations of Economic Variables and Alternative Models of the Labor Market", Discussion Paper No. 81/109, Princeton, July.

Bardhan, P. K., 1970. Economic Growth, Development, and Foreign Trade: A Study in Pure Theory, Wiley-Interscience, John Wiley & Sons.

Basevi, G. and P. DeGrauwe, 1977. "Vicious and Virtuous Circles: A Theoretical Analysis and a Policy Proposal for Managing Exchange Rates", European Economic Review, 10, pp. 277-301.

Branson, W., 1981. "Macroeconomic Determinants of Real Exchange Rates", NBER Working Paper #801, November.

__________, 1977. "Asset, Markets and Relative Prices in Exchange Rate Determination", Sozialwissenschaftliche Annalen, 1, pp. 69-89.

__________, and J. Rotemberg, 1980. "International Adjustment with Wage Rigidity", European Economic Review, 13, pp. 309-332.

Bruno, M., 1976. "The Two-Sector Open Economy and the Real Exchange Rate", AER, Vol. 66, pp. 566-577.

Corden, M. and R. M. Jones, 1976. "Devaluation, Non Flexible Prices and the Trade Balance for a Small Country", Canadian Journal of Economics, February.

Dornbusch, R., 1976. "Expectations and Exchange Rate Dynamics", Journal of Political Economy, December.

__________, 1973. "Devaluation, Money and Non-Traded Goods", American Economic Review, December.

Findlay, R. and C. Rodriguez, 1977. "Intermediate Imports and Macro-economic Policy under Flexible Exchange Rates", Canadian Journal of Economics, Vol. 10, 2, May.

Frenkel, J., 1981. "Flexible Exchange Rates, Prices and the Role of 'News': Lessons from the 1970's", Journal of Political Economy, 89, August, pp. 665-705.

Giavazzi, F., 1980. "Exchange Rate and Current Account Dynamics Following Real Disturbances," mimeo, August.

Jones, R, 1979. "Technical Progress and Real Incomes in a Ricardian Trade Model", Ch. 17 in Jones, R., International Trade: Essays in Theory, North Holland.

Katseli-Papaefstratiou, 1980. "Transmissionof External Price Disturbances and the Composition of Trade," Journal of International Economics, 10, August, pp. 357-375.

____________________, 1979a, "The Reemergence of the Purchasing Power Parity Doctrine in the 1970s," Special Paper in International Economics, No. 13, December, Princeton.

____________________, 1979b. Transmission of External Price Disturbances in Small, Open Economies, Garland Press, N.Y.

Katseli, L. and N. P. Marion, 1982. "Adjustment to Variations in Imported Input Prices: The Role of Economic Structure", Weltwirtschaftliches Archiv, Band 118, Heft 1.

Keynes, J. M., 1930. A Treatise on Money, Vol. I, London: Macmillan.

Krugman, P., 1981. "Real and Financial Determinants of the Real Exchange Rate", NBER Working Paper No.

__________, 1980. "Scale Economies, Product Differentiation and the Pattern of Trade", American Economic Review, December.

Obstfeld, M., 1981. "Aggregate Spending and the Terms of Trade: Is there a Laursen Metzler Effect", NBER Working Paper No. 686, June.

Ohlin, B., 1929a. "The Reparation Problem: A Discussion I. Transfer Difficulties, Real and Imagined," Economic Journal, June, 39 (154), pp. 172-8.

________, 1929b. "A Rejoinder", Economic Journal, September 39 (155), pp. 400-404.

Pearce, I. F., 1961, "The Problem of the Balance of Payments," International Economic Review, Jan., 2, pp. 1-28.

Sachs, J., 1981. "The Current Account in the Macroeconomic Adjustment Process", NBER Working Paper No. 796, November.

Sargent, T. J., 1979. "Estimating Vector Autoregressions Using Methods Not Based on Explicit Economic Theories", Federal Reserve Bank of Minneapolis Quarterly Review, Summer, pp. 8-15.

Sims, C. A., 1980. "Macroeconomics and Reality", Econometrica, 48, Jan., pp. 1-48.

Srinivasan, T. N., 1982. "International Factor Movements, Commodity Trade and Commercial Policy", Economic Growth Center Discussion Paper No. 399, March.

Taylor, J. B., 1980. "Output and Price Stability: An International Comparison", Journal of Economic Dynamics and Control, Volume 2 February, pp. 109-132.