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THE BEHAVIOR OF REAL EXCHANGE RATES

James R. LOTHIAN *

Citicorp Investment Bank, New York, NY 10043, USA

Abstract: Dominating the behavior of real exchange rates for the dollar during the course of the past two and a half decades have been two substantial and for many countries largely offsetting movements. In the years surrounding the breakdown of Bretton Woods most exchange rates fell precipitously and throughout the 1970s remained low. Near the start of the 1980s they began a rise that continued more or less unabated until early 1985. Any explanation of exchange rate behavior over this period, therefore, has to account for both of these movements, not simply the increase in real exchange rates for the dollar in the 1980s that has been the topic of so much discussion in the financial press. The explanation offered in this paper attributes these movements to the two important changes in monetary policy that occurred during these years.

Keywords: Exchange rates, Purchasing power parity, Real exchange rates, Monetary policy.

1. Introduction

In the course of a letter written sometime in the late 1970s, the exact topic of which escapes me, a subscriber to a Citibank publication expressed the view that 'Anyone who forecasts exchange rates must have a death wish'. The behavior of exchange since then, coupled with the results of research into such behavior, at first glance appears to have done little to disprove that statement.

The dollar appreciated continually and substantially against most major currencies throughout most of the first half of this decade. Then in the early 1985 it began a process of steady depreciation. Both exchange-rate swings, moreover, were well in excess of movements in actual inflation differentials. Purchasing power parity, which in the seventies has come to be increasingly questioned as a rule of thumb, appeared to have broken down further in the eighties. Talk of 40% or even 50% dollar overvaluation became commonplace. At the same time, a number of studies appeared that in one way or another pointed to considerable problems with exchange-rate equations that only a short time before had been considered state of the arts.

The purpose of this paper is, so to speak, to go back to square one – to reexamine the exchange-rate data, to see if any regularities can be uncovered and, if so, which economic factors

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would be capable of accounting for them. Because one of the objects is to examine exchange-rate behavior over a long time period, the focus is on real as opposed to nominal rates. [1]

The first part of the paper is largely descriptive. In it, I examine the movements in real dollar and to a lesser extent real DM exchange rates over the period 1957 through 1985. With respect to real dollar exchange rates there is one important finding: most such exchange rates were dominated by two substantial movements, a sharp decline in the early 1970s and equally sharp rise in the early 1980s. For most countries individually and for all countries on average these two swings were largely offsetting. In that, albeit limited, sense, purchasing power parity did hold tolerably well during the sample period. A further implication is that any explanation of shorter term exchange rate behavior will first of all have to be able to account for those two movements. This is the subject of the remainder of the paper.

2. Actual exchange-rate behavior

Throughout I define the real exchange rate as

$$q_t = e_t - (p_t - p_t^*), \tag{1}$$

where e is the logarithm of the foreign currency price of a United States dollar (or Deutschmark) and p and p^* are the logarithms of indexes of the foreign and U.S. (or German) price levels, respectively. In each instance, the base year of the price index was 1970. To take account of differences in price levels among countries, I adjusted the price indexes by the Kravis et al. (1978) estimates of equilibrium price levels in 1970. The end result, therefore, is two sets of indexes of deviations from absolute purchasing power parity, one relative to the dollar, the other relative to the DM. [2]

The actual behavior of these measures of real exchanges rates for 11 industrial countries viewed both individually and on average during the period 1957: I through 1985: IV is summarized in the charts labelled exhibits 1 and 2 and in the related tables labelled exhibits 3 through 8.

Suppose we turn to the charts of the real U.S. dollar exchange rates first. Here there are two things in particular to notice. One is the level of each of the exchange rates in 1970 – the year to which the cross-country price estimates apply. The other is the pattern of movements of the exchange rates over time.

In all instances, the logarithms of the real exchange rates for the dollar in 1970 were greater than zero – the dollar was above its purchasing power parity level. With the exception of Canada, moreover, such positive deviations were the rule throughout the 14-year portion of the Bretton Woods period spanned by these data – a sufficiently long period that it is difficult to associate these deviations purely with disequilibria.

After 1970, however, when the Bretton woods system began to break down, there was a pronounced decline in most such measures of real exchange rates to levels well below zero in

[1] The two exchange-rate regimes encompassed by this sample period, in theory, have substantially different implications with respect to the behavior of nominal exchange rates and monetary policy. The Lucas critique, therefore, clearly applies. Examining real exchange rates is one way to approach the problem. An alternative would be to estimate a simultaneous model in which policymakers' reaction functions for both exchange rates and monetary policy appeared explicitly and were allowed to vary between regimes.

[2] The article by Kravis et al. contains estimates of foreign vs. U.S. equilibrium price levels for 1970. I extrapolated these measures backward and forward in time using quarterly cost of living indexes published by the International Monetary Fund.

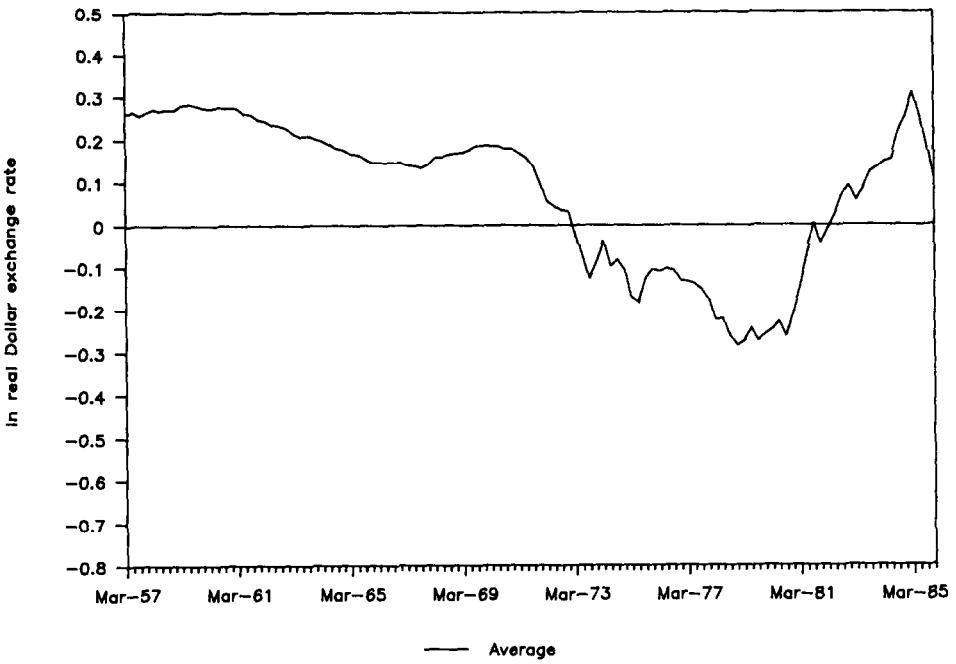


Exhibit 1a.

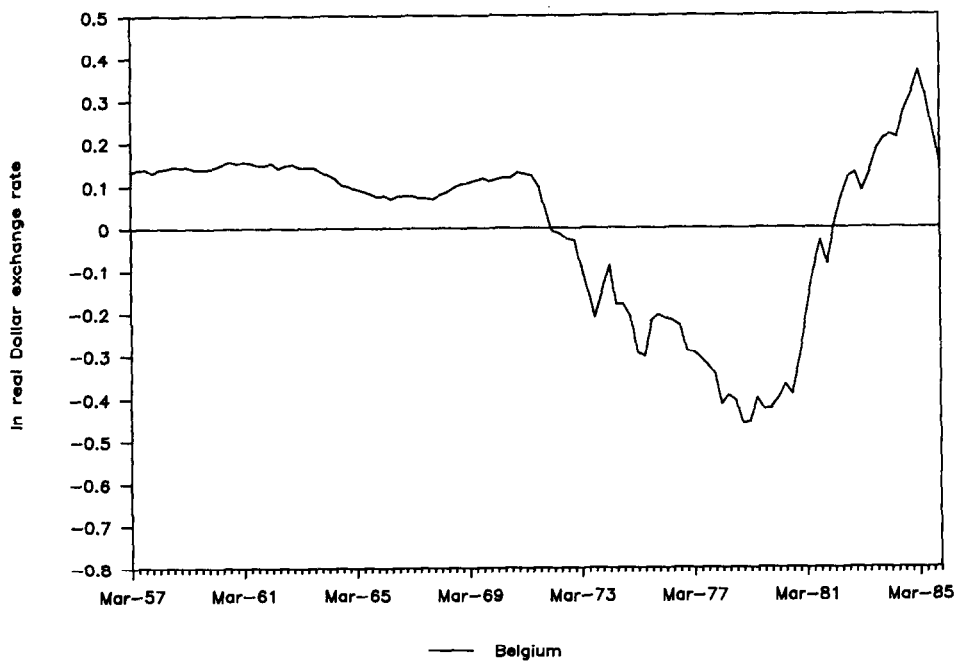
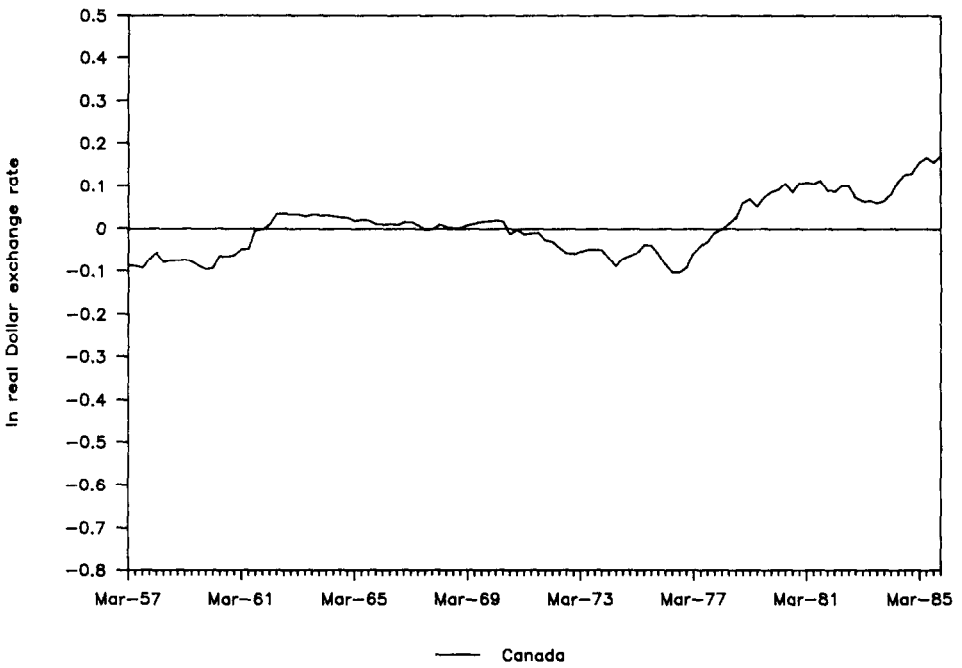


Exhibit 1b.



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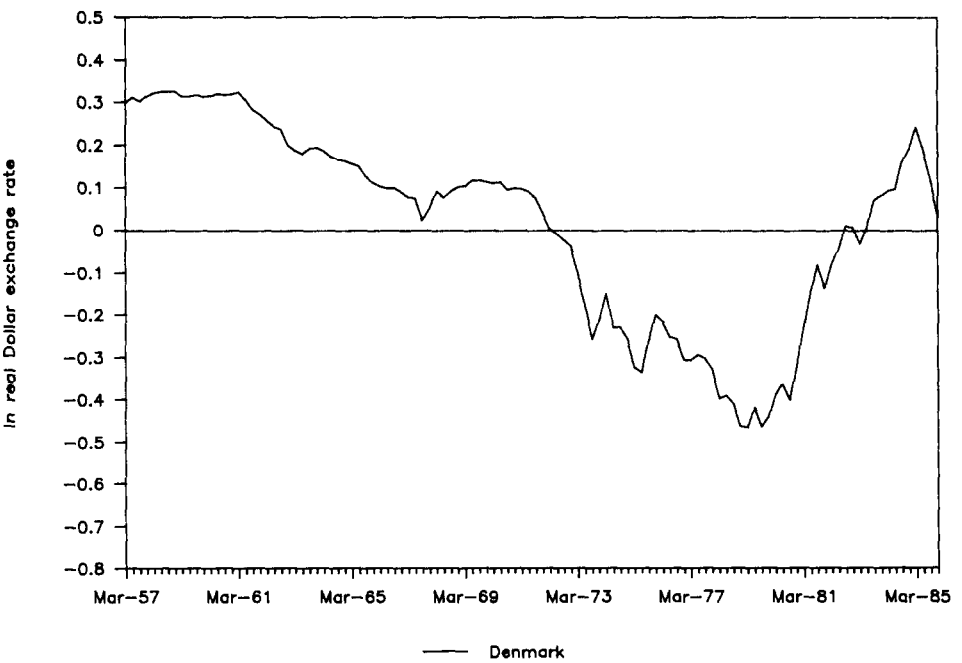

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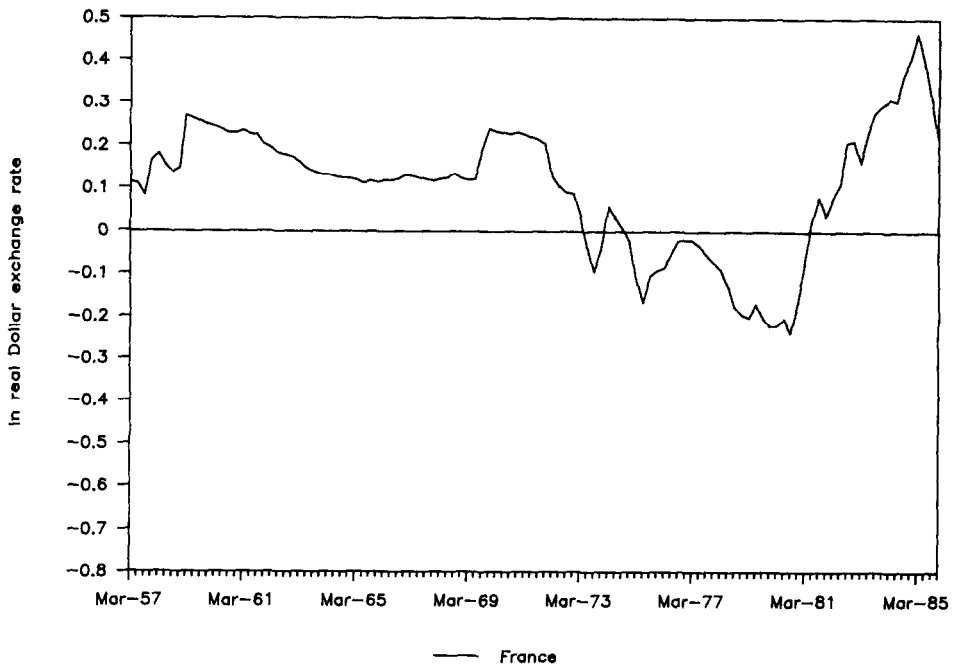

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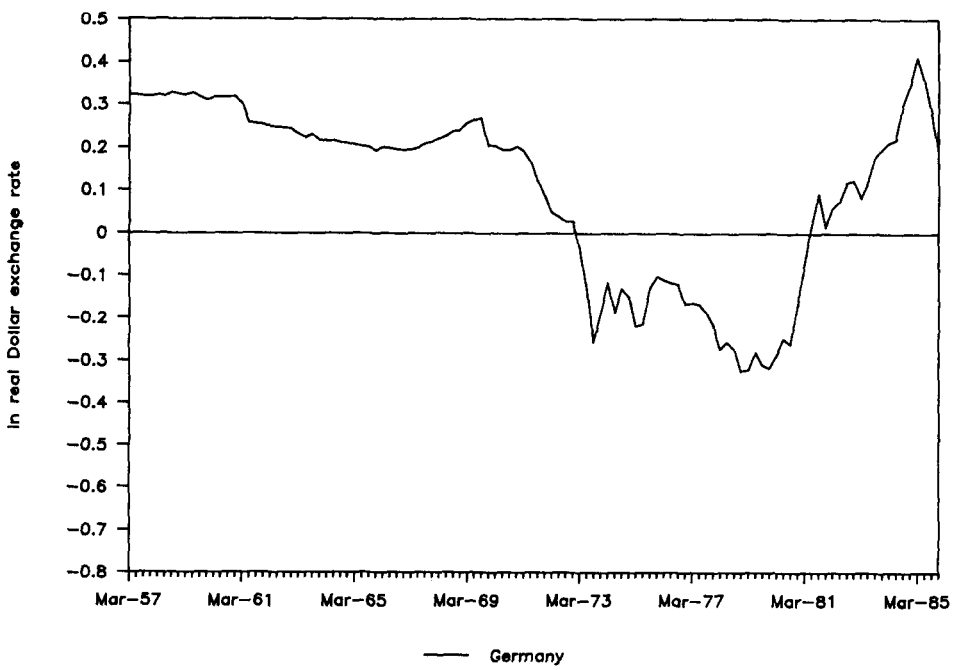

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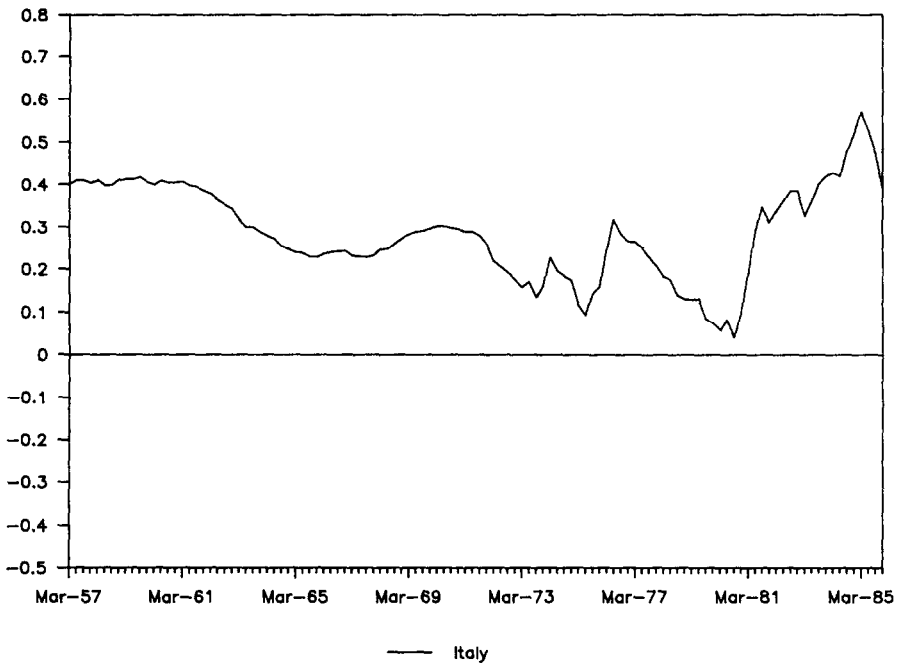

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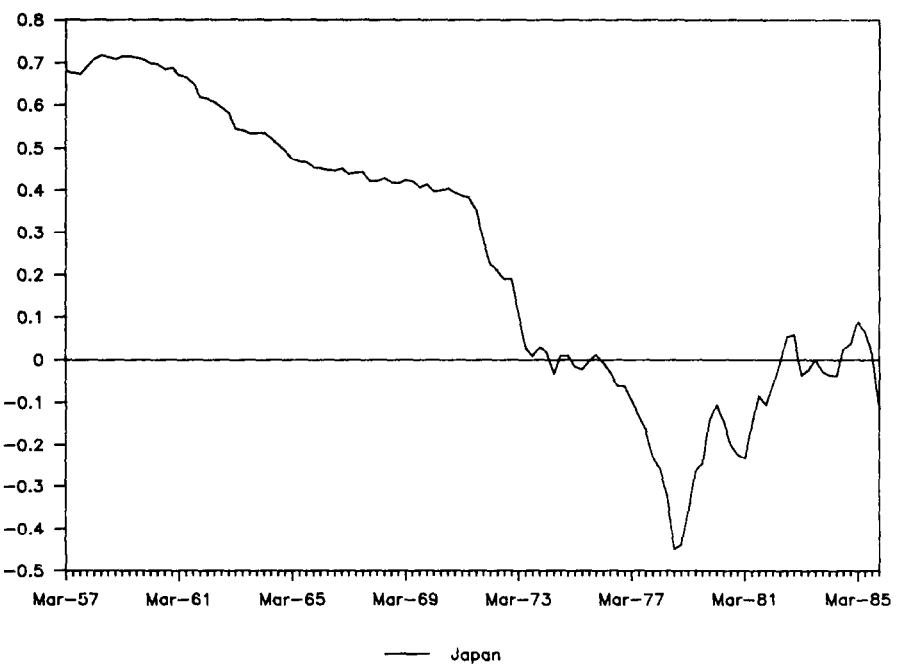

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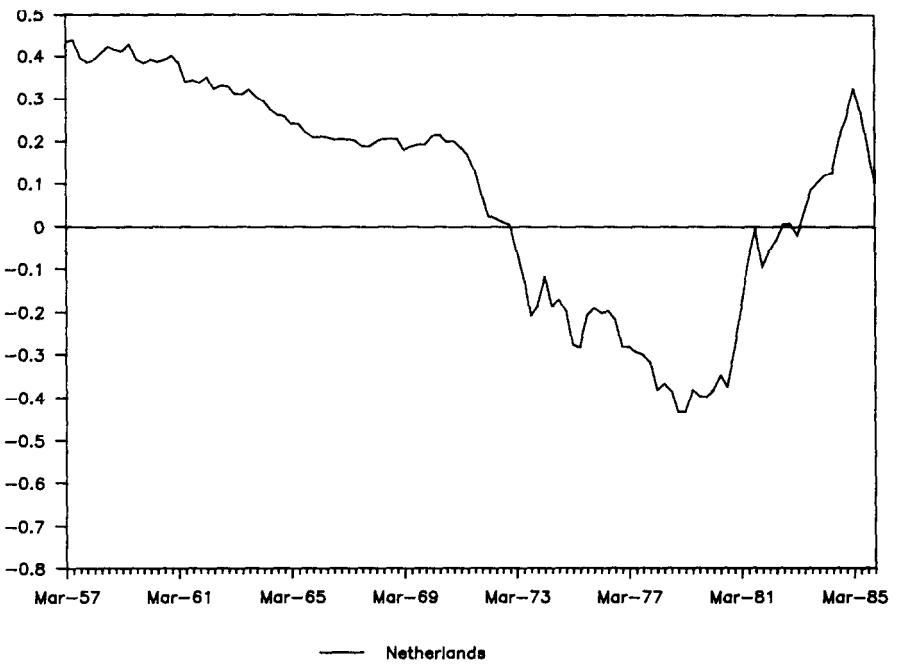

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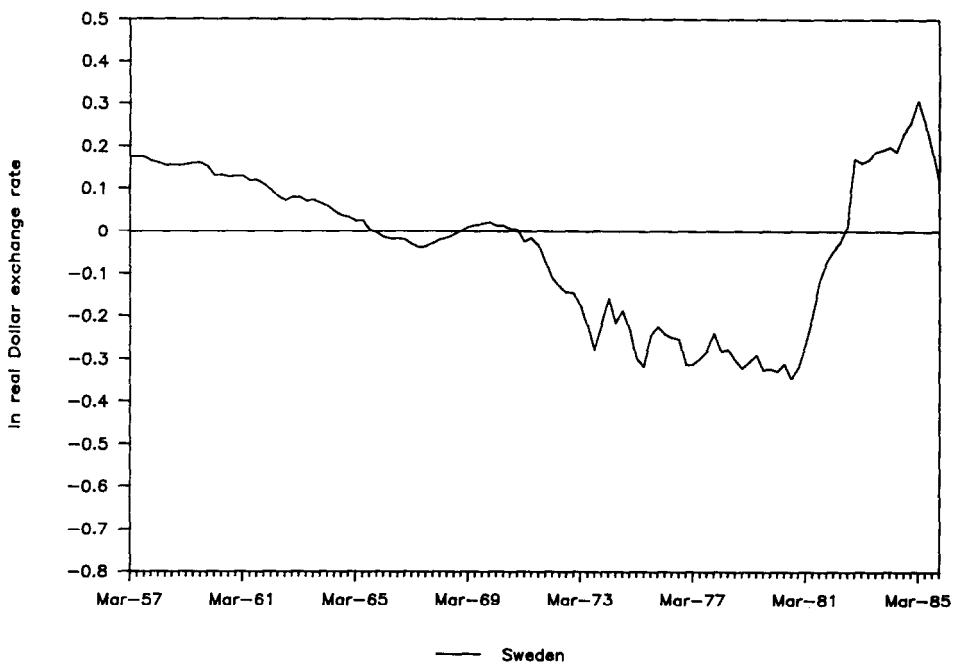

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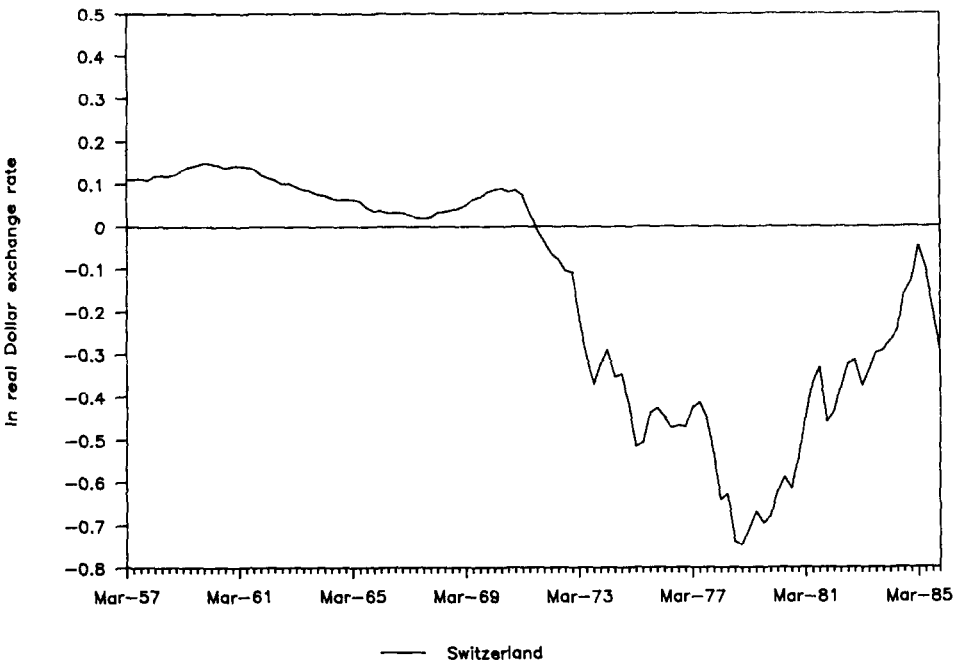

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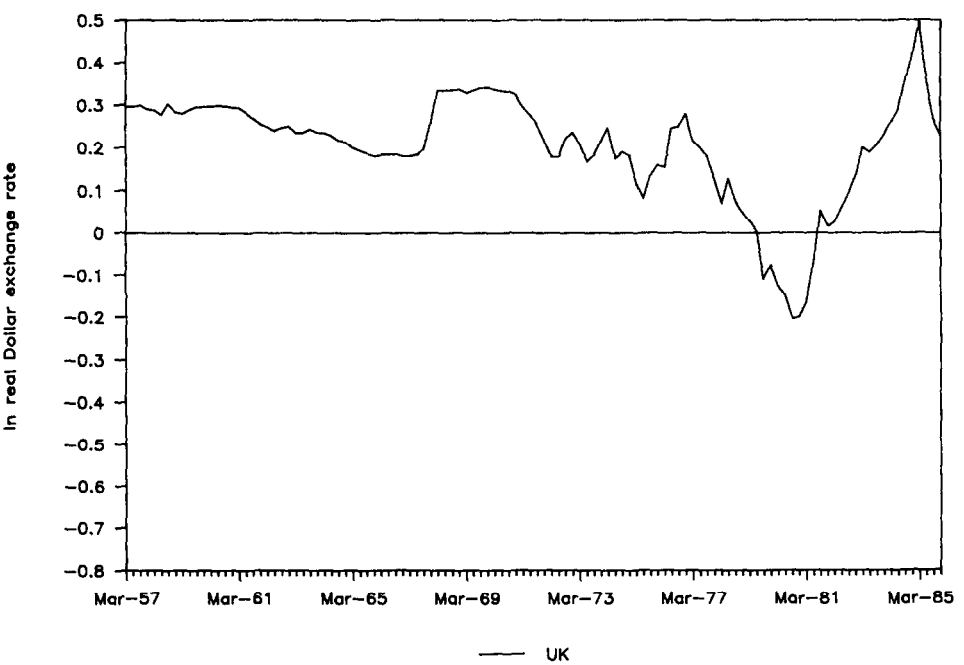

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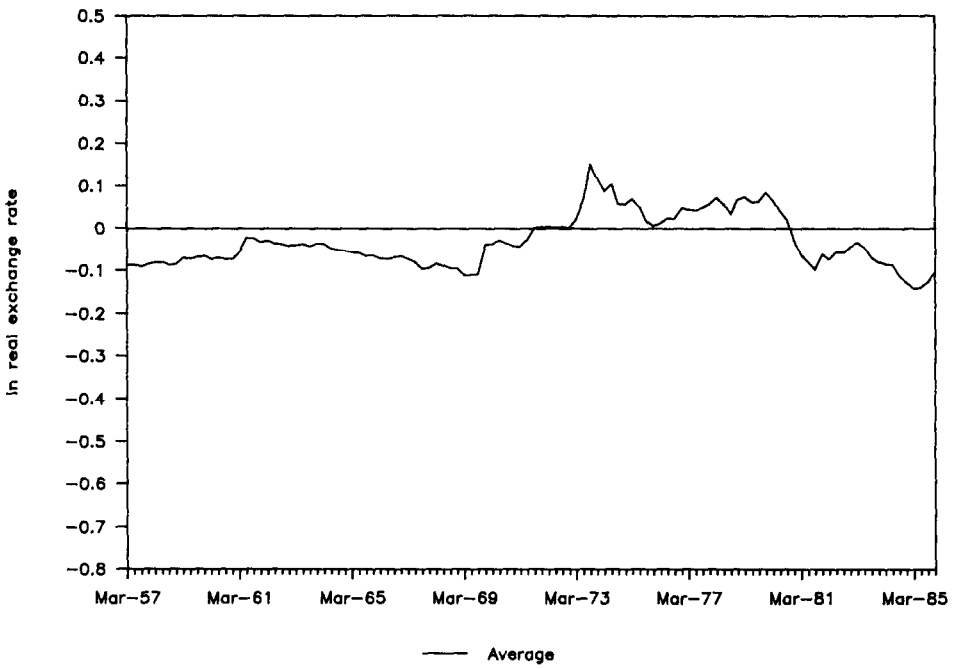

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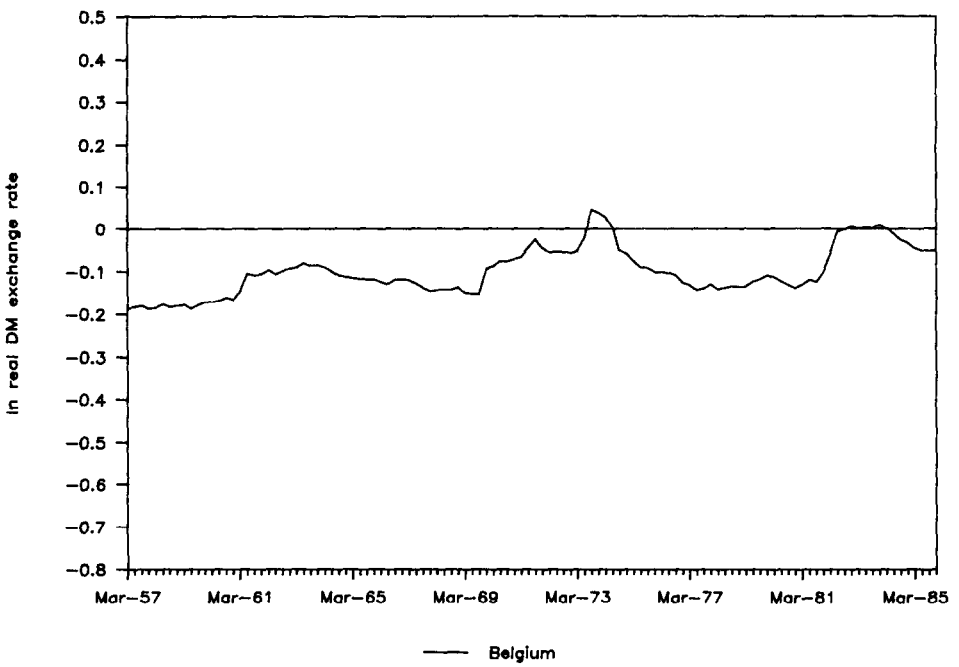

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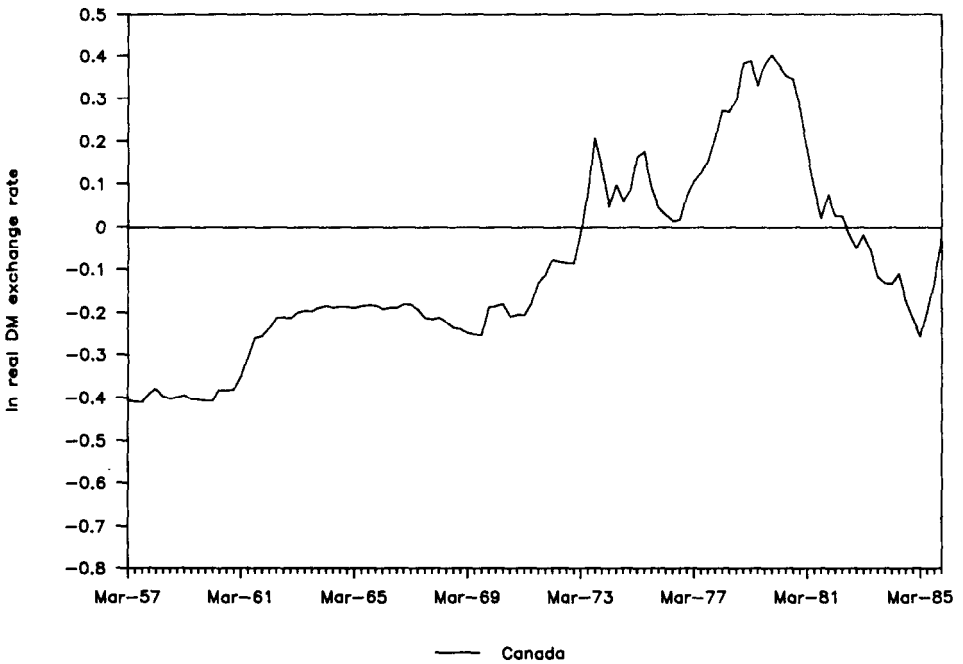

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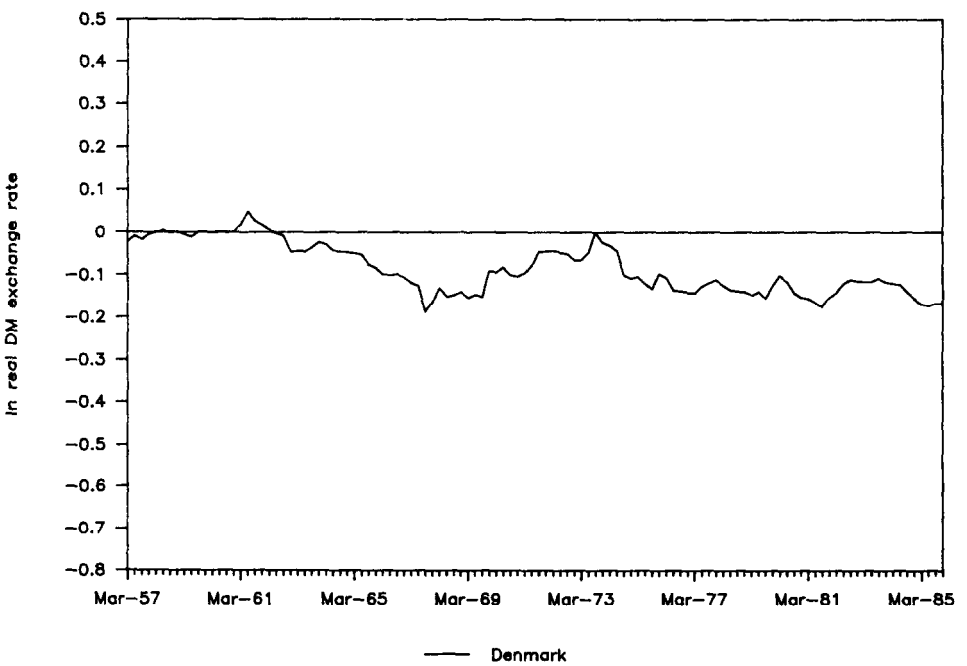

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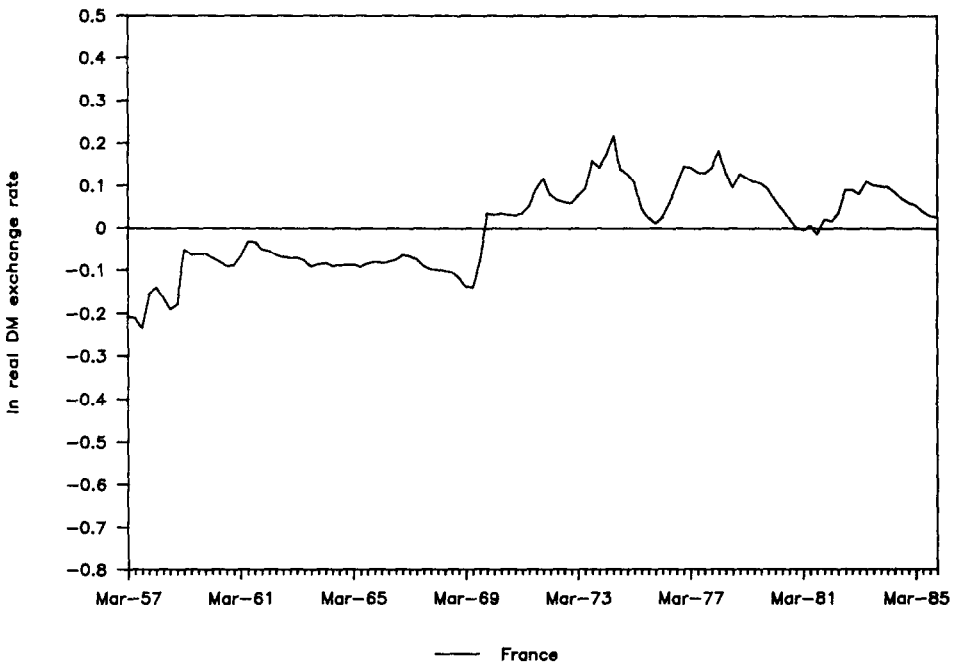

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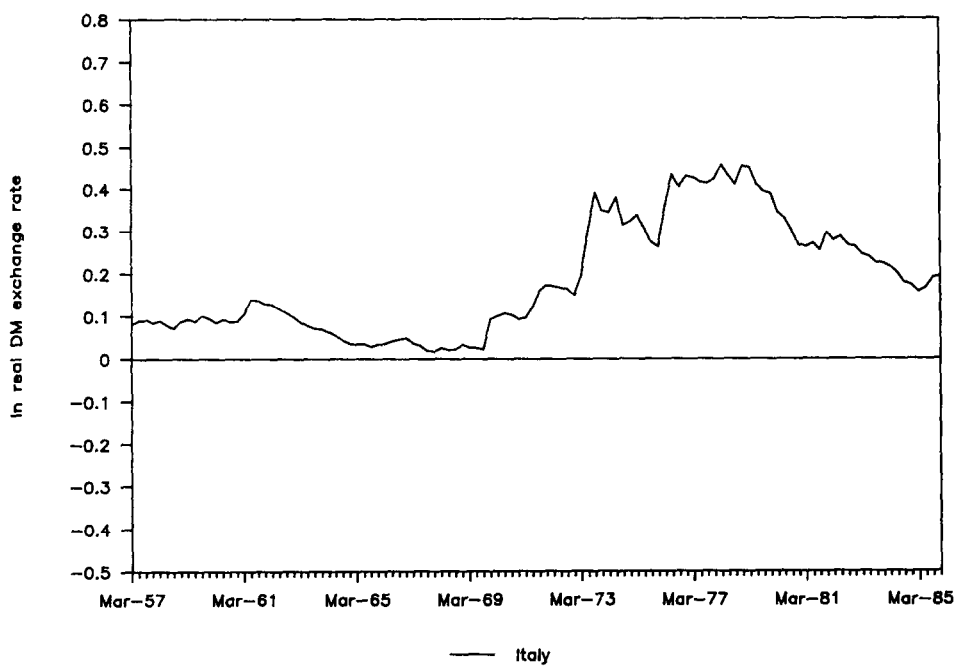

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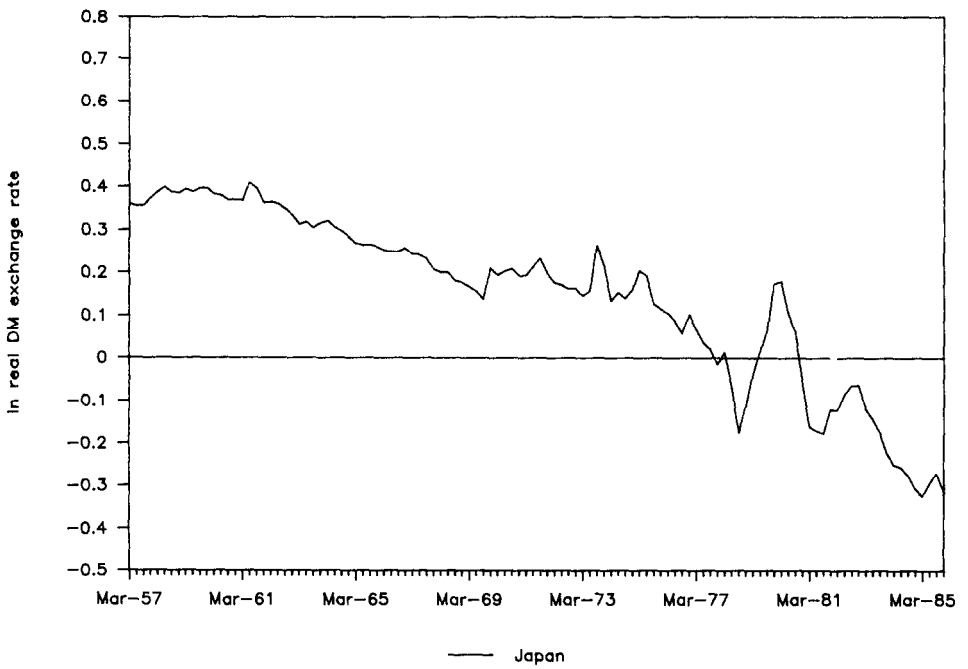

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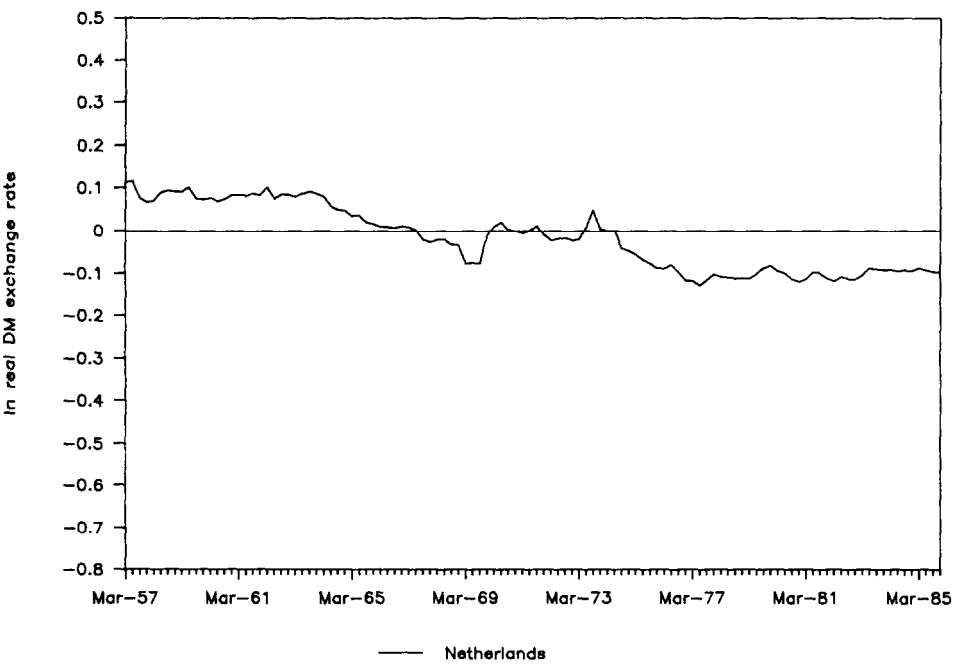

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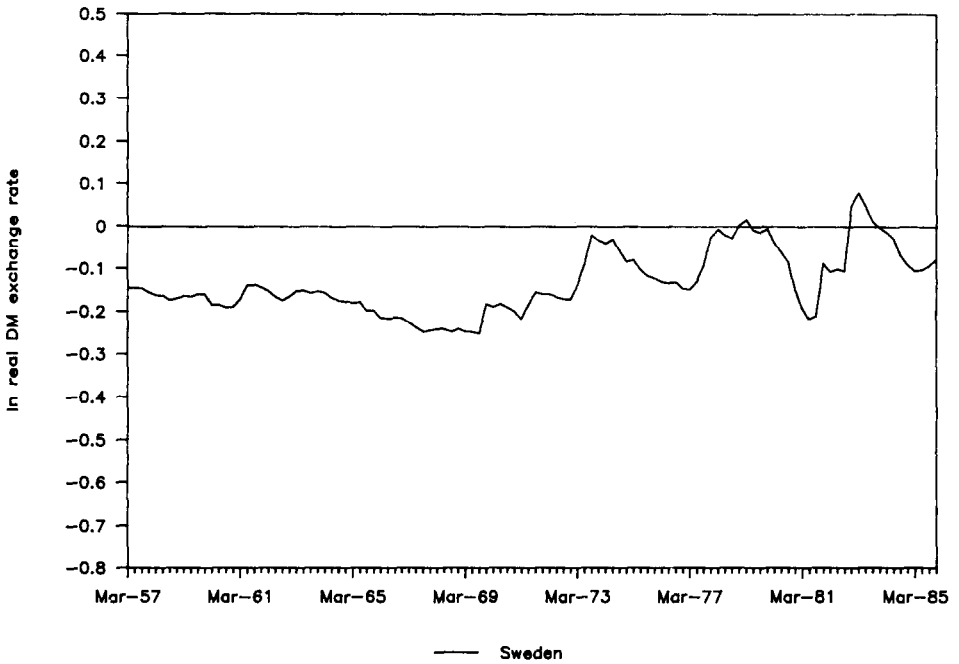
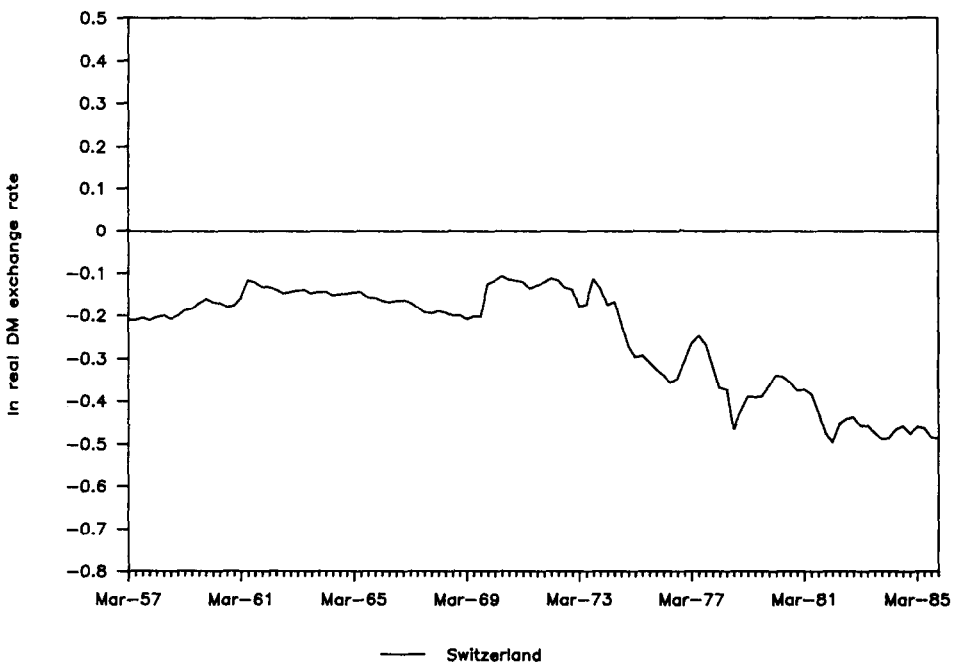


Exhibit 2i.



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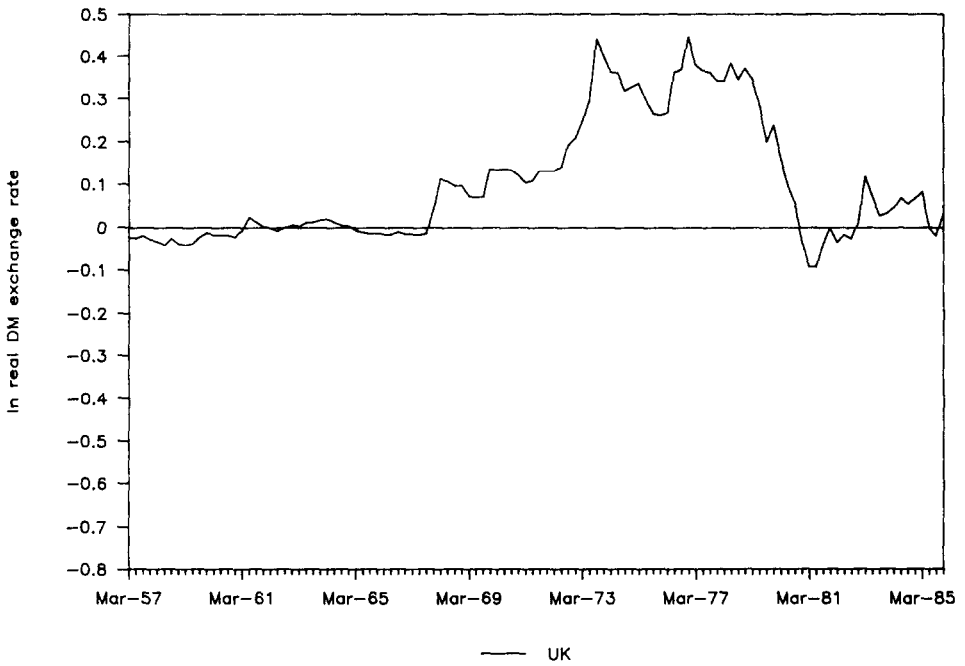

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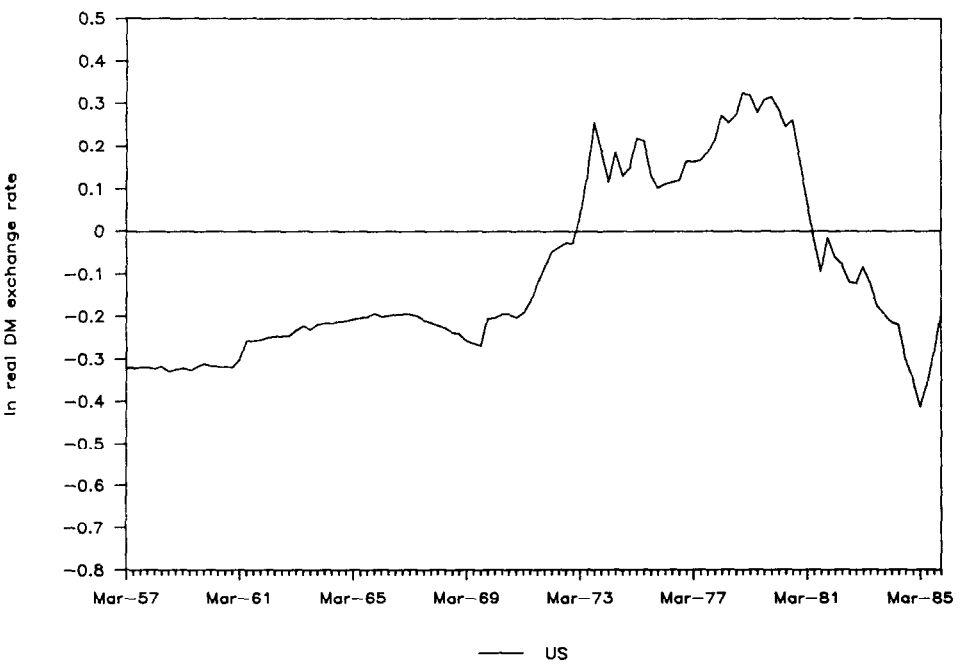

Exhibit 2l.

Exhibit 3
Correlation of real dollar exchange rates (1957: I–1985: IV).

	BEL	CAN	DEN	FRANCE	GER	ITALY	JAPAN	NETH	SWEDEN	SWITZ
BEL										
CAN	0.085									
DEN	0.932	−0.147								
FRANCE	0.948	0.103	0.850							
GER	0.963	−0.006	0.973	0.890						
ITALY	0.819	0.072	0.781	0.868	0.810					
JAPAN	0.719	−0.423	0.894	0.587	0.818	0.487				
NETH	0.921	−0.150	0.993	0.824	0.972	0.740	0.914			
SWEDEN	0.947	0.105	0.916	0.913	0.934	0.888	0.674	0.893		
SWITZ	0.845	−0.281	0.938	0.746	0.902	0.572	0.951	0.955	0.755	
UK	0.728	−0.332	0.714	0.764	0.720	0.672	0.615	0.710	0.684	0.723

Source: IMF International Financial Statistics and Kravis et al. (1978).

Exhibit 4
Rates of change of real dollar exchange rates (1957: I to 1985: IV and subperiods). [a]

PERIOD	BEL	CAN	DEN	FRANCE	GER	ITALY	JAPAN	NETH	SWEDEN	SWITZ	UK
57: I–85: IV	0.04	0.89	−0.94	0.38	−0.43	−0.04	−2.78	−1.15	−0.19	−1.39	−0.24
57: I–70: II	−0.11	0.76	−1.40	0.89	−0.95	−0.75	−2.13	−1.64	−1.21	−0.16	0.28
70: II–85: IV	0.17	0.99	−0.54	−0.05	0.01	0.57	−3.34	−0.73	0.68	−2.43	−0.68
70: II–73: IV	−7.72	−1.88	−9.34	−7.89	−10.98	−4.08	−10.57	−11.39	−6.72	−11.75	−3.41
73: IV–80: IV	−2.23	2.24	−1.54	−1.74	0.29	−0.90	−3.61	−1.49	−1.40	−3.14	−5.92
80: IV–84: IV	15.50	0.61	12.82	14.35	12.89	10.57	6.54	13.52	14.34	10.36	15.37
84: IV–85: IV	−16.74	3.89	−16.15	−18.42	−14.97	−12.79	−15.68	−15.08	−13.57	−16.04	−18.63

[a] Rates of change are continuously compounded average annual percentages.

Exhibit 5
Real dollar exchange rate regressions (1957: I to 1985: IV). [a]

	R_1^2	R_2^2	SEE_1	SEE_2	$STDEV$
BEL	0.787	0.776	0.095	0.097	0.203
CAN	0.470	0.049	0.049	0.066	0.067
DEN	0.783	0.717	0.111	0.125	0.235
FRANCE	0.673	0.645	0.087	0.090	0.151
GER	0.827	0.809	0.087	0.091	0.207
ITALY	0.561	0.501	0.074	0.078	0.110
JAPAN	0.834	0.457	0.135	0.244	0.330
NETH	0.812	0.724	0.114	0.721	0.260
SWEDEN	0.724	0.722	0.093	0.093	0.176
SWITZ	0.844	0.591	0.109	0.175	0.273
UK	0.294	0.239	0.108	0.111	0.127

[a] R_1^2 and SEE_1 are for the regression $q_t = a_1 + a_2 D_2 + a_3 D_3 + e_t$ where q_t is the logarithm of the real dollar exchange rate, D_2 is a dummy taking the value 1 from 1972: III to 1980: IV and 0 otherwise, and D_3 is a dummy taking the value 1 from 1981: I to 1985: IV and 0 otherwise. R_2^2 and SEE_2 are for the regression $q_t = a_1 + a_2 D_2 + e_t$. $STDEV$ is the standard deviation of the logarithm of the real dollar exchange rate.

Exhibit 6
Correlation of real DM exchange rates (1957: I–1985: IV).

	BEL	CAN	DEN	FRANCE	ITALY	JAPAN	NETH	SWEDEN	SWITZ	UK
BEL										
CAN	0.288									
DEN	−0.150	−0.530								
FRANCE	0.639	0.741	−0.372							
ITALY	0.287	0.853	−0.351	0.818						
JAPAN	−0.479	−0.514	0.769	−0.583	−0.515					
NETH	−0.313	−0.727	0.870	−0.655	−0.662	0.857				
SWEDEN	0.507	0.608	−0.147	0.688	0.739	−0.524	−0.456			
SWITZ	−0.255	−0.492	0.653	−0.424	−0.567	0.874	0.778	−0.631		
UK	0.266	0.666	−0.249	0.740	0.760	−0.213	0.448	0.465	−0.113	
US	0.194	0.951	−0.374	0.726	0.876	−0.317	−0.605	0.555	−0.320	0.793

Source: See exhibit 3.

logarithmic terms and a tendency during the 1970s as a whole for most of those rates to be maintained more or less in the ranges to which they initially declined. Then, sometime around the start of this decade, there was an equally pronounced movement in the opposite direction, with most real exchange rates for the dollar returning to levels equal to or higher than their levels in 1970.

The typical pattern, suggested by these data is that of a modified U. The 1970s were the bottom part of the U, the transitions at the start and end of that decade the two upright portions and the rest of the sample period – the late 1950s and 1960s and the early 1980s – linear projections from those uprights.

A glance at the correlation matrix shown in exhibit 3 provides a further indication of the broad overall correspondence among countries and the relative strength of the association between particular pairs of countries. Canada, which in a number of ways is the country most closely linked to the United States, again is the one outlier. The 10 Canadian real rate correlations are all negative and in several instances significantly so. The remaining 45 pairwise correlations, in contrast, are all positive and highly significant. With the exception of the correlation coefficients for the United Kingdom and, to some extent also those for Italy and Japan, they are all close to 0.90 or higher.

A further item of interest brought out by these charts is the relative stability of real dollar exchange rates during a large portion of the floating rate period, in the Bretton Woods period, and between the Bretton Woods period and the mid 1980s. Contrary to casual impression, purchasing power parity held tolerably well from 1957 to 1970, again from 1973 through 1980 and between 1970 and early 1985. [3]

This feature of the data is illustrated another way in exhibits 4 and 5. In the one I show continuously compounded average annual percentage rates of change of real exchange rates for the dollar over the full period and various subperiods. In the other I report summary statistics for dummy variable regressions that I used to perform analyses of variance of the real exchange rates for the dollar for each of the countries separately.

The table labelled exhibit 4 shows a pattern of rates of change that largely corresponds to our verbal description of the graphical evidence. All countries other than Canada show small per annum percentage changes in the periods 1957: I to 1970: II and 1973: IV to 1980: IV, large declines from

[3] In Lothian (1985), I present evidence on long-run purchasing power parity for a sample of 20 OECD countries over the years 1956 to 1980 that is consistent with these findings. In this regard, also see the recent paper by Davutyan and Pippenger (1985).

1970: II to 1973: IV, and large, in several instances, somewhat more than offsetting cumulative increases between 1980: IV and 1985: I.

For the long period 1970: II to 1985: I the average annual rates of change for most countries – Japan and Switzerland are notable exceptions – show little change. [4] The average change is a decline of slightly less than half a percentage point per year. Expressed as a mean cumulative percentage change the figure works out to −7.6%.

These calculations are also relevant to the much discussed question of dollar overvaluation in the 1980s. The choice of the base year – the year when equilibrium is assumed to hold – which is always of some importance in purchasing-power-parity-based calculations, is particularly crucial over this period.

Pick 1980, or as it happens any point from the middle of 1972 to the early portion of 1981, and the overvaluation appears truly substantial. Pick a year somewhat earlier than that – either, 1970, the year to which the estimates of equilibrium rates apply or, indeed, any year from the late 1950's through 1970 – and the overvaluation appears much smaller and for some countries turns into an apparent undervaluation.

The summary of regression results in exhibit 5 merely adds to this general story. Listed there are R^2's from two sets of dummy variable regressions, the corresponding standard errors of estimate from those regressions and the standard deviations of the logarithm of the real exchange rates themselves.

The first such set of regressions took the form

$$q_t = a_1 + a_2 D_2 + a_3 D_3 + e_t, \tag{2}$$

where D_2 is a dummy variable taking the value 1 from 1972: III to 1980: IV and 0 otherwise, D_3 is a dummy taking the value 1 from 1981: I to 1985: IV and 0 otherwise, the a's are coefficients to be estimated and e_t is an error term. The second set of regressions simply omitted the latter dummy variable.

Consider the first set of regressions. The median R^2 for these regressions is 0.783. On average, therefore, the difference between the means for the three periods accounts for close to 80% of the variance in the quarterly series. The only countries that are somewhat out of line with that description are the United Kingdom, Italy and Canada. At the same time, the median standard error for these regressions is 0.095 versus a median standard deviation of the logs of the real exchange rates of 0.203. Hence, given knowledge of the geometric mean of the real exchange rates for the period as a whole and of the relative price levels in the various countries, one would have had a 20.3% median error in predicting the level of the nominal exchange rates. Given knowledge of the period means and these relative price levels one would have had a 9.5% error.

Comparing the R^2's (or the standard errors) from the second set of regressions with those from the first, we see a further illustration of what was evident from visual inspection of the graphs and of the average rates of change reported in exhibit 4. For most of the countries individually and on average for all of the countries combined, the difference between the mean for the middle period – 1973: I to 1979: IV – and the mean for the two other periods taken as a whole is of greatest consequence. The median R^2 for the regressions with the dummy for the middle period alone is 0.645, slightly over 80% of the figure for the regressions with both dummies.

Viewed from this perspective, the behavior of real dollar exchange rates in the 1972 to 1980 period is the outlier. Why they declined to the extent that they did then and why they remained at relatively

[4] The behaviour of the Japanese and Swiss real dollar exchange rates, in part, appears to be the result of productivity biases that affect the measured price indices. This issue is discussed further below. See Marston (1985) for estimates of the extent to which this bias has affected measured real yen-dollar exchange rates.

low levels for so long are the first questions to be answered. To ignore these movements totally and to focus exclusively on the increases in real exchange rates after 1980 – a practice common in most discussions of dollar overvaluation in the 1980s – is to leave Hamlet out of the play. The fact that these movements are in one way or another visible in the data for almost all of the countries suggest further that the first place to look for an answer is in the behavior of U.S. rather than of individual foreign-country economic variables.

This becomes somewhat more apparent when we examine the data for the real exchange rates of the various countries relative to the DM. The average pattern, which is shown in exhibit 2a, is in some ways similar to an inverted version of the average real rate for the dollar shown in exhibit 1a. At the same time, though, there is a major difference between the two. The amplitude of the movements in the average real rate for the DM is considerably smaller than for the average real rate for the dollar. The standard deviation of the logarithm of the DM average is 0.062; for the dollar average it is 0.173. The standard deviations for the individual countries, by and large, tell the same story. [5]

This difference in amplitude is interesting in its own right. The common perception of floating exchange rates, that exchange rates were highly variable and unpredictable, one presumes has been very greatly influenced by the behavior of the major currencies relative to the dollar. Viewed relative to the DM, the predictability of exchange rates, in the sense of closer conformity of nominal rates to purchasing power parity has obviously been considerably greater.

Also of interest are the differences among countries. Inspecting the charts and the correlation matrix presented in exhibit 6, we see that there are roughly two groups of countries. The rates for the United Kingdom, Italy and Canada and to a lesser extent those for France and Sweden, also, follow patterns similar to that of the dollar/DM rate – to one degree or another, an inversion of the U observed in the dollar-based charts. The rates for the other countries show little if any such tendency. The behavior of economic variables within the individual foreign countries, therefore, also seems to have mattered during the sample period. U.S. variables were the major force but they were far from totally dominant. This behavior of foreign variables, moreover, appears to have followed, or have been forecasted by market participants to follow, patterns that differed among countries.

3. Theoretical considerations

The task now is to outline a theoretical framework that is consistent with all or, at least, most of the above observations, that allows us to evaluate the various explanations which have been advanced to account for the dollar's relative strength since 1980 and that otherwise has testable implications. A convenient point of departure is the well-known 'sticky-price' version of the monetary model of exchange rates.

As in the basic flexible-price model, the key elements are purchasing power parity and the existence of stable demand for money functions in the countries in question. In the 'sticky-price' version, however, the purchasing-power-parity relationship is assumed to hold in long-run equilibrium but not in the short run. In the short run, therefore, we need some exchange-rate adjustment mechanism to get us to long-run equilibrium. The two building blocks here are an expected-exchange-rate-change function and uncovered interest parity. We can write the first of these as

$$E[\mathrm{d}e_t] = -\theta(e_t - \bar{e}_t) + E[\mathrm{d}\bar{p}_t] - E[\mathrm{d}\bar{p}_t^*], \tag{3}$$

[5] The standard deviations of the logarithms of the real dollar exchange rates for the 11 countries range from 0.067 (Canada) to 0.330 (Japan); the median of these figures is 0.203. The standard deviations of the logarithms of the real DM exchange rates range from 0.056 (Belgium) to 0.218 (Canda); the median is 0.124.

where $E[\mathrm{d}e_t]$ is the expected change in the logarithm of the nominal exchange rate, the term in parentheses is the gap between the market rate and its long-term equilibrium value (again both in log form), θ is an adjustment coefficient, and the final two right-hand-side terms are long-term anticipated rates of inflation in the foreign and domestic economies, respectively.

Combining (3) with the assumption of uncovered interest rate parity,

$$E[\mathrm{d}e_t] = i_t - i_t^*, \tag{4}$$

where the i's are nominal rates of interest, we can express the gap between the logarithms of the actual and the long-term equilibrium exchange rate as

$$e_t - \bar{e}_t = -1/\theta(r_t - r_t^*), \tag{5}$$

where r_t and r_t^* are measures of real rates of interest in the two countries, $i_t - E[\mathrm{d}\bar{p}_t]$ and $i^* - E[\mathrm{d}\bar{p}_t^*]$, respectively.

Given the assumption of long-run purchasing power parity,

$$\bar{e}_t = \bar{p}_t - \bar{p}_t^*, \tag{6}$$

the left hand side of (5) can be seen as a measure of the real exchange rate analogous to the one used in the previous section of this paper, but with one fundamental difference. Eq. (5) implicitly defines the market rate relative to equilibrium purchasing power parity, while q_t, the measure used in the previous section, defines it relative to actual purchasing power parity. Movements in these two measures of real exchange rates will differ according to the differences in the behavior of the actual and the equilibrium price levels in the two countries.

To derive a comparable expression for q_t, we substitute from (6) into (5), add the gap between the actual price levels in the two countries to both sides and rearrange terms. The result is

$$q_t = -(1/\theta)(r_t - r_t^*) + (\bar{p}_t - p_t) - (\bar{p}_t^* - p_t^*). \tag{7}$$

In this form, the model is well suited for analyzing the effects of monetary variables on real exchange rates. Omitted from the model, however, is any consideration of (real) factors affecting the equilibrium real exchange rate or of risk.

To allow for the influence of factors affecting the equilibrium real rate, we rewrite (6) to become

$$\bar{e}_t = \bar{p}_t - \bar{p}_t^* + \bar{q}_t, \tag{8}$$

where q_t is the equilibrium real exchange rate.

Similarly, to allow risk to enter the model we rewrite (4) as

$$E[\mathrm{d}e_t] = i_t - i_t^* - \alpha_t, \tag{9}$$

where α_t is the risk premium at time t.

Then, using (8) and (9) in place of their earlier counterparts and following procedures similar to those used in deriving (7), we arrive at a final expression

$$q_t = (\bar{q}_t - 1/\theta)[(r_t - r_t^*) - \alpha_t] + (\bar{p}_t - p_t) - (\bar{p}_t^* - p_t^*). \tag{10}$$

Included in this equation are four possible (proximate) sources of variation in real exchange rates:

changes in the spread between real interest rates in the two countries, changes in the gaps between their actual and long-term equilibrium price levels, changes in risk premia and changes in the equilibrium real exchange rate. [6]

4. Empirical evidence

Several studies have successfully related real exchange rates to real economic factors that in theory could be expected to affect the long-term equilibrium real exchange rate [e.g., Stockman (1980), Kravis and Lipsey (1983), Melvin and Bernstein (1984)]. I, therefore, begin by examining the influence of such variables in this sample. To do so, I ran a series of regressions of the form

$$q_t = a + b_1(y_t - y_t^*) + b_2(OP_t - OP_t^*) + e_t, \tag{11}$$

where q_t is the logarithm of the real dollar exchange rate, the y's are logarithms of indexes of real per capita income in the foreign country and the United States respectively and the OP's are the logarithms of corresponding measures of the degree of openness of the two economics, the share of exports and imports in nominal income. [7]

Real per capita income has had widespread use in past studies [e.g., Kravis and Lipsey (1983)] as an index of differences in productivity. High-income countries, according to the argument, have higher productivity in general than low-income countries and higher productivity in tradeable goods industries in particular. Assume that prices of tradeable goods tend to be equalized across countries and wage rates to be equalized among industries within countries. Then these productivity differentials translate into higher average wages in high-income countries and hence higher price levels. In such circumstances, the sign on the coefficient of b_1 will be negative.

Greater openness can be expected to have a positive effect on other countries' price levels relative to that of the U.S. and hence a negative effect on their real dollar exchange rate. Kravis and Lipsey trace this influence of openness on the price level through factor markets and thence the market for services. Melvin and Bernstein take the view that openness decreases the divergence between tradeable goods prices and the overall price level. In both instances the hypothesized sign on b_2 is also negative.

I estimated these regressions for each year separately during the period 1957–1983, for all of the years pooled and for three subperiod pools – 1957 to 1972, 1973 to 1979 and 1980 to 1983. Exhibit 7 contains the summary statistics for the various types of pooled regressions. The yearly regressions are described in the text. A quick scan of the summary statistics for both the overall pooled regression and the yearly regressions, gives the imprecision that the model is performing reasonably well. The income coefficient is always significantly negative, the R^2 in the overall pooled regression is 0.51, the mean of the R^2's for the individual yearly regressions is only slightly lower, 0.45, and the standard errors of estimate are generally about equal to the coefficients of variation derived from the standard errors of estimate in the dummy variable regressions reported earlier.

[6] As it stands, the model is incomplete from several important perspective. One is that it provides no formal specification of the processes by which the variables on the right hand side of (10) are determined. Similarly, it largely ignores the related questions about expectations formation. Given the purpose of this paper, these omissions do not appear to me to be an important failing. A more detailed analysis that takes account of many aspects of both is provided in an excellent series of papers by Michael Mussa (e.g., 1982, 1984).

[7] These regressions were run for the seven of the eleven countries examined earlier for which Kravis et al. presented independent estimates of equilibrium price levels. Excluded from this sample were Canda, Denmark, Sweden and Switzerland.

Exhibit 7
Annual data for 7 countries: 1957–1983. [a]

Type of regression	$q_t = a_1 + a_2 D_2 + a_3 D_3 + b_1(y - y^*) + b_2(OP - OP^*)$						
	a_0	a_1	a_2	b_1	b_2	$\bar{R}^2$	SE
Full sample pooled: Single intercept	−0.280			−0.706	0.057	0.514	0.161
	(6.234)			(14.156)	(2.443)		
Full sample pooled: Period intercepts	0.016	−0.267	−0.015	−0.490	−0.019	0.703	0.126
	(0.350)	(10.950)	(4.907)	(10.910)	(0.966)		
Subsamples pooled:	0.038			−0.436	−0.013	0.595	0.094
1957–1972	(0.880)			(11.286)	(0.672)		
1973–1979	−0.320			−0.811	−0.064	0.477	0.142
	(3.773)			(6.025)	(1.418)		
1980–1983	−0.019			−0.522	−0.20	0.116	0.181
	(1.429)			(2.341)	(0.276)		

[a] D_2 is a dummy taking the value 1 for 1973–1979 and 0 otherwise; D_3 is a dummy taking the value 1 for 1980–1983 and 0 otherwise; the other variables and the countries are as defined in the text. Absolute values of t statistics are in parentheses beneath the coefficients.

The problem comes when we compare the various yearly regressions: the income coefficients vary substantially in magnitude over time; the constant terms vary in both magnitude and sign; and the openness coefficient – though remaining low in absolute value – changes sign repeatedly.

This apparent heterogeneity of the yearly regressions is borne out by analysis of covariance, the results of which are shown in Exhibit 8. The F ratio to test for differences among the yearly

Exhibit 8
Analysis of variance of regressions of real dollar exchange rates on real per capita income and openness: 7 countries, 1957–1983.

Source of variation [a]	Sum of squares	DF	Mean square	F [b]
Difference in yearly regressions	3.288	78	0.042	3.002
of which				
Difference in period intercepts	1.899	2	0.949	67.598
Difference in slopes	0.801	2	0.400	28.513
Residual (years within periods)	0.588	74	0.008	0.566
Error	1.517	108	0.014	
Total	4.805			

[a] Consider the following regressions and their corresponding sums of squared errors: A pooled regression for the full sample with a single intercept, $\bar{S}$; a pooled regression for the full sample with individual intercepts for the three periods 1957–72, 1973–79 and 1980–83, $\overline{SP}$; individual regressions for each of the years, SY_t for year t ($t = 1, \ldots, T$) and ΣSY for the sum for T years; individual regressions for each of the periods, SP_1, SP_2 and SP_3 for each period separately and ΣSP the sum of the three.
Beginning at the top of the table and working down, we can then define the sums of squares listed therein as follows: $\bar{S}$-ΣSY, $\bar{S}$-$\overline{SP}$, $\overline{SP}$-ΣSP, ΣSP-ΣS, ΣS and $\bar{S}$, respectively.

[b] The Error Mean Square ($\Sigma S/108$) is the denominator mean square in all of the F tests.

Source: See exhibit 3.

regressions is 3.002, which with 78 and 108 degrees of freedom is significant at well over the 99% confidence level.

Further analysis of the temporal variation in the relationship reveals that most of the variation is between the three periods and that most of this between-period variation in turn can be accounted for by inter-period shifts in the intercept. The variation between years within the periods is not statistically significant.

The implication, therefore, is similar to that of the descriptive analysis of the data. The question that remains to be answered is the cause of the major shifts in real exchange rates in the early 1970s and early 1980s. Real variables account for a significant and substantial portion of the variance in real exchange rates in this subsample of countries. Left unexplained is a significant amount of temporal variation of the kind documented earlier. The remainder of the paper discusses possible explanations for that shift.

4.1. Risk premia

The standard analysis relates risk premia to relative asset supplies. Viewed in this context, however, risk is incapable of explaining the movements of greatest interest.

In his investigation of the mark/dollar rate during the years 1974 to 1981, Frankel (1984, p. 249) states with regard to this point 'The supply of mark bonds, like the German money supply, has increased during precisely those periods in which the mark has appreciated rather than depreciated, due largely to the Bundesbank's habit of resisting such appreciation through foreign exchange intervention.' Substantial U.S. budget deficits from 1982 on, the resultant increase in U.S. bond supply and the propensity of the Bundesbank to resist the dollar's appreciation must certainly have produced the opposite result – a substantial decline in the relative supply of German to U.S. bonds since then. The remainder of the discussion, therefore, deals with the other two sets of variables.

4.2. Real interest rates

Real interest rates in the United States have followed a pattern that in general conforms to that of real dollar exchange rates. An often-voiced explanation for the appreciation of the dollar in the 1980s is that increases in the federal government's real budget deficit caused high real rates of interest in the United States, that these high real rates of interest produced substantial capital inflows and that these capital inflows, in turn, caused the dollar to appreciate in real terms.

A major problem with this argument is that it can be at best only explain one of the two major movements in exchange rates. The U.S. government budget dificit as a ratio to GNP, was much higher on a period-average basis in the early 1980s than in the 1970s. But in the 1970s, the period of low real exchange rates for the dollar, and of low real interest rates, it was actually much higher than in the late 1950s and the 1960s. Over the years 1957 to 1970, the deficit-to-GNP ratio averaged 0.4 per cent. In the period 1971 to 1980, in contrast, the average was 1.8 per cent, considerably below the 4.3 per cent figure registered from 1981 to 1985 but, nevertheless, more than four times the average for the preceding period.

A further problem is that it is no way clear that the increase in the budget deficit has been the major cause of the high real interest rates in the 1980s. An alternative explanation relates the low U.S. real interest rates of the late 1960s and 1970s to the inflation process then underway and the much higher real interest rates in 1979 and the 1980s to the turn to monetary restrictiveness and the abrupt deceleration of inflation in the early part of the decade [Huizinga and Mishkin (1985)]. [8]

[8] On this point see also the more general discussion in Friedman and Schwartz (1982, pp. 495–96) of the relation between inflation (and monetary) uncertainty and real rates of interest.

4.3. Monetary policy

A variety of studies have documented the poor performance of simple empirical versions of the monetary models of exchange rates over the floating-rate period. The object here is not to replicate those results or to try to improve upon the estimated equations. Instead, it is to see whether the behavior of policy within the various countries is, in broad outline, consistent with the behavior of exchange rates over the full sample period, in particular, whether it can explain the major movements at the start of this and the last decade.

As in the case of real interest rates, there is clearly a close temporal correspondence between changes in the policy regime in the United States and the two large shifts in real dollar exchange rates. In the latter half of the 1960s, monetary policy in the United States started to become increasingly expansive. By the early 1970s the result was an incipient divergence between the price level in the United States and the price levels in those industrial countries that in the absence of fixed exchange rates would have pursued less expansive policies than the United States. This conflict in domestic policy goals was the underlying reason that the Bretton Woods system broke down [Darby and Lothian (1983)].

When it did, exchange rates for the dollar fell, both in nominal and in real terms. To some extent these declines were the result of existing divergences in price levels internationally. But, given the leeway that floating rates provided to policymakers abroad to pursue independent inflation targets, the declines must also have reflected market participants expectations of a future widening of such price-level gaps. [9]

One test of this hypothesis is to compare the declines in real exchange rates with the actual course of policies in the various countries in subsequent years, or alternatively with actual future inflation rates. If market participants, accurately anticipated the degree of policy divergences among countries, we should see a positive correlation in either instance.

This is in fact the case. The simple correlation between the declines in real exchange rates from 1970 to 1973 and the average annual inflation rates from 1973 to 1980 in the 11 countries is 0.73; the rank correlation is 0.70. Even with these few degrees of freedom both are statistically significant at better than the 95% level.

After it became clear that U.S. inflation would accelerate again in the late 1970s, the dollar, which against some currencies had risen in real terms, started to decline anew. At this point, monetary policy in the United States began to show signs of change. Federal Reserve operating procedures were altered. Then, following the Reagan election in 1980, money supply growth fell and on average remained low for the next two and a half years. As all of this was unfolding, real exchange rates of most countries relative to the dollar began to rise.

To some extent, such increases might be expected to have occurred even in the absence of a tightening of U.S. monetary policy. The effects of past shocks would eventually have waned and any overshooting accompanying the policy-induced declines in real exchange rates for the dollar in the 1970s would have been reversed. If a return to equilibrium of this sort had been the sole factor operating in the early 1980s then the increases in real exchange rates during those years would have provided perfect offsets to the declines that took place during the 1970s.

[9] Longer term policy independence did materialize under floating rates [See Lothian (1986a)]. Over shorter periods this has been less evidently the case. If market participants did indeed form expectations of increased policy divergences among countries they apparently did so with an eye towards longer term developments, in effect, looking past the common movements in inflation rates in the early 1970s resulting from the lagged effects of synchronized policies under Bretton Woods and the oil shock.

There is a negative correlation between the two movements but the correlation is extremely low – a simple correlation of −0.32 between the changes in real exchange rates from 1970 to 1980 and the changes from 1980 to 1984 and a rank correlation of −0.6. It appears instead that the policy changes in the early 1980s were also important, and that these changes produced a new shock. Some evidence supporting this hypothesis comes from examination of the residuals from the regression corresponding to this simple correlation. There is a high rank correlation (0.72) between the average rates of inflation in the 11 countries in the 1980s and the residuals from the regression of the real exchange-rate change from 1980 to 1984 on the real exchange-rate change from 1970 to 1980. Correspondingly, there is a similarly high rank correlation (0.78) between the real exchange rate change from 1970 to 1984 (the algebraic sum of the two separate changes) and the averages rates of inflation in the 1980s.

5. Conclusions

Data for dollar real exchanges during the past three decades have been dominated by two major and largely offsetting movements. The question that arises is whether these movements were simply the result of two random shocks or whether they were the result of a common process that can be more clearly related to behavioral variables.

After examining various possible explanations, the conclusion I reach is that the most plausible hypothesis is that they were related to and the result of the two major changes in the monetary-policy regime that occurred during this period. The evidence I present to support this conclusion is of two types. One is simply the temporal correspondence between average exchange-rate behavior and these two regime changes. The other is based on comparisons of real exchange rate changes across countries and the subsequent behavior of average inflation rates in these countries. Though limited in scope, these comparisons suggest a drawn-out process of real-exchange adjustment to changes in inflation and, hence, policy. This pattern, moreover, is similar to the patterns observed in other inflationary episodes. The evidence here includes experience during the unusually wide range of historical episodes investigated by Bernholz (1982) and studied further by Bernholz et al. (1985), the experience of several Latin American countries during the post-World War II period as documented in Harberger (1966) and the behavior of the real sterling-dollar exchange rate during periods of inflation over the course of the slightly more than a century of data examined by Friedman and Schwartz (1982, pp. 287–294).

One implication of these findings is that further research on the relationship between exchange rates and monetary policy is apt to yield a much higher payoff than has been commonly believed. [10] The results reported here suggest, moreover, that such research will have to go beyond the very simple empirical representations of the monetary models that have been prevalent in the literature. Expectations with respect to future policy apparently have mattered greatly and such expectations, perhaps not surprisingly, cannot be proxied adequately by past values of the variables, particularly

[10] In a follow-up study to this one [Lothian (1986b)], I present additional evidence of monetary effects on real exchange rates derived from further regression analysis of the cross-section of time series examined here. In this regard also, see Finn (1986) and Somanath (1986). Both authors – Finn for the dollar–sterling exchange rate and Somanath for the DM–dollar rate – conduct studies along the lines of Meese and Rogoff (1983). They conclude that monetary models outperform the random-walk model that Meese and Rogoff found dominant in somewhat earlier data samples.

not when, as in both the early 1970s and near the start of the 1980s, changes in policy regime take place. [11]

Several important questions, however, remain unanswered. One is the nature of the mechanism linking monetary variables and real exchange rates. I have described the mechanism in terms of a drawn out adjustment process following a change in policy. An alternative hypothesis is that inflation affects the equilibrium real exchange rate itself over a long but not necessarily the longest period. [12] A somewhat related question is the relationship between real exchange rates and real interest rates. The broad patterns in the movements of the two are so nearly similar that they appear to be influenced by the same underlying variables. [13] Whether this, in fact, is the case and, if so, how the influences have worked in both instances are questions for further study.

Finally, let me conclude on a note that is similar to the one on which I began and say something about the implications for forecasting or, put more broadly, market analysis. If my interpretation of the data is correct and if policies remain variable, then the major gains from such analyses will accrue to those who quickly and accurately anticipate the future drift of policies. Market participants appear to have done this amazingly well over the past decade and a half. [14]

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[11] The regime changes, in one sense, were very different. The move to floating marked a change in the rules governing policy internationally. Monetary policies abroad became domestic matters rather than simply a play off U.S. policy. It also of course was accompanied by a move to further expansiveness on the part of U.S. policymakers. Near the start of this decade, in contrast, the major change of interest was in U.S. policy goals. The two and a half years following the Reagan election of 1980 were on average a period of tighter policy than in the late 1970s. This tighter policy coupled with deregulation in banking and the resultant move to interest payments on transactions deposits apparently has had feedback effects on the demand for money. Some of the increase in recorded rates of money supply (M1) growth for the period beginning in 1982 has, therefore, most likely been offset. Given the higher average rate of recorded M1 growth since the middle of 1982, and in particular, the further acceleration that began in late 1984, it seems premature to view the policy regime as having undergone a permanent change.

[12] The standard theoretical presentations all assume long-run neutrality. Non-neutrality might, however, be rationalized along the lines of a shift in the terms of trade, the efficiency of the United States as a producer of world monetary services being reduced in the 1970s by increased uncertainty with regard to the path that U.S. price levels would follow. See Klein (1979) for a discussion of the international monetary role of the United States. Such an argument is similar to the one advanced by Friedman (1977) to rationalize the apparent increases in the natural rate of unemployment in most industrialized countries in the 1970s. As noted above, an argument of this sort might be of some relevance in explaining the time pattern of real interest rates.

[13] See Darby (1986) for a discussion of the links between the two. Meese and Rogoff (1985) present evidence of differences in the time-series processes generating real exchange rates and real interest rates, thus suggesting the lack of any simple relationship between the two.

[14] Since early 1985, when the first version of this paper was written, exchange rates for the dollar have declined markedly in both nominal and real terms. This is consistant with the apparent turn to expansiveness of U.S. domestic monetary policy. This may indeed offer a new degree of freedom for testing alternative hypotheses about exchange rate determination. At present, however, it is also consistent with a number of other explanations. As such, it provides a further illustration of the complexity of the task faced by market analysts and forecasters.

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Biography: James R. LOTHIAN is vice president in charge of positioning support for Citicorp Investment Bank. Lothian joined Citicorp in 1972, receiving his doctorate from the University of Chicago the following year. He is coauthor of *The International Transmission of Inflation*, of numerous articles in the areas of monetary economics and monetary history and has written extensively in business and financial-market oriented publications. He is Editor of the *Journal of International Money and Finance* and has been a Research Associate of the National Bureau of Economic Research.