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No 11

Exchange rate variability:
evidence for the period 1973 — 1982

by
D G Barr

November 1984

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The object of this Technical Series of Discussion Papers is to give wider circulation to econometric research work predominantly directed towards revising and updating the various Bank models. Any comments should be sent to the authors at the address given below.

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Introduction

Since the end of the Bretton Woods fixed exchange rate system in 1971, most major exchange rates have been allowed to float with greater or lesser freedom. While some have claimed clear theoretical advantages for a floating system [see eg Friedman (1953)], one disadvantage is that rates sometimes seem to change dramatically from one period to the next without regard for prevailing underlying economic conditions. These changes are often ascribed to changed perceptions of the future path of economic variables, making exchange rates susceptible to rumour and general economic speculation. Thus, while a floating rate has the advantage of being able to move to a level consistent with current economic conditions, it may also move in response to a variety of phenomena not related to these conditions and in doing so may impose costs on firms, investors and the international economy as a whole. Exchange rates seem generally to have been much more volatile than would be suggested by changes in economic conditions, giving rise to concern about the costs thus imposed.

The objective of this paper is to present evidence on the level of exchange rate variability for the period 1973-1982. A variety of exchange rates and measures of variability is considered, but no attempt is made to assess the effects of variability. (The first section of the paper presents a brief survey of the available literature on these effects.) The creation of the European Monetary System (EMS) and its flexible fixed rate system, the exchange rate mechanism (ERM), in 1979 produced a significant change in the international economic structure and this paper attempts to assess how far exchange rate variability has changed since that date.

I The effects of variability: a survey

Theoretical models produce unambiguous results for the effects of variability on output and prices only with the help of some strong restrictions on the behaviour of trading firms. Of the theoretical

models, those by Clark (1973) and Cushman (1980) illustrate this limited theoretical progress very well. The former considers a firm which produces goods for export only and imports no materials, and which maximises profits in nominal rather than real terms. (The firm is also assumed to be risk averse.) This model produces the expected result that greater exchange rate variability increases risk and so reduces export volume. The model produced by Cushman is considerably more general and allows the firm to produce, raise finance and sell at home or abroad; and, in this case, the firm maximises real profits. The results of an increase in variability on exports are ambiguous in this more realistic model.

The models considered above ignore two forms of possible correlations between the exchange rate and other variables. Firstly, it may be correlated with variables such as interest rates, prices and national incomes, with the result that higher exchange rate variability may be offset by reduced variability in (for example) domestic interest rates. A particular example of this, and one which the Clark model fails to treat, is the possible correlation between the exchange rate and relative prices at home and abroad. In the extreme case of a perfectly offsetting correlation between the exchange rate and foreign currency export prices, variability of the nominal rate will have no effect in models of this type. The second correlation of importance is that between different bilateral exchange rates. It may be that a firm exporting to two countries will respond to variability changes in each individual rate but, if these are negatively correlated, total exports need not respond negatively to individual variability measures. Nevertheless, it is strongly believed by producers themselves, as well as by governments, that exchange rate volatility has important effects on activity - perhaps as much by reducing investment by increasing uncertainty as by affecting production from existing capital. This has led many authors to measure variability and to use these measures in empirical work.

Pigot, Sweeney and Willett (1975), Kenen (1979), Thursby and Thursby (1981) and Lanyi and Suss (1982) use several different definitions of variability for a variety of periods and currencies; and find that real rates are more variable than nominal rates in most cases. When these measures were included in equations

determining the overall level of trade, the results were rather mixed. Kenen (1979) found that real variability measures were more influential than nominal ones; but that neither set produced a statistically significant influence. Thursby and Thursby and Blackhurst and Tumlir (1980) found similar results. A paper by Abrams (1980) included nominal variability measures and found significant negative effects. Justice (1983) attempts to find volatility effects on the volume and price of UK exports from 1973 to 1981. A wide variety of short run measures of sterling variability seemed to have no influence on the volume of exports. However a broader measure based on world trade share weighted real effective rates of all of the major manufacturing countries exhibited a weak, but significant, negative effect on UK exports. The results for export prices showed somewhat stronger variability effects, with an increase in sterling's real variability raising export prices.

A recent paper by Akhtar and Spence Hilton (1984) employs an interesting measure of variability (they calculate variability for each quarter as the standard deviation of daily rates within the period) and obtains significant results. Although their results are necessarily tentative, being based on the experience of only two countries (the USA and West Germany), they do uncover a relationship between variability and trade. Attempts at the Bank of England to replicate these results, using the same methodology, for the UK have failed (see BEQB September 1984).

There appears, then, to be little evidence that variability substantially alters the behaviour of firms engaged in international trade. This could be because behaviour is independent of variability, or because of inadequacy of the techniques employed in detecting any existing dependence; in view of the difficulties involved, the latter conclusion seems perfectly possible.

II Measures of Variability

Some care is needed in the interpretation of variability measures per se. We may consider any change in an exchange rate to be partly predictable, partly unpredictable. Both of these elements may impose non-zero costs on market participants and it is generally

assumed that fully forecastable changes impose lower costs than those that cannot be anticipated. We attempt to distinguish between the two by using variations in monthly changes (which is suggested as a measure of unpredicted change by the fairly common finding that the exchange rate follows a random walk) and variations about a time trend. A brief discussion of appropriate measures is provided in Annex I.

Real and nominal rates

Any measure for the effect of variability on trade should take account of relative prices between trading countries. The nominal rate scaled by an index of relative prices is termed the real rate*. Consider the extreme case in which only real rates matter for trade and one of the countries has a high inflation rate. If we now find that the nominal rate changes to compensate exactly for the change in relative prices, we will not see the real rate change and there will be no trade effects. Restricting our analysis to nominal rates would be misleading in this case, since variability would appear high. Equally, if the nominal rate is restricted by a fixed exchange rate system, such compensatory changes will not be possible and the system could be the cause of a rise in the variance of real rates, while giving the appearance of success due to the lower nominal variability.

For completeness, we report results using both real and nominal rates. The mathematical derivation of each measure is given in Annex II.

III Official Responses to exchange rate variability

The level of the exchange rate may be considered as consisting of two separate components. Firstly, there is a quasi equilibrium level reflecting such factors as relative production costs and prices in the two countries. In the long run, this is the level at which the current account and flows of structural capital will be in equilibrium at some suitable level of high employment. This rate may reasonably be assumed to change smoothly and slowly over time. Secondly, there is a more volatile component arising from the nature

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* We use consumer price indices. See Annex IV.

of the market for foreign exchange. This market adjusts quickly to "news" whether this concerns changes in the equilibrium rate, other economic conditions, policy changes or simply changes in the way expectations concerning future exchange rates are formed. Since this news contains a high proportion of spurious information that will be contradicted at a later date, the exchange rate may change frequently without any regard for actual changes in the equilibrium rate. A fixed exchange rate is prevented from responding to changes in either the equilibrium rate or the determinants of the second more volatile component by intervention. Furthermore, if it is not fixed at the equilibrium rate, it will require persistent support in the form of exchange market intervention, from one or both of the two central banks involved. The main aim of a fixed rate system is to reduce variability. Here, however, there is an obvious problem in that, while there may be a degree of success in eradicating variability due to short-term news effects, any changes in the equilibrium rate away from the current fixed level will require the latter to be maintained by intervention. If this equilibrium change persists, a change in the fixed rate will be required which may itself be the cause of disruption both inside financial markets and in the economy as a whole. If the system is to operate smoothly, some solution to the problem of underlying exchange rate changes must be found.

One possibility is to allow for changes in the equilibrium rate by adjusting the fixed parity when or soon after they occur; but this possibility can give rise to speculative attacks on the parity. The second, and rather more long-term solution, is to reduce the variability of the equilibrium rate per se. The major cause of changes in this rate is divergences between economic conditions at home and abroad. Since many of these conditions are influenced directly or indirectly by economic policy, stability could be enhanced by a degree of co-ordination between policies in the countries concerned. But even in the extreme case of complete policy harmonisation, changes in tastes or technology would still lead to changes in the equilibrium rate.

These factors were an influence in the demise of the Bretton Woods fixed rate system and the European "snake". The EMS, however,

explicitly contains a political element. Participating countries are required to set their parity rates co-operatively and simultaneously and to endeavour to bring about some degree of economic policy co-ordination. The aim of the EMS is not to stabilise exchange rates solely by intervention, but also to promote the multilateral co-ordination of policy that may then permit whatever joint policies are chosen to function as efficiently as possible. In these circumstances, fixed (but adjustable) exchange rates act as:

(i) A guide to policy makers wishing to pursue policies consistent with their neighbours'.

(ii) A constraint upon those who might be tempted to "go it alone" for short periods.

(iii) Even in the absence of full co-operation, a source of reduced uncertainty leading hopefully to greater international trade.

IV The European Monetary System

The desire for some form of political and economic unity among the countries of Europe led, in 1969, to the Report of the Werner Committee, which called for the establishment of a complete European Monetary Union (EMU) by 1980. This entailed a system of irrevocably fixed exchange rates and free convertibility of currencies within the EEC. Although this target date was officially abandoned in December 1974, the motivation behind it remained. While the EMS is not therefore a direct result of the Werner Report, it is seen in many areas as a step towards EMU.

The framework of the EMS was established in the European Council Resolution of 5 December 1978, and was put into practice with the Central Bank Agreement (CBA) on 13 March 1979. A substantial part of the CBA lays down "principles" rather than rules reflecting the intention that the EMS should be allowed to develop over time. This is, of course, consistent with the evolution of general economic co-ordination towards eventual EMU.

At the heart of the EMS is the Exchange Rate Mechanism. That these two institutions are not synonymous is illustrated by the fact that the

UK is a member of the EMS but not the ERM. All other EEC members are participants in both schemes except for Greece which entered the EEC on 1 January 1981 and has not yet joined either.

The ERM is essentially a fixed rate system which permits central rate changes to be negotiated by all EMS members jointly. In this way, the system makes some allowance for changes in equilibrium rates. Furthermore, when it becomes apparent that a particular currency is under pressure, there is a presumption that the authorities concerned will take appropriate action in the form of exchange market intervention and domestic policy changes. It is hoped that these domestic responses will reduce the variability of equilibrium against short run variability. For a description of the mechanics of the ERM, see BEQB (1979).

A useful description of the parity changes since the creation of the EMS is given in Ungerer, Evans and Nyberg (1983).

V Other Influences on variability

Although the creation of the EMS marked a significant change in international economic conditions, two other changes which occurred at much the same time make it difficult to draw conclusions as to the effects of the EMS in isolation.

Oil Price changes - OPEC II

The second round of oil price increases, starting with an official price rise on 1 April 1979, will have had substantial effects on world financial markets. Further increases led to a total increase in the price of oil of 102% in just over a year. In proportional terms, this was considerably smaller than the 300% increase of OPEC I in 1973/74; but both price rises represented a rise in the OECD oil bill of approximately 2% of OECD GNP.

The consequences of this rise in the real oil price differed between countries in both short and medium terms. The impact effects would clearly depend on the relative importance of imported oil in each country, while the reactions to these effects, whether in terms of private sector adjustments or government policy responses, would

greatly influence the medium term effects. Since these induced changes differed between countries, there will have been differential pressures on exchange rates.

We would expect, therefore, that the sharp rise in the price of oil would have caused an increase in the variability of exchange rates by inducing different economic effects in the major countries. It should be noted that a similar series of effects will have been inititated by OPEC I.

US Monetary Policy

One of the proximate causes of exchange rate variability is variable interest rates. Variable interest rates in the United States can be expected to lead to $ US exchange rates in the main, but also to variable rates between other currencies.

In October 1979, the US introduced a form of monetary base control which led to significantly more variability in (US) interest rates. By early November 1979, the Federal Funds rate was 4% above its mid-September level. A further round of interest rate rises occurred after stricter monetary controls were introduced in March 1980, the Fed Funds rate reaching 20% by mid-April. By mid-May, inflationary expectations and the monetary restrictions had eased, with the result that the rate was down to an average of 12.7% for Q2 1980. These high and variable US interest rates can reasonably be expected to have caused an increase in exchange rate variability.

VI Bilateral rates

(i) Nominal bilateral rates

Table 1 gives the variance of the level and of the change in the 10 major rates involving the five chief currencies using monthly data for a number of sub periods. The second is graphed in Charts 1 to 10. The years are chosen so that they coincide with the creation of the EMS, eg 1978-1979 represents 1978 April to 1979 March and is recorded as 1978 in the charts. In addition, aggregate variability before EMS (1973-1979) and after (1979-1982) are presented. Not surprisingly, strong general conclusions concerning trends in variability are difficult to find. However, some localised results are of interest.

The most stable rate over the period was the DM/FF with consistently low variability by either measure in all years. This rate was part of the "snake" system for much of the pre-EMS period. The DM was a member from 1972 to 1979, while the FF was a member for 1972-74 and July 1975 to March 1976. In terms of the variance of its rate of change, it was the most stable rate before and after the creation of the EMS and this variance showed a significant* fall between these periods. It is fairly clear, however, that this rate was becoming more stable during the pre-EMS period and the change in variability between 1973-1974 and 1978-1979 is also statistically significant. Both measures show that stability is highest in the first year of the EMS but that the rate has become more unstable since then.

The £/$US rate has also been relatively stable but has become less so during the sample period as measured by monthly changes. The rise in variability between the two sub periods is not statistically significant, although the results for the two end points do differ significantly. Against the DM, sterling produces markedly different results. In terms of the levels variance measure, there has been a substantial fall in variability. This is because sterling fell against the DM along a trend from 1973 to 1976; when allowance is made for this trend in the second measure, we find an insignificant change in variability. The two years, 1977.4 to 1979.3, were particulary stable but the first two years of the EMS were considerably more variable. Again, it seems that the DM was becoming more stable in the pre-EMS period, although this conclusion rests on the

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* See Annex III.

TABLE 1
VARIANCE OF NOMINAL RATES

	£/$		£/DM		$/DM		£/FF	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	1.73	0.57	3.75	1.76	3.97	2.67	1.89	1.3
1974-1975	0.29	0.18	1.80	0.36	2.58	0.73	3.03	0.3
1975-1976	3.60	0.48	1.37	1.03	1.97	1.06	0.66	0.8
1976-1977	1.47	0.86	4.47	1.25	1.11	0.27	0.64	0.8
1977-1978	2.34	0.61	0.60	0.55	3.27	0.36	1.07	0.8
1978-1979	2.07	1.13	0.51	0.55	3.57	2.50	0.30	0.2
1979-1980	1.43	1.36	1.42	1.00	1.67	1.41	1.22	0.8
1980-1981	0.90	1.06	4.56	1.75	5.30	1.38	4.43	1.1
1981-1982	3.18	1.21	2.29	0.73	1.39	1.02	1.26	0.9
1973.1-1979.3	18.80	0.70	42.49	0.90	13.22	1.32	13.68	0.7
1979.4-1982.12	15.93	1.05	4.77	1.11	18.51	1.14	8.91	1.0

	$/FF		DM/FF		£/YEN		$/YEN	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	4.55	2.16	2.13	0.61	0.42	0.52	1.66	0.9
1974-1975	3.30	0.52	1.06	0.68	0.30	0.30	0.80	0.4
1975-1976	2.12	1.02	0.50	0.37	2.33	0.44	0.21	0.0
1976-1977	0.60	0.14	3.03	0.40	2.49	0.70	0.54	0.1
1977-1978	0.57	0.22	1.27	0.34	1.46	1.35	4.88	0.6
1978-1979	1.64	1.97	0.70	0.22	2.77	1.13	4.72	3.0
1979-1980	1.22	1.07	0.06	0.06	5.90	1.60	3.43	0.8
1980-1981	5.65	1.15	0.08	0.11	2.40	0.92	2.14	1.2
1981-1982	2.06	0.88	1.17	0.20	1.19	0.93	1.82	1.7
1973.1-1979.3	4.04	1.10	12.57	0.43	45 96	0.80	21.15	1.0
1979.4-1982.12	38.41	1.19	4.99	0.18	9.03	1.58	5.48	1.6

	DM/YEN		FF/YEN	
	(a)	(b)	(a)	(b)
1973-1974	2.90	1.75	1.38	1.12
1974-1975	2.66	0.61	4.76	0.58
1975-1976	1.07	0.91	1.28	0.96
1976-1977	0.73	0.42	1.86	0.25
1977-1978	0.57	0.74	2.27	0.30
1978-1979	3.36	1.28	1.89	0.79
1979-1980	6.82	2.09	6.06	1.64
1980-1981	12.05	1.72	12.21	1.27
1981-1982	0.88	1.32	0.82	1.35
1973.1-1979.3	5.63	0.91	19.05	0.69
1979.4-1982.12	15.53	1.56	28.23	1.43

(a) Variance of exchange rate
(b) Variance of monthly change of exchange rate

Years begin in April and end in March

VARIANCE OF NOMINAL BILATERAL RATES

Chart 1

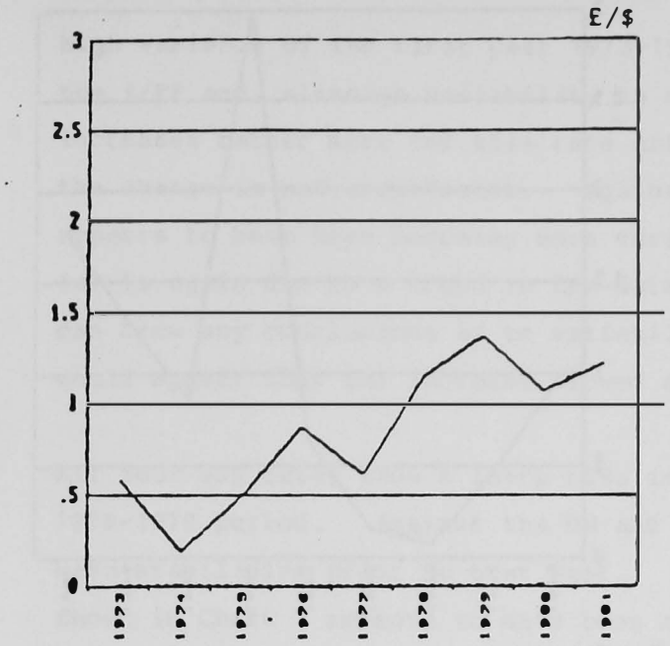
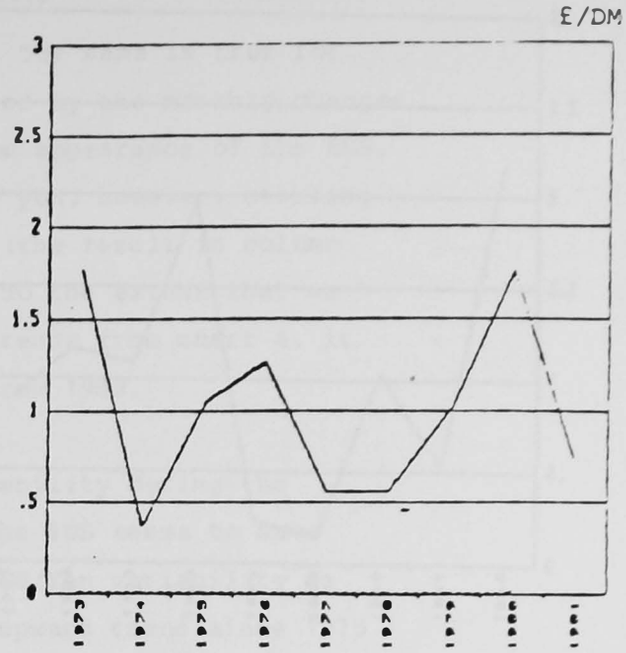


Chart 2



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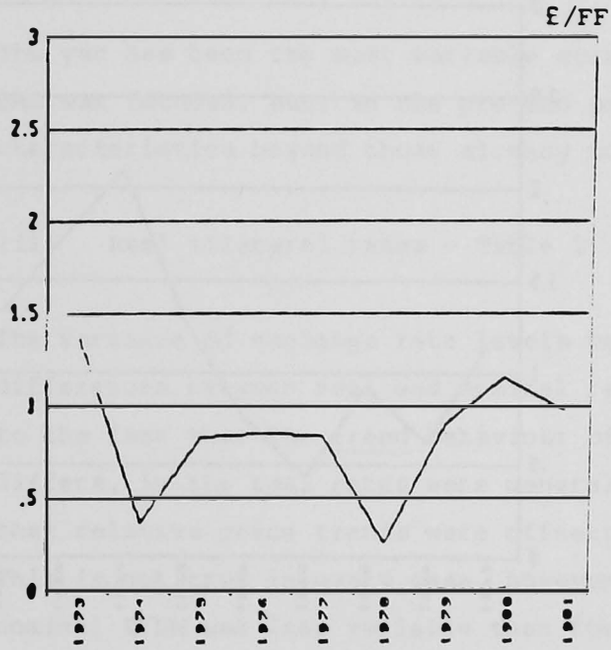

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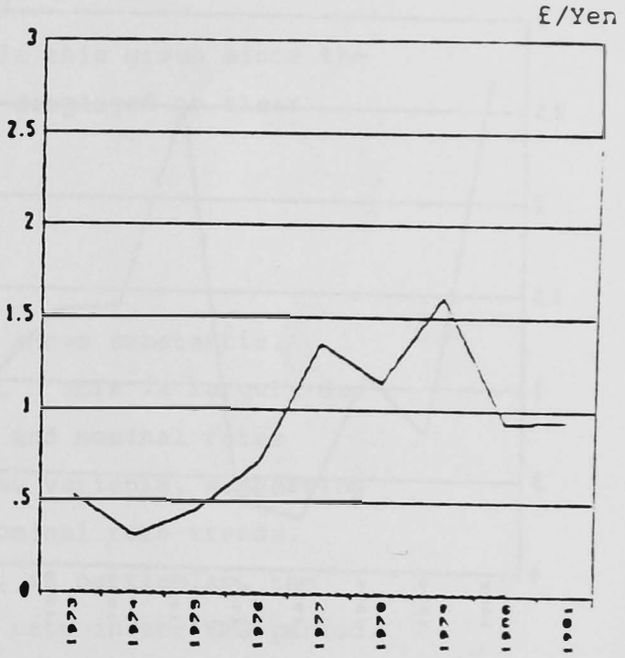
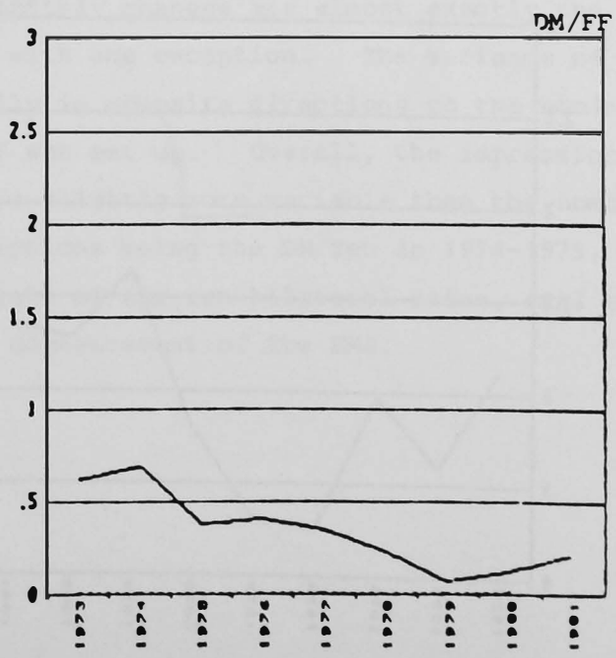


Chart 5



VARIANCE OF NOMINAL BILATERAL RATES

Chart 6

$/FF

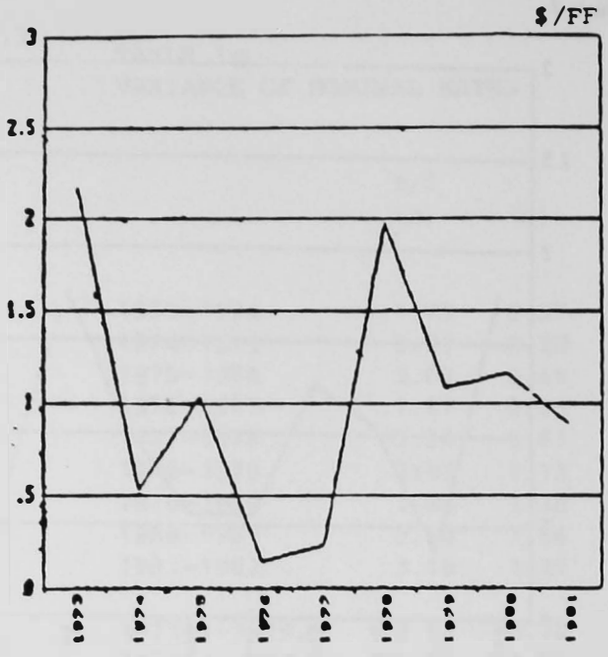


Chart 7

$/Yen

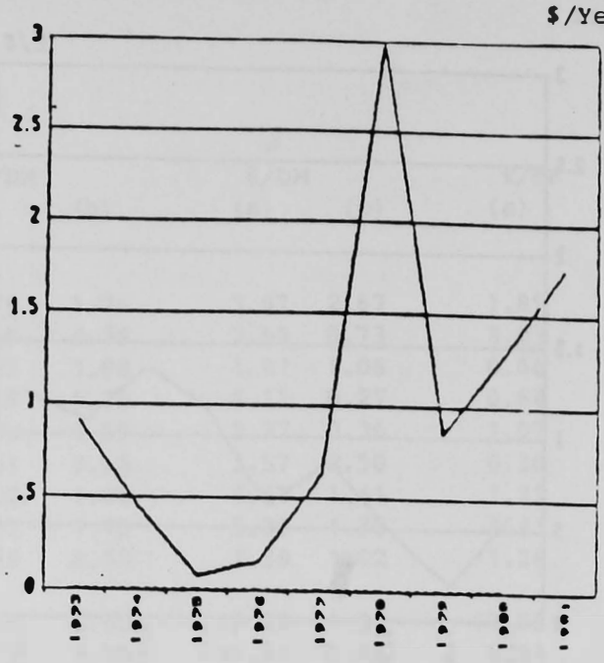


Chart 8

$/DM

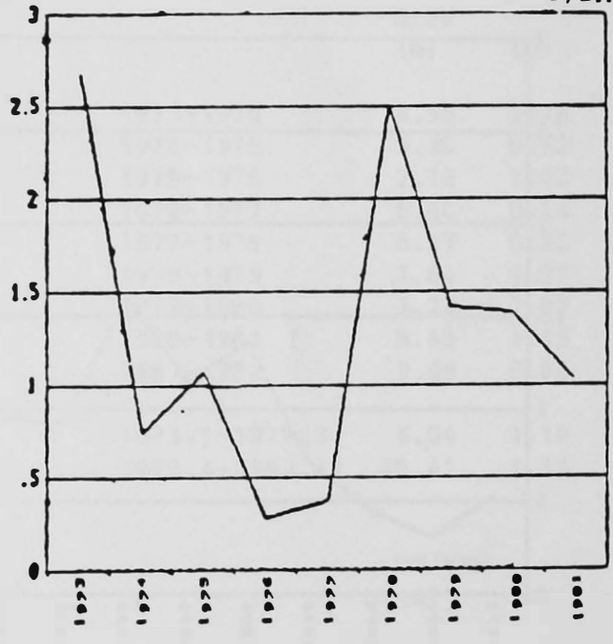


Chart 9

DM/Yen

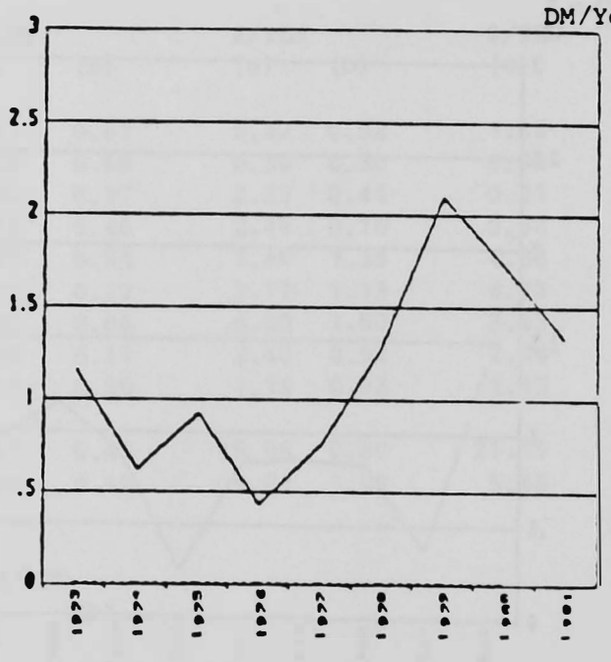
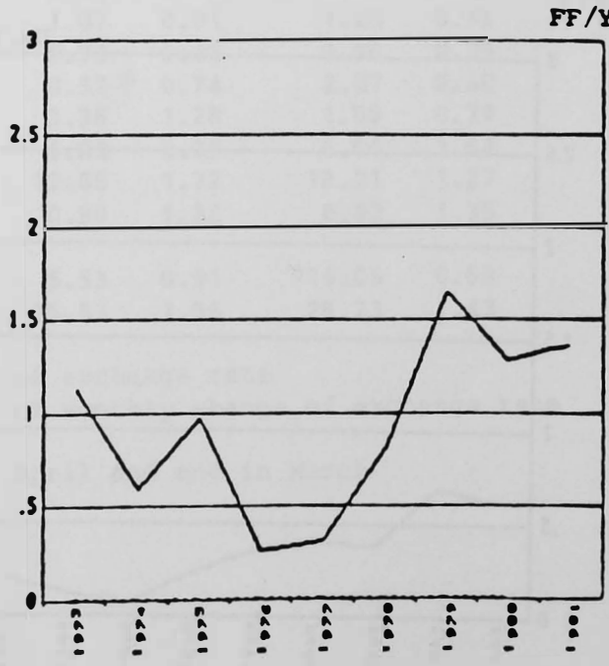


Chart 10

FF/Yen



high variance of the first year 1973-1974. The same is true for the £/FF and, although variability as measured by the monthly changes increases rather more for this rate after the appearance of the EMS, the change is not significant. Against the yen, however, sterling appears to have been becoming more variable (the result in column (a) is again due to a trend in the data). To the extent that we can draw any conclusions as to variability trends from chart 4, it would appear that the increase slowed down from 1980.

All four $US rates show a sharp rise in variability during the 1978-1979 period. Against the DM and FF, the $US seems to have been stabilising prior to that year. The $US/Yen variability as shown in Chart 7 appears to have been on an upward trend since 1975 with a sharp one year interruption in 1978-1979.

The yen has been the most variable currency in this group since the EMS was founded, but, in the pre-EMS period, displayed no clear characteristics beyond those already noted.

(ii) Real bilateral rates - Table 2

The variance of exchange rate levels measure shows substantial differences between real and nominal results. This is largely due to the fact that the trend behaviour of real and nominal rates differs, ie the real rates were generally less variable, suggesting that relative price trends were offsetting nominal rate trends. This is not true in every case, however, and, in particular, the nominal £/DM was less variable than the real rate in the EMS period.

The results for real monthly changes are almost exactly the same as in the nominal cases, with one exception. The variance of the real £/FF rate moves annually in opposite directions to the nominal rate variance since the EMS was set up. Overall, the impression is that the real rates are slightly more variable than the nominal ones with notable exceptions being the DM/Yen in 1974-1975, 1976-1977 and 1981-1982. In eight of the ten bilateral rates, real variability was greater after the commencement of the EMS.

TABLE 2
VARIANCE OF REAL RATES

	£/$		£/DM		$/DM		£/FF	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	1.38	0.72	3.27	1.86	3.88	2.71	2.19	1.43
1974-1975	1.33	0.54	0.42	0.28	2.27	0.86	1.80	0.57
1975-1976	1.38	0.73	0.77	1.10	2.70	1.25	0.25	0.60
1976-1977	1.20	0.82	1.99	1.21	0.71	0.25	1.18	0.82
1977-1978	2.58	0.63	0.55	0.57	2.45	0.38	0.94	0.88
1978-1979	1.84	1.04	0.51	0.55	1.93	2.41	0.34	0.27
1979-1980	2.51	1.79	3.10	1.33	1.46	1.47	1.85	1.23
1980-1981	0.96	1.29	5.99	1.60	7.38	1.34	3.23	0.96
1981-1982	3.38	1.41	1.74	0.86	1.44	1.03	1.89	1.17
1973.1-1979.3	4.91	0.72	2.87	0.92	5.84	1.36	1.87	0.74
1979.4-1982.12	12.44	1.29	14.24	1.23	30.26	1.18	8.50	1.22

	$/FF		DM/FF		£/YEN		$/YEN	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	4.01	2.24	1.17	0.54	1.52	0.72	0.66	0.89
1974-1975	4.00	0.50	2.45	0.69	0.78	0.31	0.61	0.36
1975-1976	1.63	1.10	0.44	0.34	0.83	0.50	0.30	0.22
1976-1977	0.28	0.14	1.43	0.27	1.33	1.02	0.78	0.21
1977-1978	0.88	0.21	0.62	0.39	1.13	1.45	3.72	0.64
1978-1979	1.71	1.98	0.28	0.25	4.74	1.22	4.72	3.18
1979-1980	1.20	1.04	0.41	0.07	12.18	2.05	6.01	0.82
1980-1981	4.93	1.11	0.35	0.16	1.48	1.03	1.28	1.35
1981-1982	1.11	0.86	[illegible]	0.20	0.86	0.82	2.62	1.67
1973.1-1979.3	5.40	1.10	2.77	0.42	15.01	0.94	24.97	1.03
1979.4-1982.12	26.75	1.23	1.84	0.22	5.47	1.67	11.03	1.63

	DM/YEN		FF/YEN	
	(a)	(b)	(a)	(b)
1973-1974	3.38	2.13	4.10	1.47
1974-1975	1.15	0.46	4.33	0.61
1975-1976	1.51	0.95	1.03	0.90
1976-1977	0.47	0.31	1.58	0.27
1977-1978	0.71	0.83	1.09	0.30
1978-1979	4.20	1.35	2.89	0.74
1979-1980	6.40	2.21	8.97	1.67
1980-1981	11.85	1.77	8.08	1.31
1981-1982	1.15	1.12	0.96	1 26
1973.1-1979.3	11.73	0.94	14.41	0.75
1979.4-1982.12	15.00	1.53	10.45	1.38

(a) Variance of exchange rate
(b) Variance of monthly change of exchange rate

VARIANCE OF REAL BILATERAL RATES

Chart 11

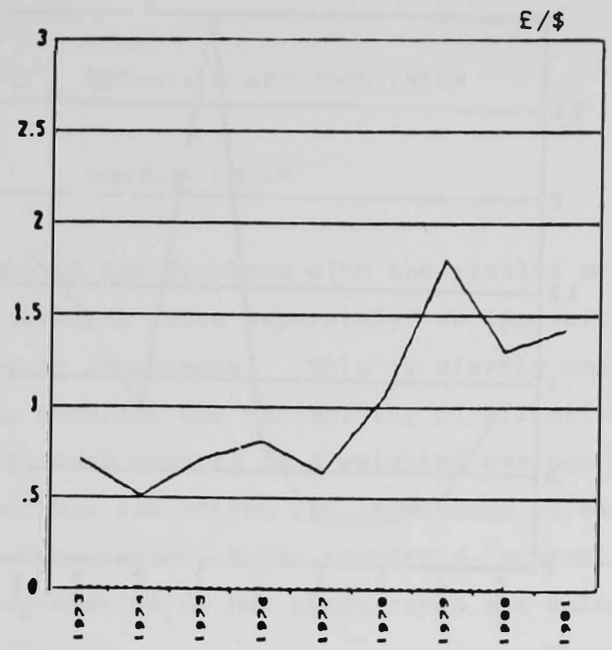


Chart 12

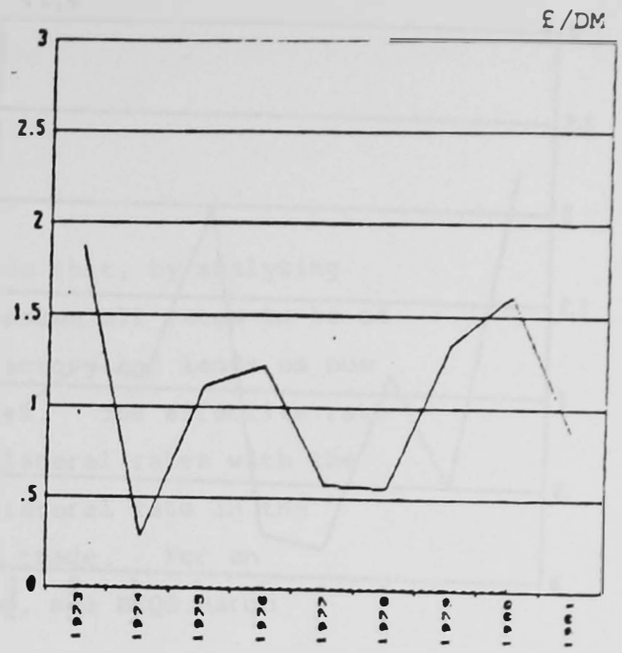


Chart 13

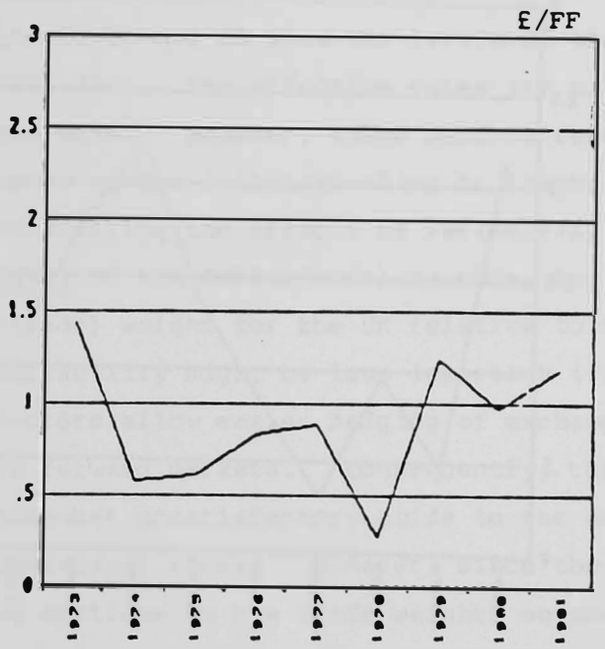


Chart 14

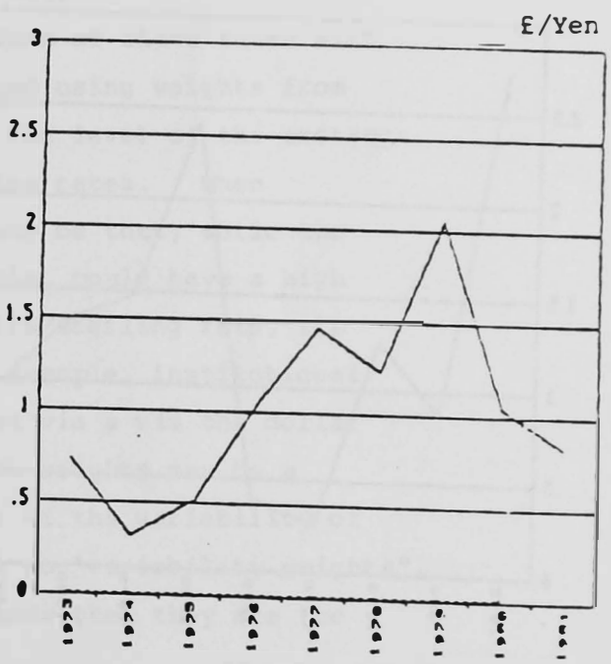
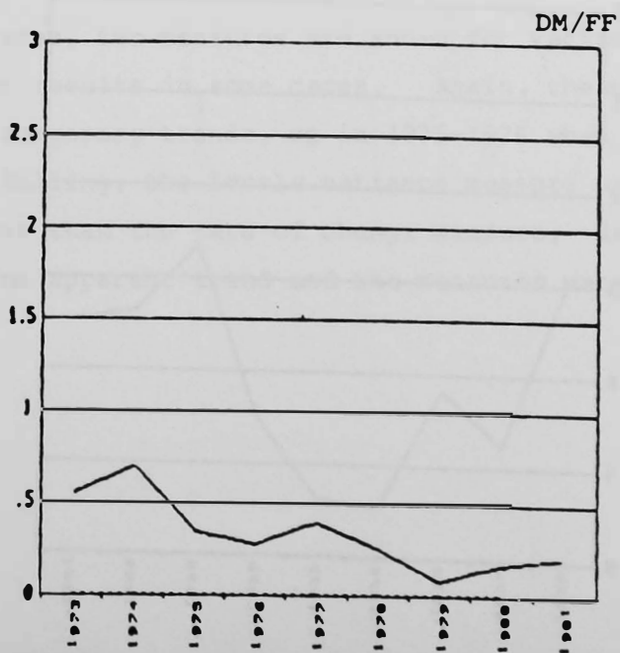


Chart 15.



VARIANCE OF REAL BILATERAL RATES

Chart 16

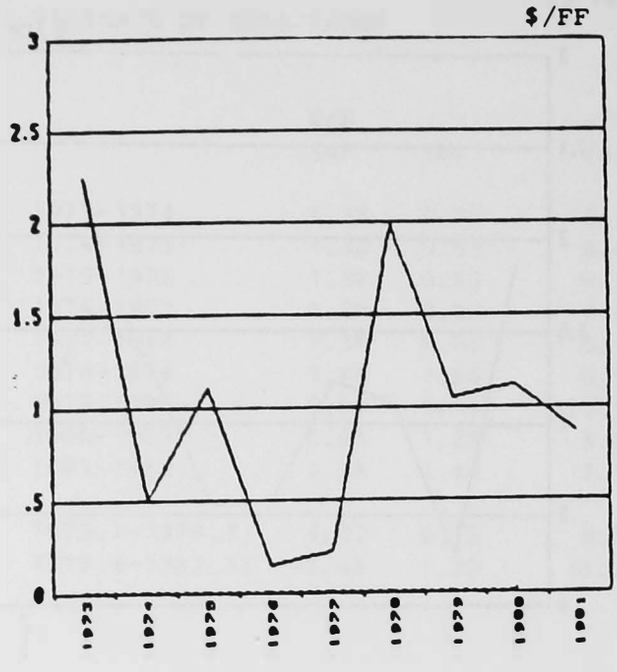


Chart 17

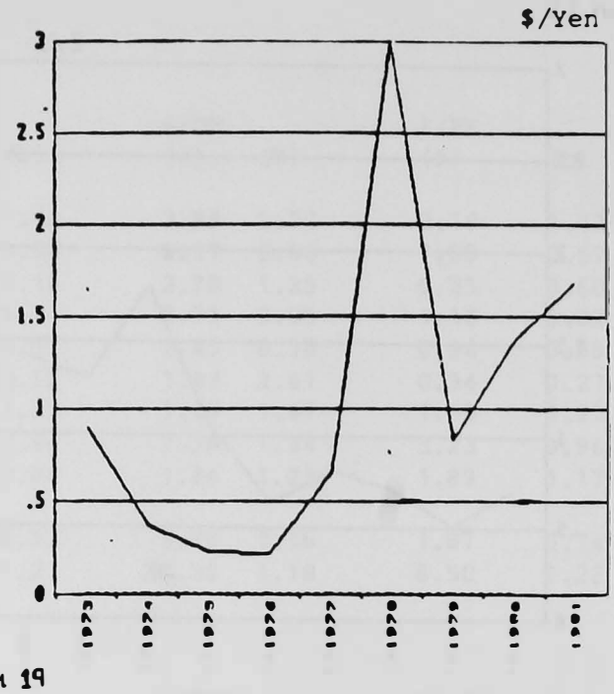


Chart 18

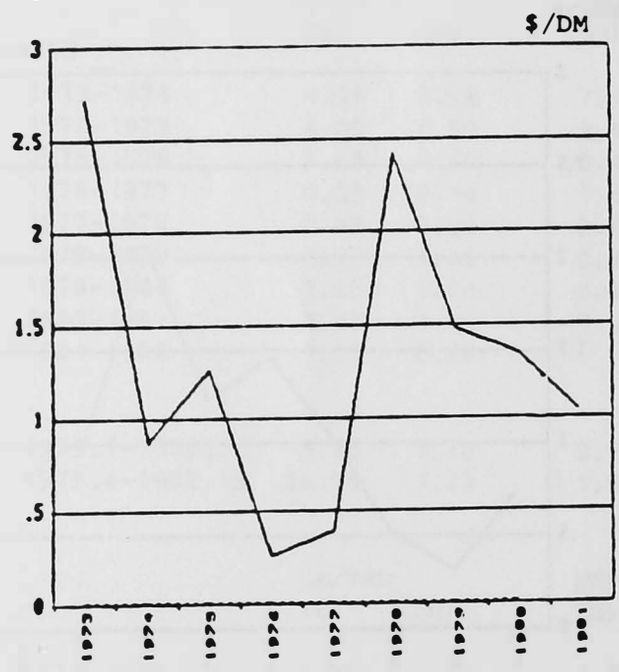


Chart 19

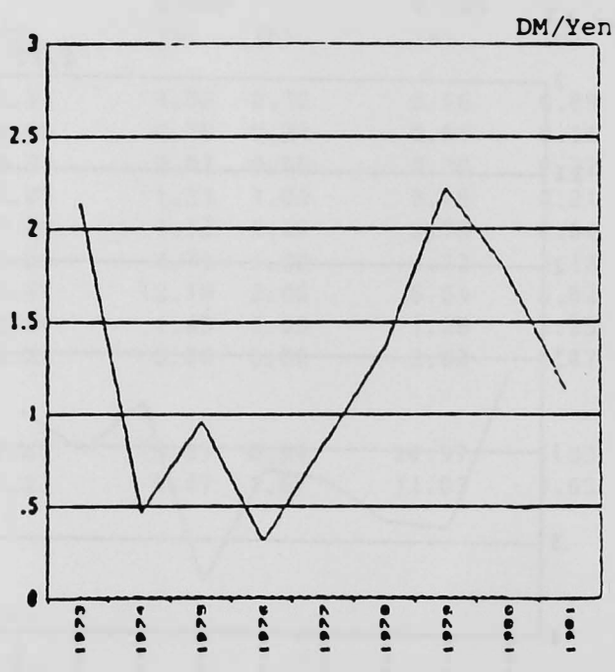
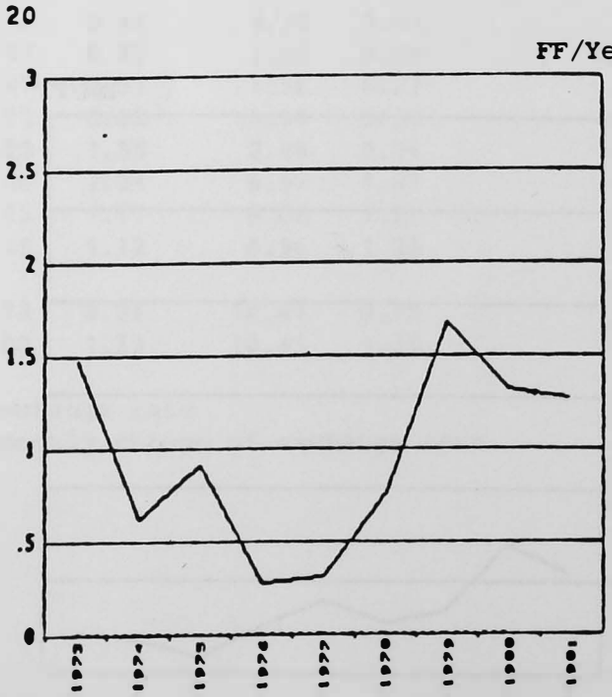


Chart 20



VII Effective exchange rates

(i) Nominal rates

One of the problems with the results so far is that, by analysing bilateral rates separately, we implicitly assume all rates to be of equal importance. This is clearly unsatisfactory and leads us now to consider the variability of effective rates. The effective rate for each country is a weighted average of bilateral rates with the weights reflecting the importance of each bilateral rate in the determination of the country's international trade. For an explanation of how these rates are calculated, see BEQB March 1981.

Charts 21 and 22 show the levels of the indices of these rates with 1975=100. The effective rates are calculated using weights from the MERM. However, these weights refer to the level of the exchange rate, eg the dollar/sterling or franc/sterling rates. When considering the effects of variability, it may be that, while the level of the dollar/sterling rate, for example, could have a high (trade) weight for the UK relative to the lira/sterling rate, its variability might be less important if, for example, institutional factors allow easier hedging of exchange risk vis a vis the dollar in forward markets. Consequently, the trade weights may be a somewhat unsatisfactory guide to the effects of the variability of individual rates. However, since there are no "variability weights", we continue to use trade weights on the grounds that they are the best available.

As with bilateral rates, two measures are shown for variability and give quite different results in some cases. Again, these differences are largely due to temporary trends, eg in 1975-1976 when the UK effective rate was falling, the levels variance measure was substantially greater than the rate of change measure; in 1977-1978, however, there was no apparent trend and the measures were fairly similar.

TABLE 3

VARIANCE OF NOMINAL EFFECTIVE RATES

	France		Italy		Japan	
	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	1.57	0.68	0.93	0.82	0.76	0.44
1974-1975	1.83	0.32	0.43	0.10	0.90	0.33
1975-1976	0.24	0.33	5.15	1.27	0.13	0.15
1976-1977	1.02	0.21	0.98	1.03	0.48	0.14
1977-1978	0.11	0.15	0.44	0.10	3.12	0.53
1978-1979	0.09	0.24	0.37	0.09	3.09	1.63
1979-1980	0.40	0.18	0.13	0.15	3.97	0.91
1980-1981	1.28	0.18	1.91	0.18	4.63	0.98
1981-1982	0.46	0.21	0.66	0.11	0.77	1.17
1973 -1979	1.69	0.34	33.69	0.57	17.20	0.60
1979 -1982	8.43	0.28	11.56	0.14	5.09	1.20

	United Kingdom		United States		West Germany	
	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	0.89	0.34	0.93	0.59	1.70	1.03
1974-1975	0.32	0.06	0.45	0.17	0.75	0.33
1975-1976	1.20	0.40	0.73	0.21	0.55	0.39
1976-1977	1.86	0.82	0.05	0.09	1.05	0.22
1977-1978	0.67	0.52	0.80	0.10	0.95	0.16
1978-1979	0.37	0.11	1.11	1.09	1.02	0.44
1979-1980	1.19	0.76	0.41	0.44	0.72	0.38
1980-1981	1.13	0.84	0.99	0.50	1.32	0.35
1981-1982	1.50	0.57	1.02	0.58	0.54	0.23
1973 -1979	18.73	0.38	2.04	0.43	9.36	0.41
1979 -1982	2.57	0.72	10.63	0.54	1.41	0.26

(a) Variance of exchange rate
(b) Variance of monthly change of exchange rate

Years begin in April and end in March

CHART 21

Nominal effective exchange rate (1975 = 100)

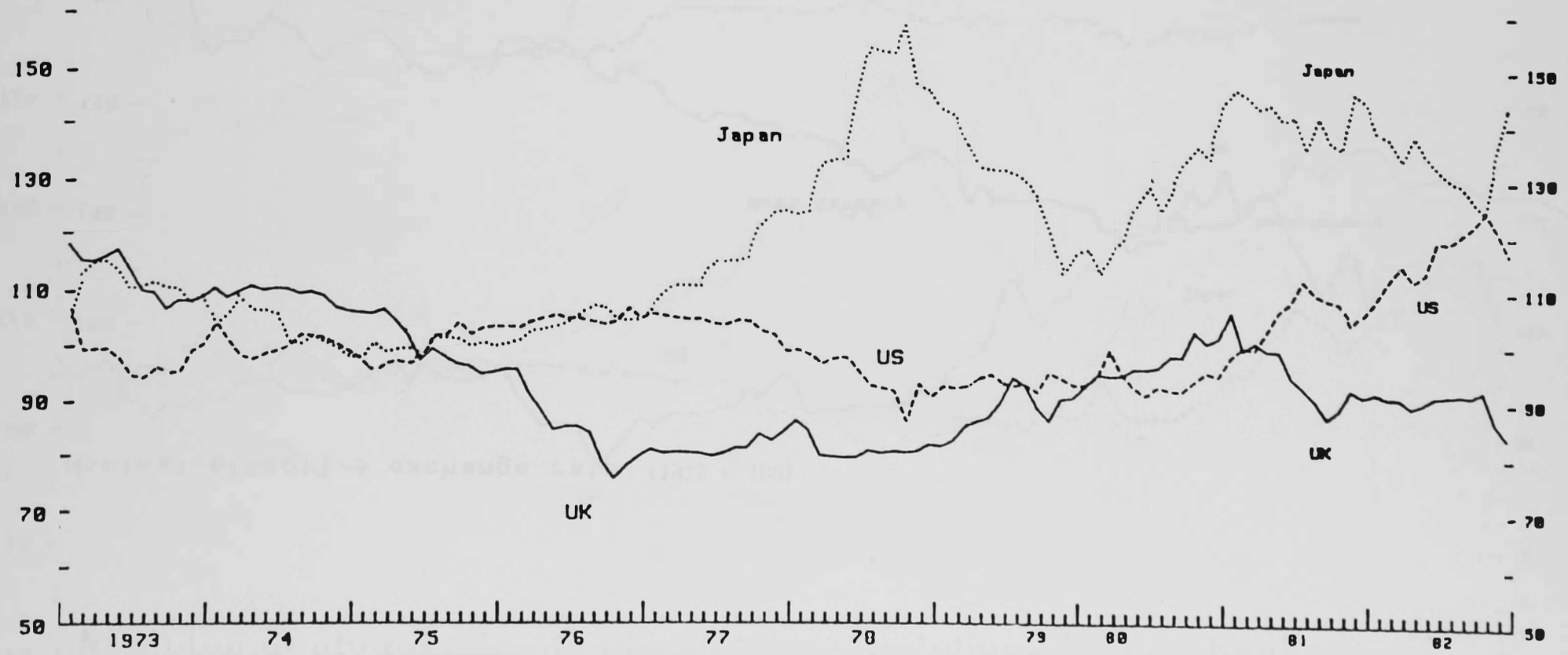


CHART 22

Nominal effective exchange rate (1975 = 100)

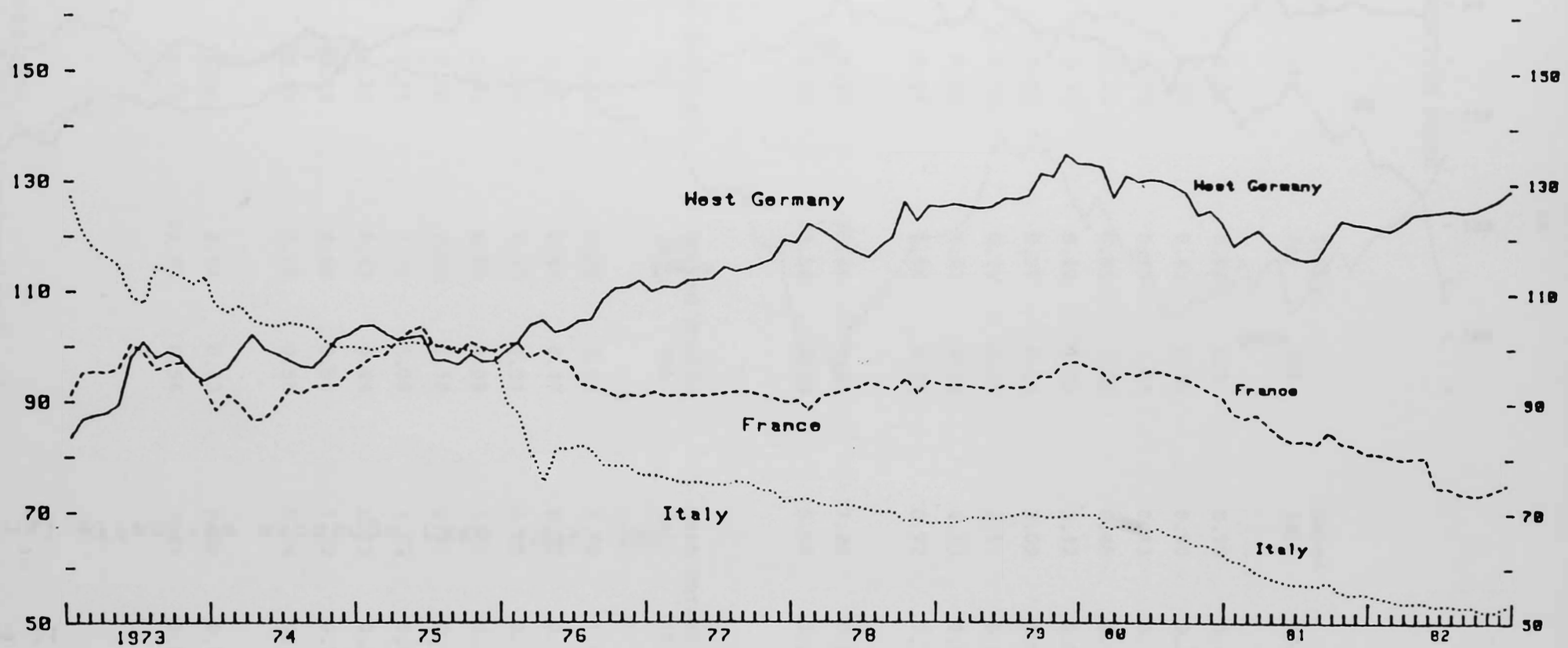


CHART 23

Real effective exchange rate (1975 = 100)

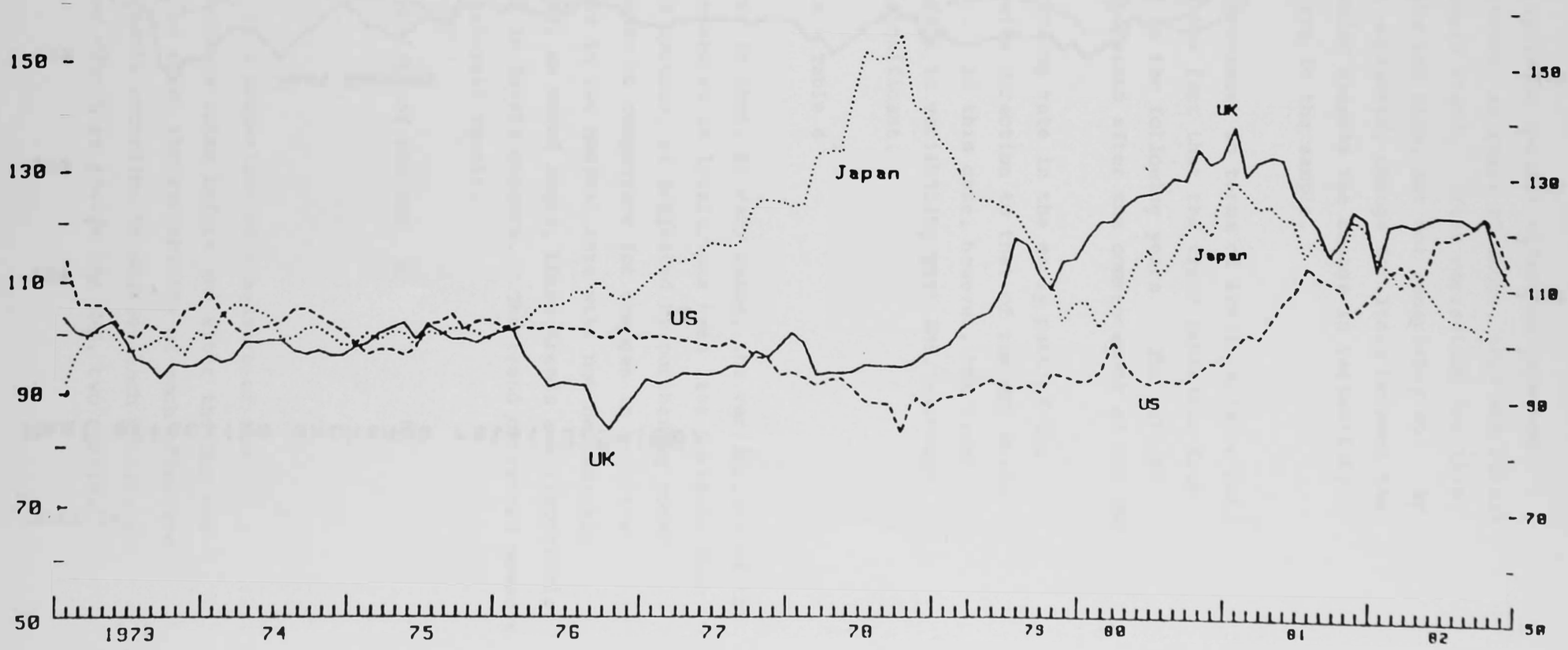
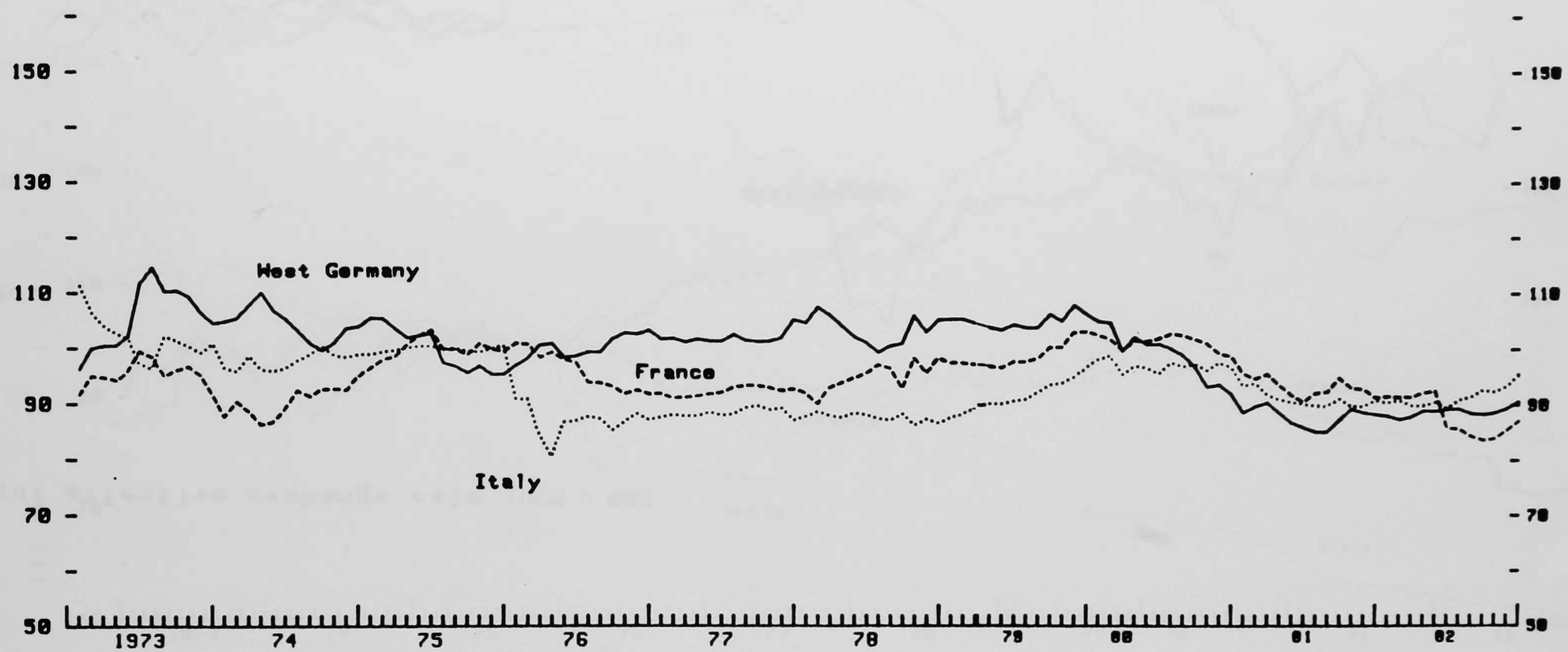


CHART 24

Real effective exchange rate(1975=100)



In levels terms, the most variable nominal effective rate was clearly that of Italy, although, as Chart 22 shows, this was mainly due to its persistent downward trend. After correcting for this, the Italian rate variability was high, but not remarkably so. By either measure, there is a noteworthy change for Italy between the pre-EMS and EMS periods, which exceeds the change in variability achieved by any other country in the sample.

The UK shows a distinct improvement in terms of level variance but, here again, this is due to the fact that the trend behaviour from 1973-1977 was not repeated in the following years. The rate of change variance actually increased after the commencement of the EMS.

West Germany also had a trending rate in the early part of the sample (albeit in the opposite direction to that of the UK) which did not continue throughout. In this case, however, the trend corrected measure shows a fall in variability post EMS, although this is not statistically significant.

(ii) Real effective rates - Table 4

The most notable result here is that, in many cases, the variability of the real effective rate, when measured in levels, has been less variable than the nominal rate. This is because, as suggested by purchasing power parity the exchange rate tends to compensate for changes in relative price levels. Thus, trends in the nominal rate will not necessarily appear in the real rate, and, as noted above, these trends are responsible for pushing up the variance in levels measure. The trend corrected measure does not produce this nominal-real result.

VIII The effects on variability of the EMS

Methodology

The basis of this analysis is a comparison of a measure of the variability of effective exchange rates before and after the EMS was established. In addition to this, the variability of each effective rate is decomposed into elements according to whether each particular bilateral rate refers to two countries inside the EMS, two outside, or one of each.

TABLE 4

VARIANCE OF REAL EFFECTIVE RATES

	France		Italy		Japan	
	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	1.60	0.71	0.62	0.84	0.68	0.55
1974-1975	1.87	0.31	0.21	0.14	0.52	0.22
1975-1976	0.18	0.31	3.34	1.19	0.17	0.21
1976-1977	0.89	0.15	0.66	0.88	0.51	0.18
1977-1978	0.11	0.16	0.08	0.11	2.11	0.56
1978-1979	0.22	0.26	0.09	0.13	3.69	1.73
1979-1980	0.56	0.15	1.04	0.19	6.08	0.93
1980-1981	0.90	0.18	0.39	0.28	2.97	1.06
1981-1982	0.15	0.22	0.04	0.09	1.41	1.07
1973 -1979	1.57	0.33	4.40	0.56	17.39	0.63
1979 -1982	3.87	0.29	11.02	0.18	4.49	1.19

	United Kingdom		United States		West Germany	
	(a)	(b)	(a)	(b)	(a)	(b)
1973-1974	0.96	0.44	0.65	0.60	1.45	1.05
1974-1975	0.17	0.18	0.66	0.20	0.73	0.35
1975-1976	0.27	0.41	0.55	0.29	0.78	0.42
1976-1977	1.26	0.89	0.08	0.10	0.28	0.16
1977-1978	0.74	0.54	0.90	0.11	0.44	0.18
1978-1979	0.66	0.10	0.85	1.09	0.48	0.43
1979-1980	2.87	1.16	0.67	0.45	0.38	0.39
1980-1981	0.98	0.85	1.09	0.48	2.67	0.37
1981-1982	1.69	0.69	0.91	0.61	0.25	0.20
1973 -1979	1.72	0.41	3.04	0.44	1.33	0.42
1979 -1982	4.18	0.87	10.39	0.57	5.77	0.27

(a) Variance of exchange rate
(b) Variance of monthly change of exchange rate

Years begin in April and end in March

The total variance of (say) the sterling effective rate can be broken down into the following five elements*, each of which is a weighted sum of variances of bilateral rates:

V1 - Variance of the £ rate against currencies outside the ERM.

V2 - Variance of the £ rate against currencies inside the ERM.

V3 - Variance of rates between two non-£ currencies both outside the ERM.

V4 - Variance of rates between two non-£ currencies, one of which is inside and one outside the ERM.

V5 - Variance of rates between two non-£ currencies both inside the ERM

The weights in V1 and V2 are just the weights attached to the corresponding bilateral rates in the usual effective rate calculation (Equation 1 of Annex II. Thus each sterling bilateral rate appears with a higher weight than might have been expected: weights in a linear sum like the effective rate will usually appear squared (and therefore smaller, since all the weights are less than unity) in the variance of that linear sum. This arises because the covariance between (say) the £/$ and £/FF has been replaced by an expression in terms of the variance of each of those rates, adding to their weights in the variance of the effective rate. But offsetting this, there is a term in the variance of the $/FF rate, to be subtracted. If sterling rises against the dollar, but falls against the franc, the covariance will be negative; the negative covariance will be replaced by small positive terms (the variances of the £/$ and £/FF rates) and a larger negative one, reflecting the (much larger) variance of the $/FF rate.

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* See Annex II.

Results

Nominal rates - variance about the mean

Table 5 presents the variability of the nominal effective rates for all 18 of the countries used in the MERM effective rate calculation. Of the seven ERM participants, only four have improved in total variability terms since the system began. It is noticeable that Belgium and Denmark both show large increases. These currencies suffered considerable pressure throughout the EMS period. Despite changes in domestic policy, several realignments were needed which clearly were not sufficient to produce a currency value close to equilibrium for very long. Italy has been the major beneficiary in exchange rate terms with an approximate 60% fall in variability. On the face of it, this is surprising; the lira was devalued against most other ERM currencies on four occasions, which would suggest a relatively high variance for the EMS period. The net reduction must be due to a substantial reduction in the very short term variability. This, of course, is precisely what the ERM was intended to achieve.

Outside the ERM group (denoted NERM henceforth), there is considerable evidence of improvement. Seven of the eleven countries show a fall in variability, Switzerland, the UK and Austria benefiting most. The US experienced a sharp increase which was probably linked to the increased variability of US interest rates following the change in US monetary policy in 1979.

Despite the usefulness of total variance as a descriptive statistic, it is difficult to draw any conclusions as to the role of the ERM from this alone. Column VI shows the trade weighted variability of own currency/NERM currency rates. Only in three cases does an ERM currency show a reduced variability relative to NERM currencies. Further, these falls are small relative to the four increases. Conversely, for currencies themselves outside the ERM, variability against NERM currencies has fallen in nine of the eleven cases. This pattern will reappear throughout the results and suggests that the variability of exchange rates between the ERM and NERM groups has increased.

Variability within the ERM group has also fallen, as shown by the first part of column V2. All own currency/ERM rates have stabilised for the ERM currencies, and most of these reductions are substantial, leading to an 83% fall on average.

The apparent area of calm within the ERM is probably responsible for the reduced variability between the ERM currencies and their geographical neighbours, Austria, Norway, Sweden, Switzerland and the UK. That the currencies of these countries should share in the reduced ERM variability should not be surprising; an analysis (not reported here) based on an "effective" ERM group including these countries produced almost exactly the same intra and inter ERM/NERM group results.

In column V3, the fall in NERM cross rate variability is very apparent. For only one country (Japan) is there a (rather minor) rise in this figure. Clearly, at least one cross rate within the NERM group has become more variable, and it (or they) have relatively high significance for Japan. For the rest, the trade weights emphasise the effects of the more stable intra-NERM rates.

A similar result is obtained for intra-ERM rates in column V5. In this case, all countries show a fall in the relevant statistic. It should be remembered that a reduction in this variance cannot, ceteris paribus, be seen as beneficial to the countries concerned, because it will tend to raise the volume of trade between third parties at the expense of trade with the "own" country.

Finally, column V4 gives clear evidence of the increased variability of cross rates involving one currency from each group.

We conclude from these results that the ERM may have been successful in reducing the variability between its participating currencies. However, a similar reduction has occurred within the group of currencies outside the ERM. We cannot reject the suggestion that the ERM group results would have appeared with or without the fixed rate system. We also find evidence of increased variability between rates crossing the ERM and NERM groups.

TABLE 5

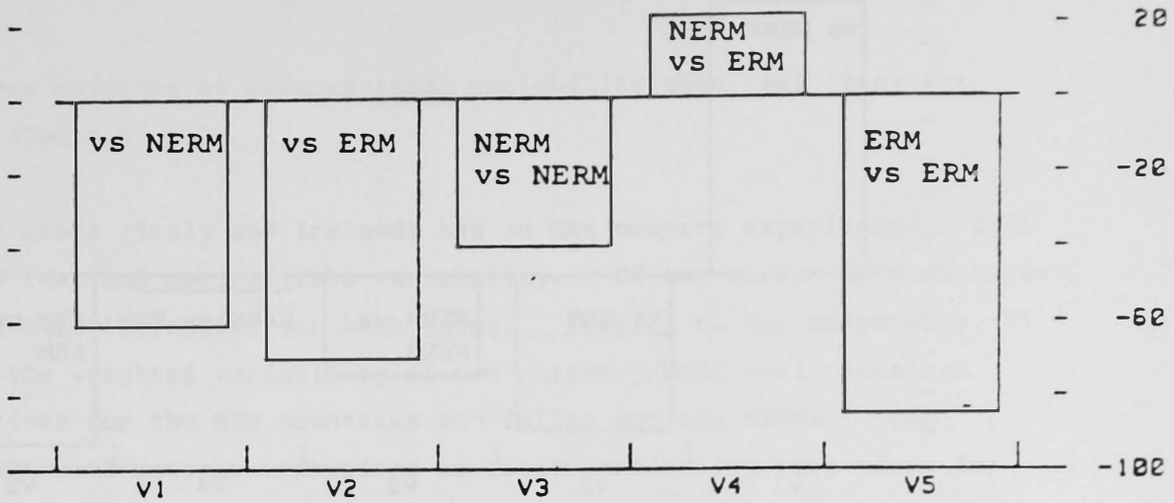
NOMINAL EFFECTIVE RATES - VARIANCE ABOUT THE MEAN

	Country	V1 (vs NERM)		V2 (vs ERM)		V3 (NERM v NERM)		V4 (NERM v ERM)		V5 (ERM v ERM)		VT	
		Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS*	EMS
ERM	Belgium	4.94	9.88	6.61	1.93	1.17	0.72	4.08	4.68	3.05	0.55	3.25	5.86
	Denmark	5.91	12.04	4.68	0.75	2.87	2.19	4.49	4.70	1.44	0.19	1.79	7.71
	France	5.83	14.11	6.97	1.38	2.45	1.41	5.75	5.30	2.86	0.35	1.74	8.43
	Germany	9.26	7.09	10.21	2.01	3.01	1.70	4.99	5.84	1.47	0.15	10.00	1.41
	Italy	18.89	15.86	22.09	2.01	2.42	1.29	3.78	4.72	0.73	0.30	34.05	11.56
	Netherlands	7.59	6.22	8.54	1.90	1.60	1.01	4.72	5.61	2.91	0.43	6.90	1.07
	Ireland	10.31	11.16	11.19	0.61	2.48	1.58	4.53	5.17	1.36	0.24	13.13	4.78
NERM	Austria	10.91	7.08	6.63	1.54	2.91	1.59	4.60	5.15	1.55	0.24	8.48	1.64
	Canada	7.10	2.18	3.55	4.15	2.40	1.64	2.19	4.03	0.28	0.04	5.78	0.62
	Japan	17.26	4.79	5.82	7.23	1.49	1.54	3.34	5.25	0.79	0.14	17.46	5.09
	Norway	6.79	6.17	4.09	1.91	3.27	2.03	4.20	4.82	1.14	0.18	2.27	1.05
	Sweden	6.08	12.56	4.56	1.73	2.85	1.54	3.99	4.80	1.18	0.19	2.62	7.76
	Switzerland	23.38	5.61	18.58	3.69	2.25	1.59	4.35	5.65	1.69	0.25	33.67	1.81
	United Kingdom	15.95	6.24	11.54	3.48	2.23	1.34	4.54	5.53	1.92	0.28	18.80	2.57
	United States	8.24	4.93	4.98	11.85	4.47	1.41	5.28	4.53	1.34	0.21	2.13	10.63
	Australia	12.61	3.68	6.36	6.36	2.85	1.84	3.36	5.34	0.71	0.11	12.05	2.75
	Finland	7.58	6.20	4.61	1.86	3.38	2.44	3.61	4.29	0.80	0.13	4.40	1.20
	Spain	12.74	18.47	12.63	1.75	1.83	0.83	4.14	6.39	1.86	0.30	17.54	12.70

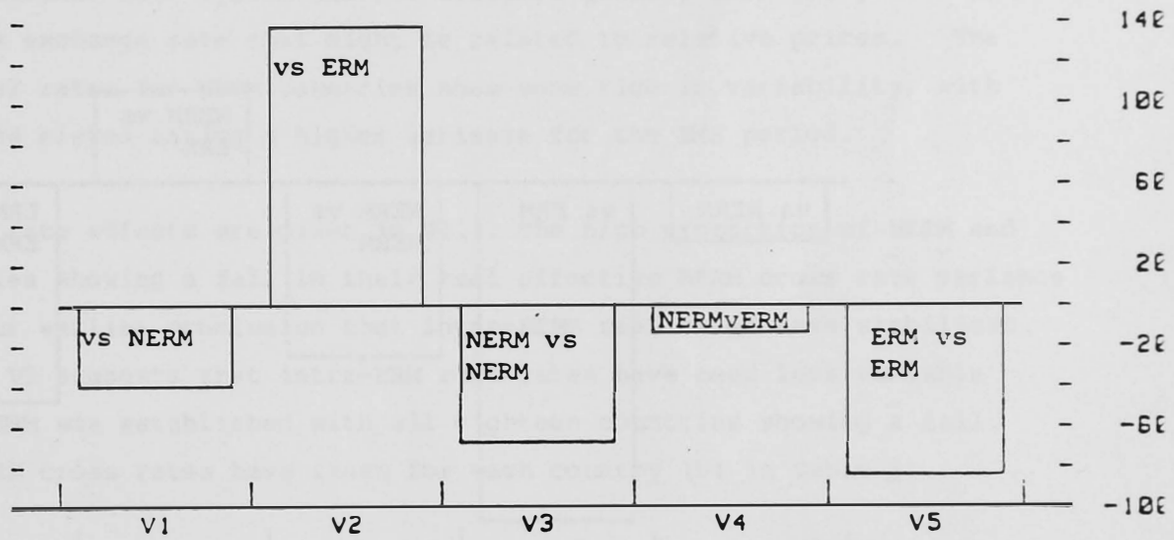
* These results differ slightly from those in Table 3 because the latter omit the first observation of the pre-EMS sample.

CHART 25 Percentage Change in variability of nominal effective rate components

UK



USA



Germany

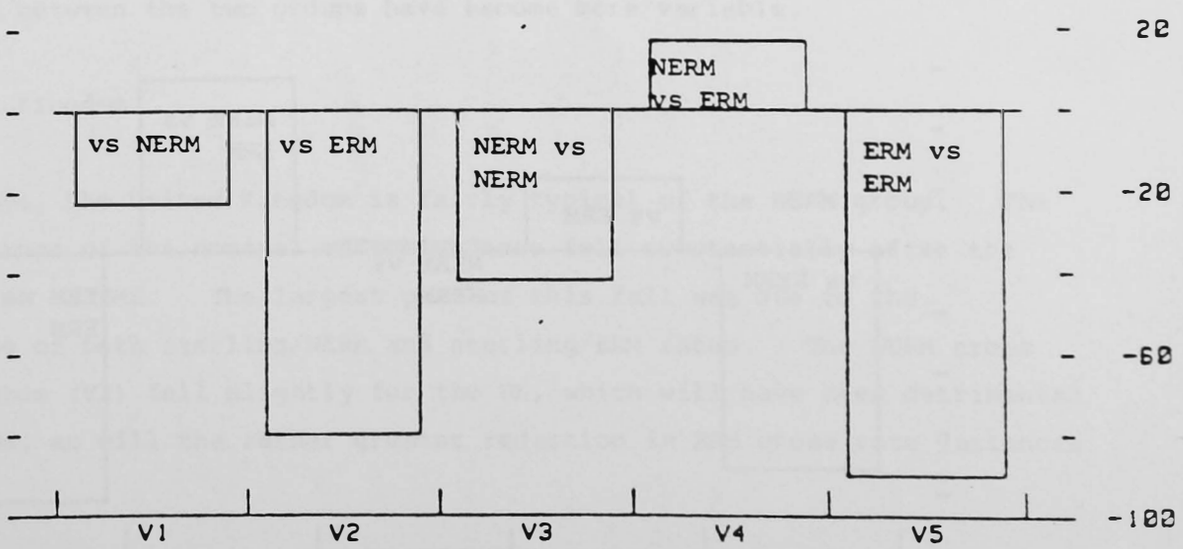
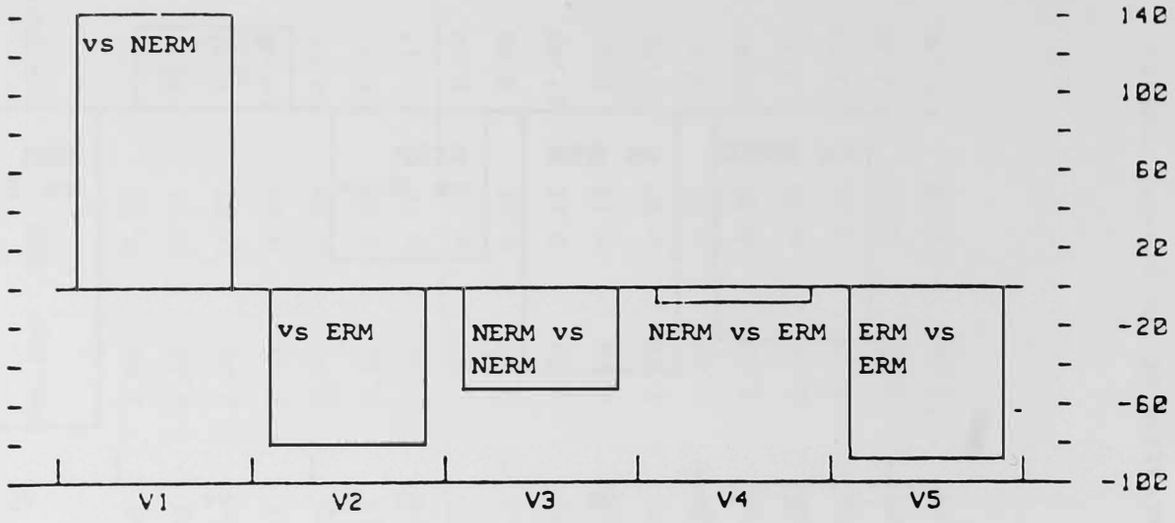
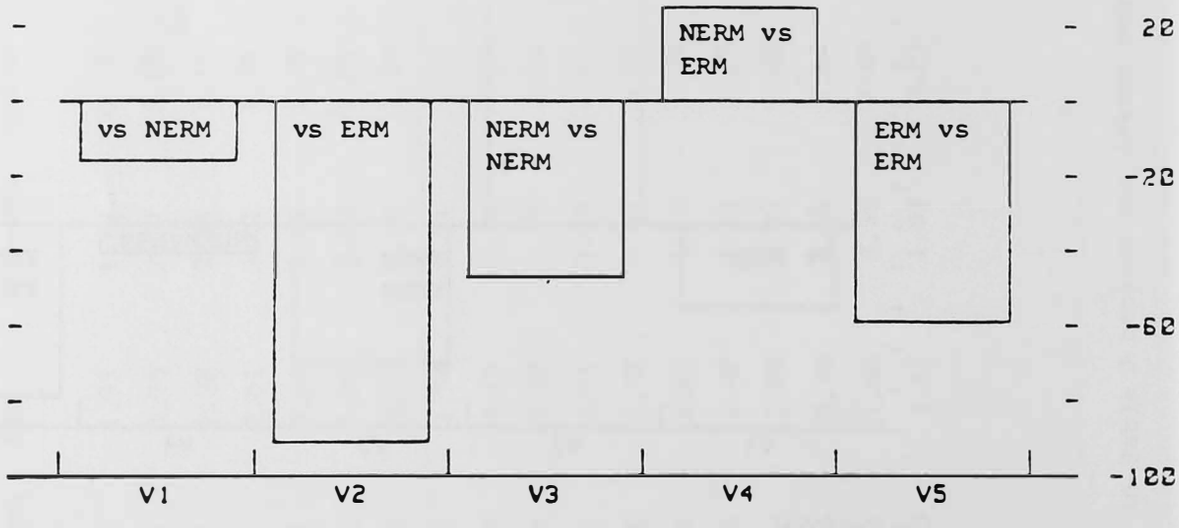


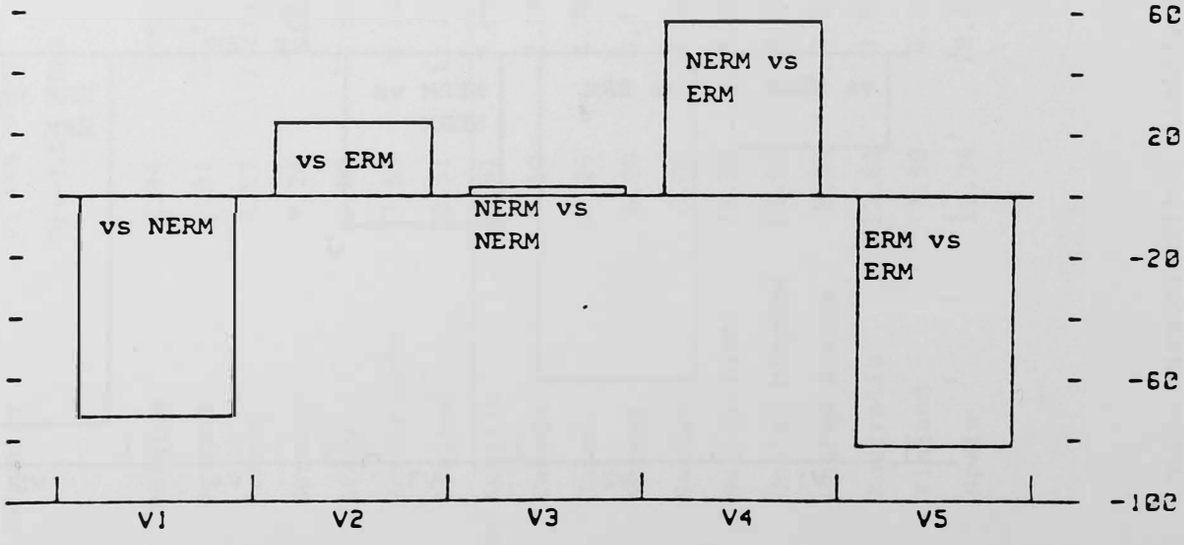
CHART 26 France



Italy



Japan



Real rates

There is less evidence of reduced total variability when real rates are considered (Table 6).

Only in two cases (Italy and Ireland) has an ERM country experienced a fall in both its real and nominal rate variability. Of the eleven NERM countries, six show favourable results for both rates. Turning to the components, V1 shows that the weighted variability of own currency/NERM real rates has generally risen for the ERM countries and fallen for the NERMs. Own currency/NERM real rate contributions to total variability have risen for all of the ERM participants, but for only four of the eleven NERMs. The variability of weighted own/ERM real rates has fallen for six of the ERM currencies (V2). Relating this to the nominal V2 measure, we can see that the fixed nominal rate system has not suffered greatly from changes in the equilibrium exchange rate that might be related to relative prices. The own/ERM real rates for NERM countries show some rise in variability, with seven of the eleven having a higher variance for the EMS period.

NERM cross rate effects are given in V3. The high proportion of NERM and ERM countries showing a fall in their real effective NERM cross rate variance supports our earlier conclusion that intra-NERM real rates have stabilised. Similarly, V5 suggests that intra-ERM real rates have been less variable since the ERM was established with all eighteen countries showing a fall. The ERM/NERM cross rates have risen for each country (V4 in Table 6).

The evidence from the analysis of real rates lends strong support to the conclusion suggested for the nominal rates. Between the two periods, real rates inside the ERM and those outside it have stabilised; but the weighted real rates between the two groups have become more variable.

The United Kingdom

In many ways, the United Kingdom is fairly typical of the NERM group. The total variance of the nominal effective rate fell substantially after the introduction of EMS. The largest part of this fall was due to the stabilising of both sterling/NERM and sterling/ERM rates. The NERM cross rate variance (V3) fell slightly for the UK, which will have been detrimental to UK trade, as will the rather greater reduction in ERM cross rate variances

TABLE 6

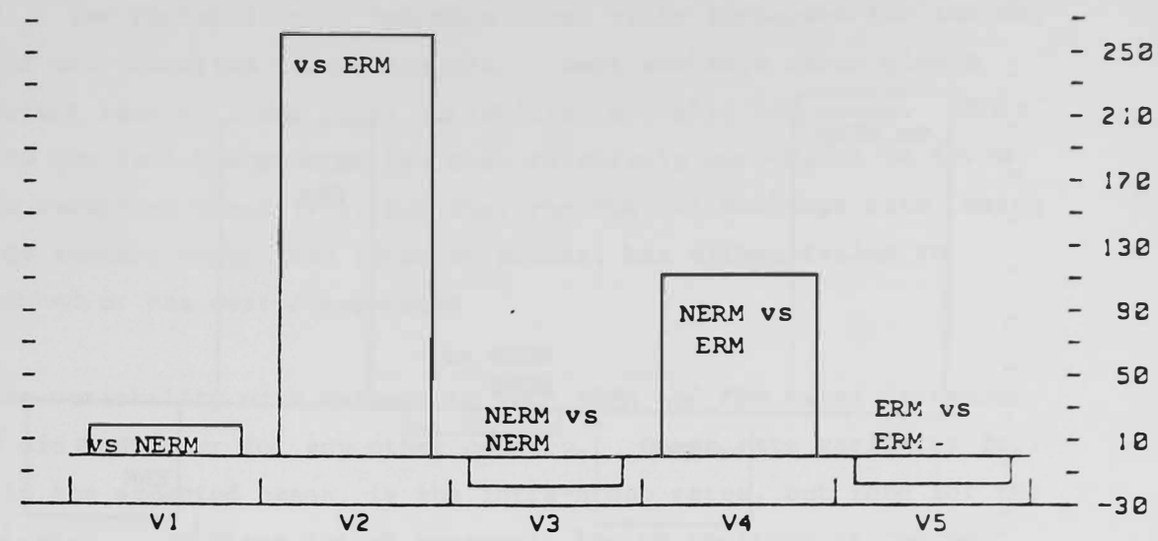
REAL EFFECTIVE RATES - VARIANCE ABOUT THE MEAN

	Country	V1 (vs NERM)		V2 (vs ERM)		V3 (NERM v NERM)		V4 (NERM v ERM)		V5 (ERM v ERM)		VT	
		Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS*	EMS
ERM	Belgium	3.29	10.87	2.96	2.28	0.70	0.67	1.75	4.00	0.56	0.24	3.24	8.24
	Denmark	4.78	11.56	1.53	0.56	1.68	1.88	1.65	3.76	0.23	0.12	2.75	6.36
	France	3.86	8.97	1.67	0.88	1.45	1.30	2.06	4.46	0.42	0.22	1.60	3.87
	Germany	3.89	10.45	1.47	0.85	1.69	1.66	2.00	3.70	0.36	0.17	1.31	5.77
	Italy	5.23	5.73	2.80	1.28	1.36	1.21	1.81	4.63	0.23	0.15	4.86	1.02
	Netherlands	3.88	8.64	2.49	0.80	0.92	0.90	1.88	4.67	0.51	0.31	3.06	3.56
	Ireland	3.35	3.94	1.56	3.56	1.24	1.37	1.75	4.85	0.29	0.14	1.63	1.14
NERM	Austria	4.99	9.72	1.62	0.40	1.86	1.49	1.96	4.42	0.26	0.14	2.53	4.07
	Canada	5.37	2.56	2.27	4.32	1.74	1.62	0.96	3.28	0.05	0.03	4.89	1.95
	Japan	16.12	6.90	4.25	4.09	0.62	1.27	1.38	5.15	0.15	0.08	18.22	4.49
	Norway	4.08	3.93	1.31	2.67	2.01	1.86	1.74	4.06	0.21	0.11	1.43	0.51
	Sweden	3.75	9.99	1.38	1.91	1.86	1.40	1.79	4.03	0.23	0.12	1.25	6.35
	Switzerland	8.47	8.18	4.26	1.46	1.81	1.52	2.03	4.35	0.28	0.15	8.61	3.62
	United Kingdom	4.33	5.16	1.37	4.99	1.59	1.30	2.06	4.38	0.35	0.29	1.70	4.18
	United States	6.92	5.32	2.37	10.4	3.00	1.49	2.60	3.75	0.24	0.13	3.45	10.39
	Australia	5.11	2.94	2.30	5.43	2.20	1.82	1.66	4.31	0.14	0.07	3.41	2.17
	Finland	6.01	4.68	2.22	2.28	2.41	2.25	1.64	3.79	0.14	0.08	4.04	0.84
	Spain	4.60	10.33	2.01	0.81	1.24	0.91	1.95	5.10	0.36	0.19	3.06	4.94

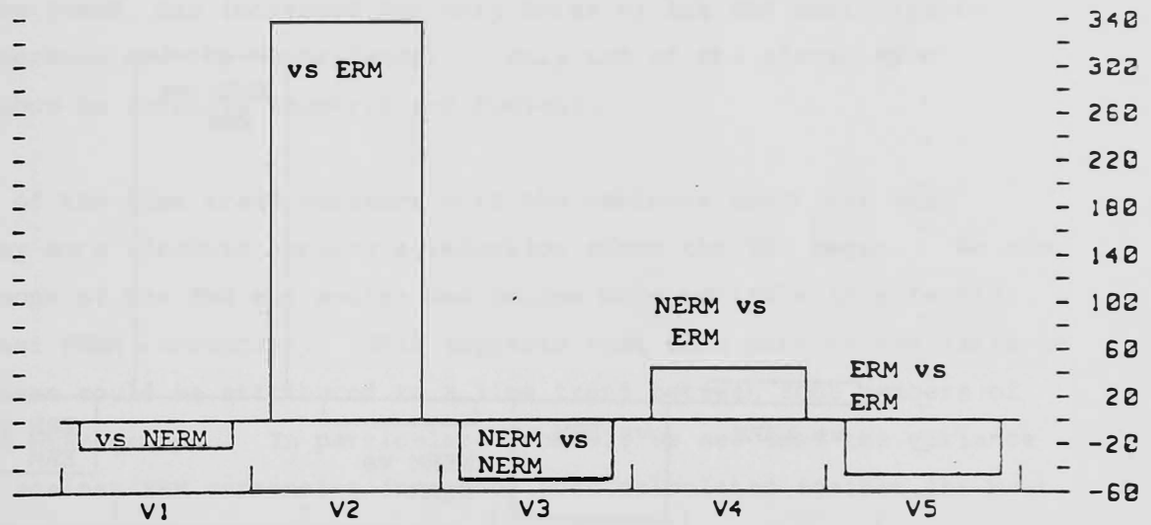
* These results differ slightly from those in Table 4 because the latter omit the first observation of the pre-EMS sample.

CHART 27 Percentage change in variability of real effective rate components

UK



USA



Germany

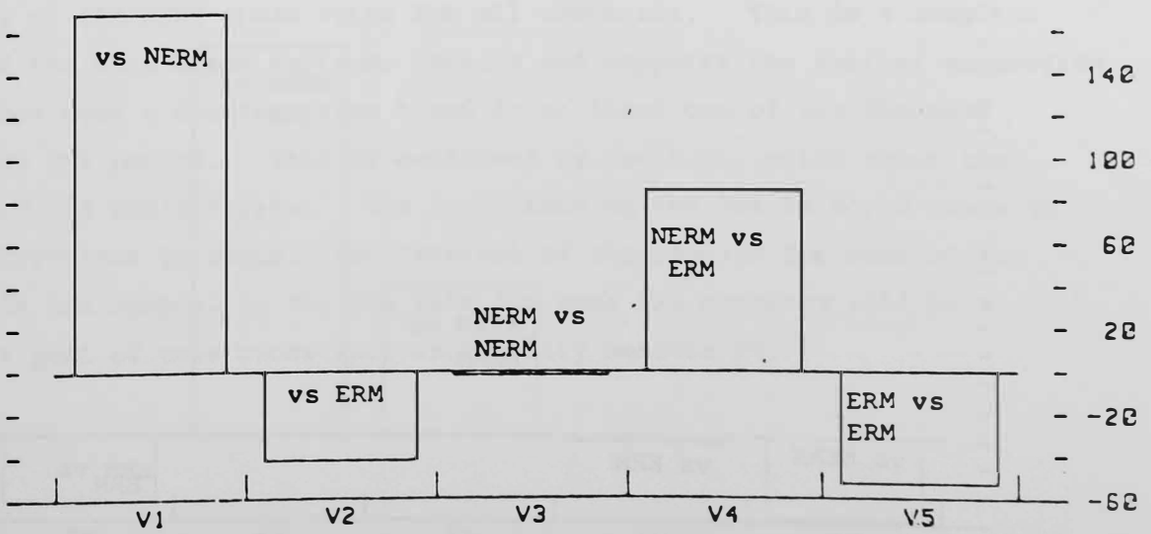
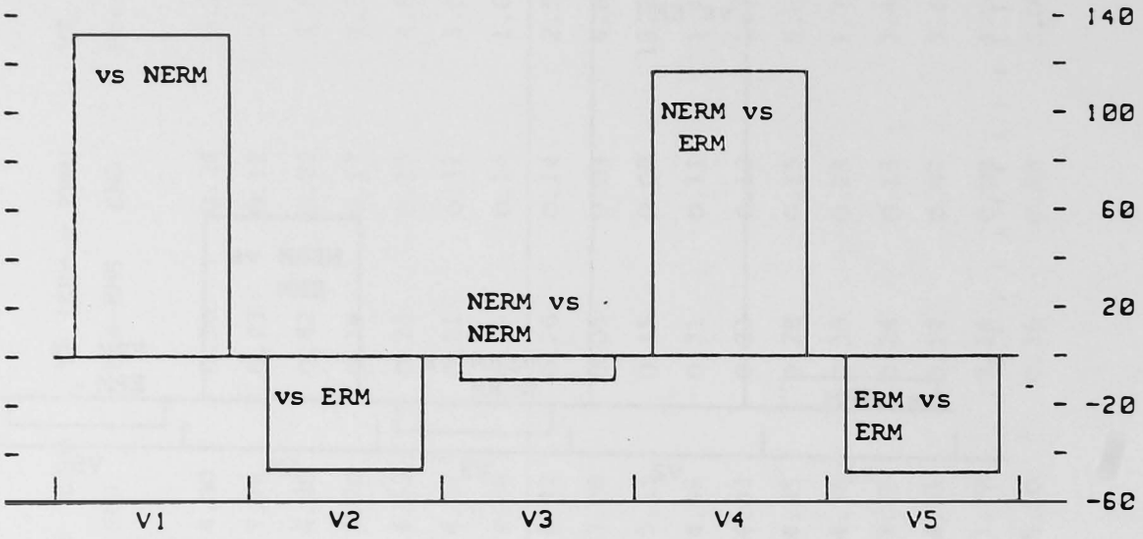
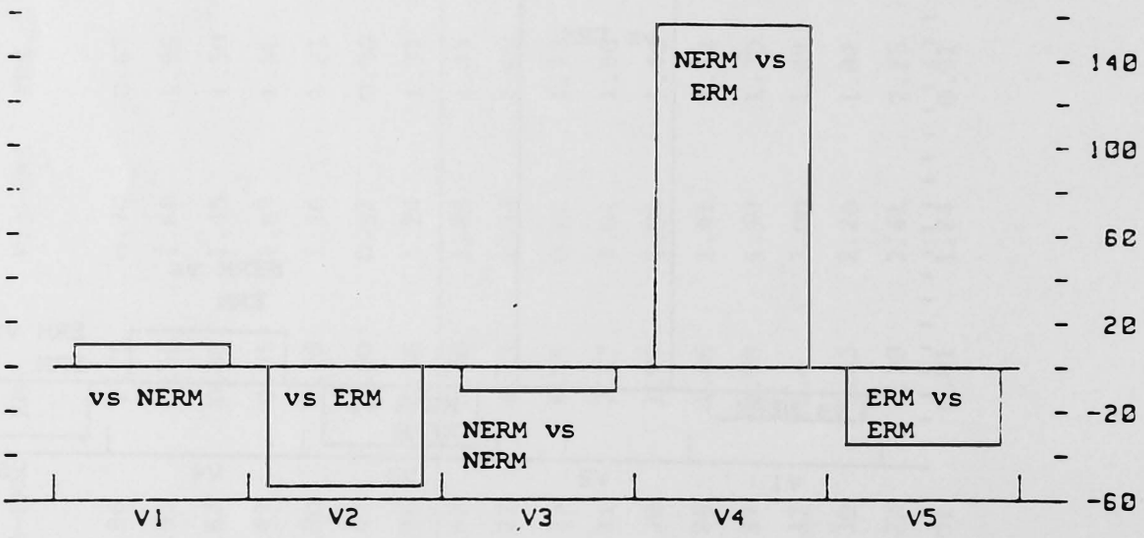


CHART 28

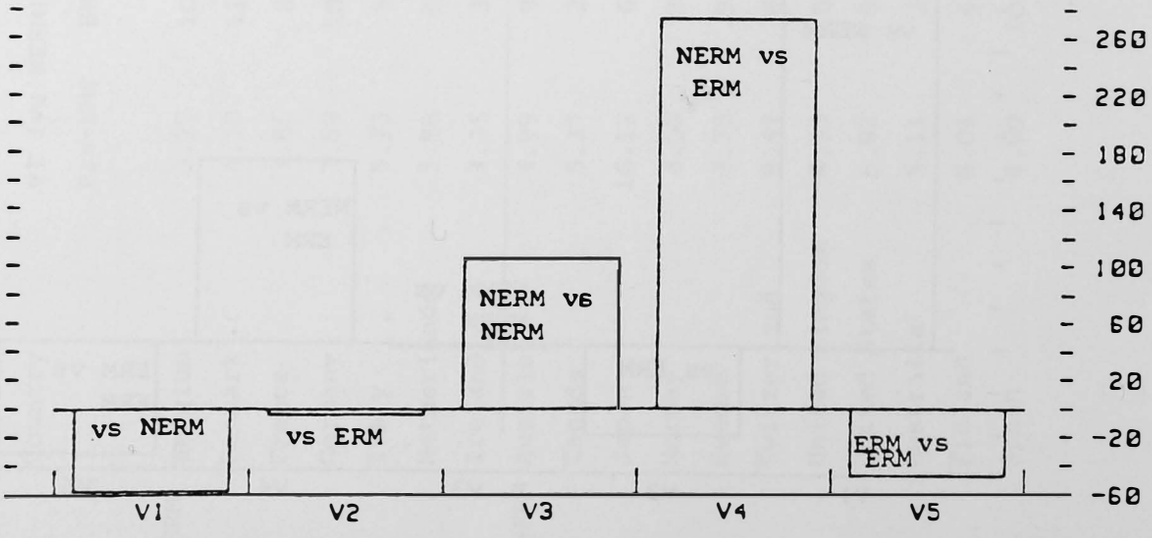
France



Italy



Japan



shown in V5. The variability of ERM/NERM cross rates increased for the UK, as it did for all countries except the USA. Real exchange rates give a rather different result. The total variability actually increased. This may be due to the fact that the UK has been relatively successful in terms of inflation reduction since 1979, but that the nominal exchange rate, being influenced by factors other than relative prices, has either failed to compensate enough or has over compensated.

The real rate variability with respect to both NERM and ERM rates increased. This result did not occur for any other country. Cross rate variances fell for the UK in the expected cases, ie the intra-group rates, but rose for the inter-group rates. In these latter respects, the UK position is "normal".

Time Trend Results

Total variability, as measured by the variance of the nominal effect rate about a time trend, has increased for only three of the ERM participants (Belgium, Germany and the Netherlands). Only two of the eleven NERM countries show an increase (Austria and Sweden).

Comparison of the time trend variance with the variance about the mean reveals many more elements showing a reduction since the ERM began. We now find that none of the ERM currencies has become more variable in effective terms against NERM currencies. This suggests that some part of the variance about the mean could be attributed to a time trend between some members of the ERM and NERM groups. In particular, from V2, we see that the variance of the $US against ERM currencies increased when calculated against the mean but fell after taking account of the time trend.

V3 and V5 continue to suggest calmer seas within the ERM and NERM groups. The interesting result here is that we now observe a fall in the weighted variability of ERM/NERM cross rates for all countries. This is a complete reversal of the mean based variance results and supports the earlier suggestion that there has been a distinct time trend in at least one of the ERM/NERM rates in the EMS period. This is confirmed by Chart 29, which shows the time path of the ECU/$US rate. The importance of the USA in world trade is probably sufficient to explain the reversal of the results for most of the countries in the sample, ie the $US rate for each ERM currency will be a significant part of this cross rate variability measure V4.

A similar, though rather weaker, effect appears for the real rates (Table 8). All eighteen countries show a rise in V4 about the mean, but only thirteen for V4 about a trend. This is clearly a step in the same direction as for nominal rates. Again, V2 for the USA shows a more stable variance about trend than about the mean.

As before, there is strong evidence of increased stability of ERM participants' effective real rates; V2 and V5 both fall for all ERM members. The change in the variance of NERM real cross rates is slightly lower when considered against a trend and there is similar evidence of a smaller increase in variability between ERM own rates and NERM currencies (V1). Total real variability for the ERM countries shows a rise for five participants using the mean based measure, but for only three using the trend*. A similar result obtains for NERM countries. Again, this similarity between the changes in variability for both groups makes it rather difficult to draw any conclusions as to the overall effects of the ERM.

Summary and Conclusions

The intention of this paper was to present data that might be useful in assessing the level of exchange rate variability from 1973 to 1982. In addition, we have attempted to present the data in a way that promotes discussion of the effects of the EMS.

In drawing conclusions from this data, it should be emphasised that, in the absence of further statistical work, it is not suitable for analysing the causes or effects of variability, eg from the outset it was not going to be possible to answer questions such as: "Has the EMS reduced variability?". The reason for this is that we have no control data in the analysis, ie we do not know what the level of variability would have been without the EMS. In view of this, we have set up a number of implicit premises in the course of the paper upon which some logical conclusions may be founded. It is the foundation of these premises that is weak, eg we have tried to control for the creation of the EMS by comparing changes in the variability of currencies inside and outside the system under the assumption that the latter will reflect changes in "world variability" that would also have appeared in the EMS country data

* The Swedish krona joins sterling as a currency whose real variability has increased since 1979 against both ERM and NERM currencies.

TABLE 7

NOMINAL RATES - VARIANCE ABOUT A TIME TREND

Country	V1 (vs NERM)		V2 (vs ERM)		V3 (NERM v NERM)		V4 (NERM vs ERM)		V5 (ERM vs ERM)		VT	
	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS
Belgium	1.60	1.51	0.75	0.67	0.40	0.21	1.10	0.90	0.29	0.11	0.56	0.96
Denmark	2.30	1.76	0.55	0.21	1.10	0.59	1.10	0.85	0.10	0.03	0.55	0.45
France	2.73	2.13	1.04	0.43	0.85	0.41	1.22	0.95	0.14	0.04	1.56	1.16
Germany	2.51	2.25	0.86	0.36	0.99	0.54	1.16	0.90	0.12	0.05	1.10	1.12
Italy	2.71	1.83	1.13	0.23	0.80	0.39	1.19	1.00	0.15	0.08	1.70	0.59
Netherlands	1.89	1.81	0.68	0.37	0.54	0.27	1.20	0.90	0.24	0.09	0.59	0.90
Ireland	3.56	1.98	1.20	0.15	0.89	0.47	1.11	0.89	0.12	0.05	2.64	0.72
Austria	2.62	2.55	0.46	0.15	1.06	0.49	1.21	0.96	0.12	0.05	0.69	1.20
Canada	2.96	0.78	1.47	0.55	0.96	0.51	0.64	0.56	0.02	0.01	2.81	0.25
Japan	8.22	2.93	2.25	2.07	0.45	0.34	0.94	0.77	0.07	0.03	9.01	3.86
Norway	3.06	1.68	1.06	0.51	1.23	0.63	1.10	0.90	0.09	0.04	1.70	0.62
Sweden	3.03	2.37	1.36	1.31	1.07	0.52	1.08	0.80	0.10	0.04	2.14	2.32
Switzerland	3.67	2.41	1.05	0.80	1.00	0.44	1.25	0.97	0.14	0.05	2.33	1.75
United Kingdom	3.77	2.55	1.20	1.40	0.86	0.40	1.26	1.02	0.17	0.06	2.68	2.47
United States	3.70	1.70	1.68	1.47	1.68	0.53	1.53	0.99	0.11	0.04	2.06	1.61
Australia	3.02	1.76	1.09	1.26	1.20	0.51	1.06	0.78	0.06	0.02	1.79	1.71
Finland	3.40	1.97	1.19	0.50	1.42	0.71	1.04	0.86	0.07	0.03	2.06	0.87
Spain	4.15	1.24	2.64	0.54	0.70	0.34	1.23	1.01	0.17	0.07	4.69	0.36

CHART 29

NOMINAL $US/ECU EXCHANGE RATE

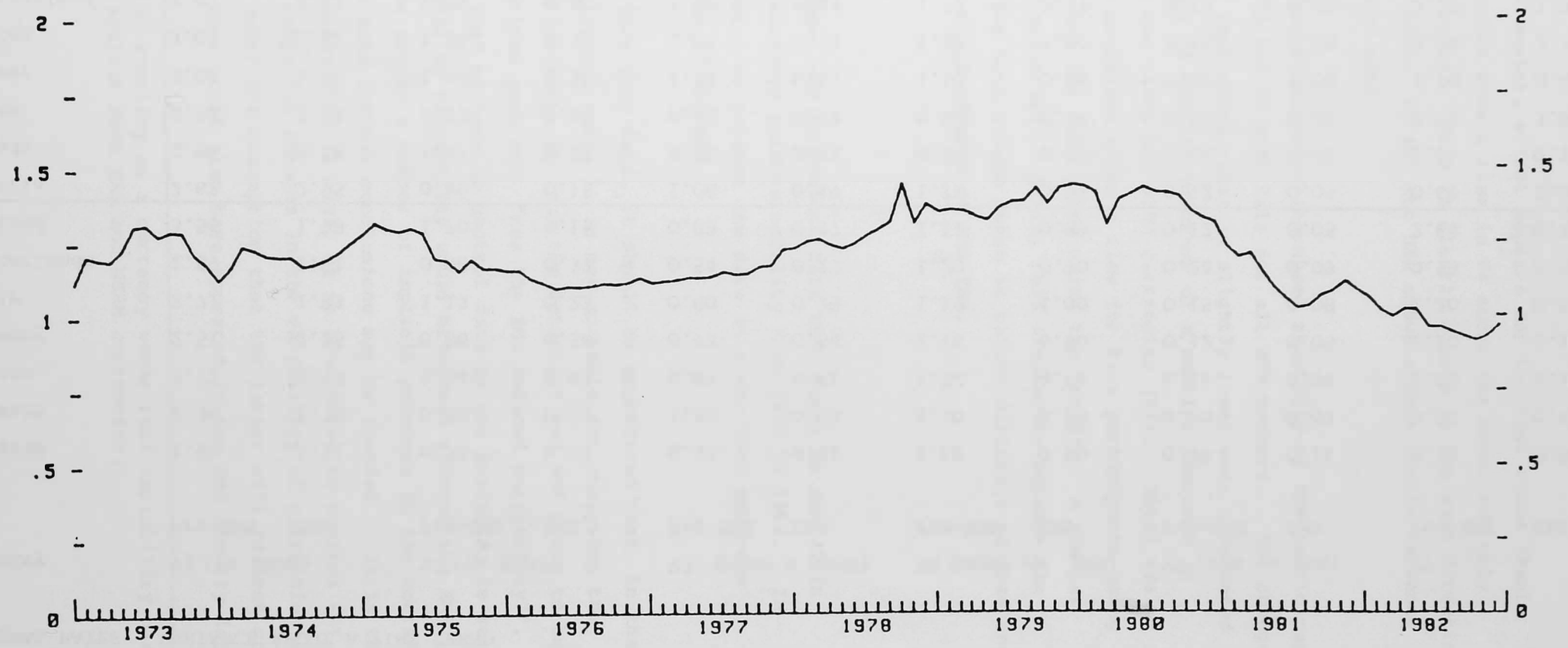


CHART 30

REAL $US/ECU EXCHANGE RATE

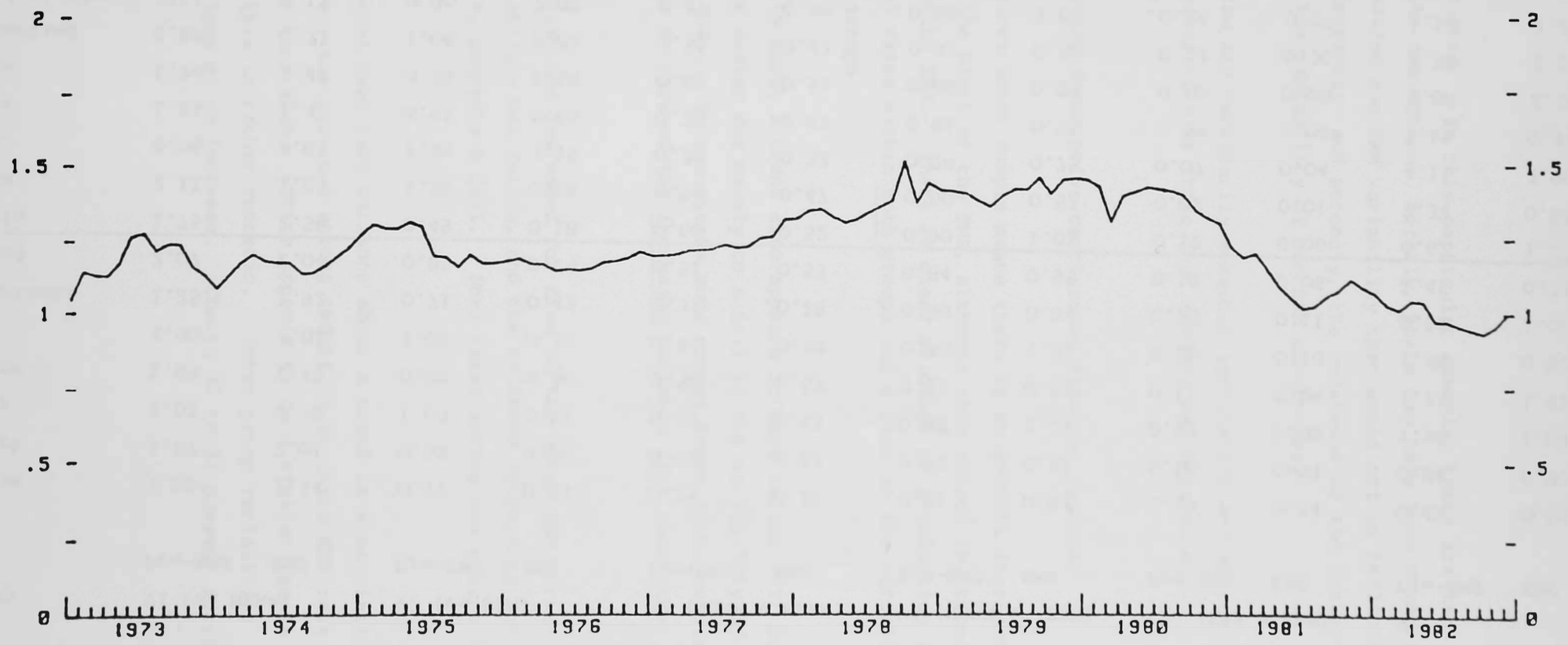


TABLE 8

REAL EFFECTIVE RATES - VARIANCE ABOUT A TIME TREND

	Country	V1 (vs NERM)		V2 (vs ERM)		V3 (NERM v NERM)		V4 (NERM v ERM)		V5 (ERM v ERM)		VT	
		Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS	Pre-EMS	EMS
ERM	Belgium	1.05	1.34	0.77	0.54	0.23	0.21	0.81	0.94	0.29	0.14	0.49	0.59
	Denmark	1.87	2.01	0.52	0.26	0.63	0.62	0.82	0.91	0.10	0.04	0.84	0.70
	France	2.02	2.02	1.03	0.52	0.48	0.43	0.88	1.01	0.13	0.06	1.56	1.04
	Germany	1.89	2.49	0.87	0.46	0.56	0.57	0.82	0.92	0.11	0.05	1.27	1.41
	Italy	1.90	2.02	1.05	0.35	0.45	0.42	0.86	1.03	0.16	0.10	1.48	0.82
	Netherlands	1.25	1.92	0.71	0.43	0.31	0.28	0.90	0.94	0.23	0.11	0.52	1.02
	Ireland	2.07	2.04	0.85	0.24	0.51	0.53	0.84	0.95	0.12	0.06	1.45	0.74
NERM	Austria	1.75	2.58	0.49	0.18	0.60	0.52	0.90	1.01	0.12	0.06	0.62	1.17
	Canada	2.12	1.03	1.26	0.66	0.52	0.47	0.50	0.53	0.02	0.01	2.34	0.68
	Japan	4.06	3.01	1.20	2.19	0.30	0.33	0.78	0.75	0.07	0.04	4.11	3.98
	Norway	1.84	1.47	0.91	0.66	0.70	0.67	0.81	0.95	0.09	0.04	1.15	0.47
	Sweden	1.74	2.48	0.95	1.66	0.65	0.51	0.86	0.83	0.10	0.05	1.08	2.75
	Switzerland	2.88	2.73	1.06	1.01	0.54	0.43	0.91	0.98	0.13	0.06	2.36	2.27
	United Kingdom	2.14	3.12	0.90	2.07	0.47	0.40	0.88	1.02	0.16	0.07	1.53	2.25
	United States	2.04	1.66	1.35	1.34	0.98	0.64	1.12	1.10	0.11	0.05	1.18	1.21
	Australia	1.90	1.13	1.15	1.06	0.69	0.53	0.80	0.78	0.06	0.03	1.50	0.85
	Finland	3.11	1.82	1.76	0.65	0.76	0.72	0.76	0.90	0.07	0.03	3.28	0.82
	Spain	2.38	1.36	1.39	0.57	0.39	0.36	0.94	1.01	0.17	0.08	2.27	0.48

had the system not existed. In this particular example, there are two clear objections to the assumption: firstly, there may have been country specific factors affecting non ERM variability that would not be reflected in the data for participants; and secondly, the existence of the system may itself have affected the variability of non ERM currencies.

The conclusions we draw are necessarily somewhat speculative and we recognise that they will not necessarily be those that readers may draw after examining our results.

We may draw the following descriptive conclusions from the results:

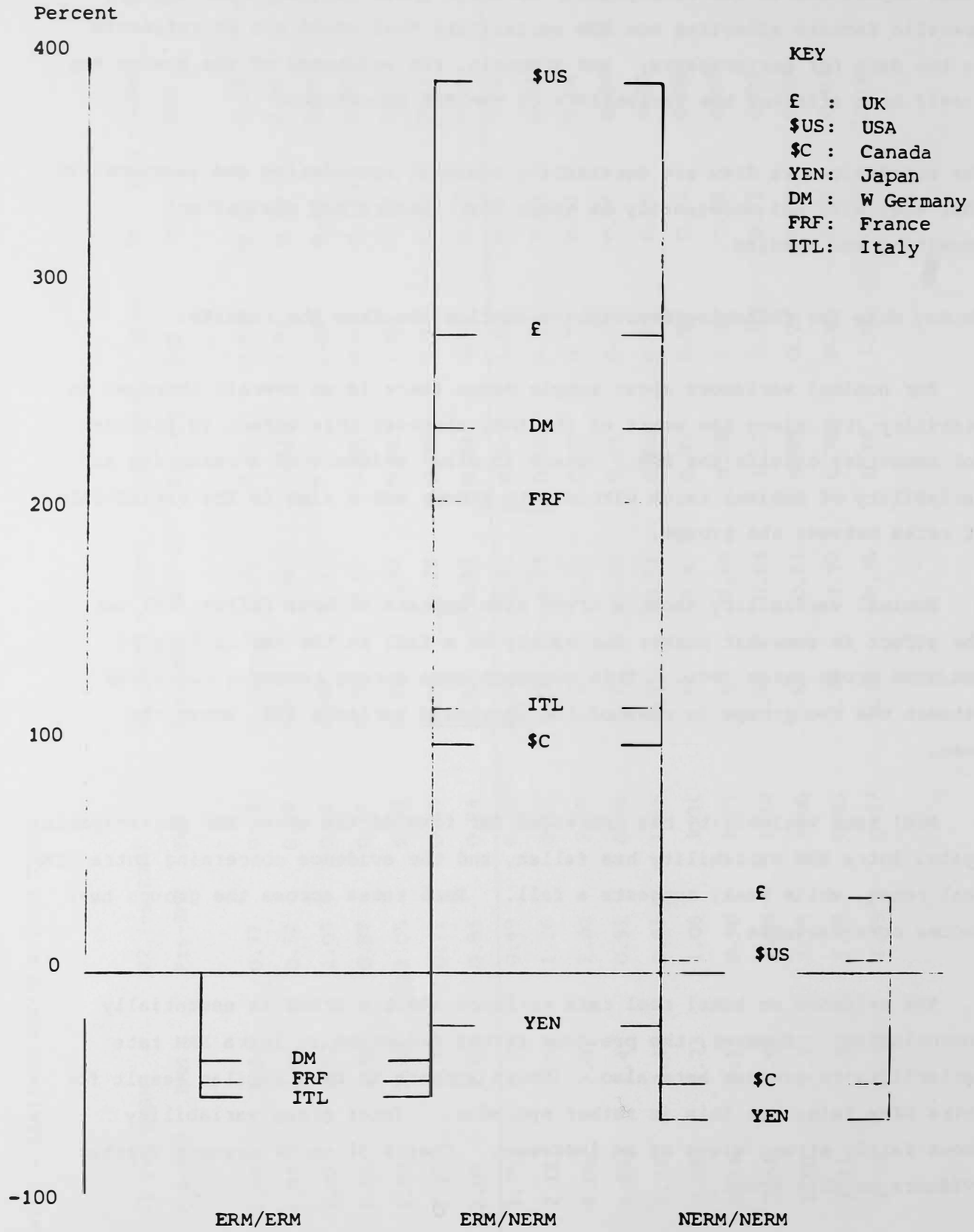
1 For nominal variances about sample means there is an overall increase in stability (VT) since the start of the EMS, although this effect is stronger for countries outside the ERM. There is clear evidence of a reduction in variability of nominal rates within both groups and a rise in the variability of rates between the groups.

2 Nominal variability about a trend also appears to have fallen (VT) but the effect is somewhat weaker due mainly to a fall in the variability of ERM/NERM cross rates (V4). This suggests some strong trending behaviour between the two groups in view of the increased variance (V4) about the mean.

3 Real rate variability has increased for five of the seven ERM participants. Again, intra ERM variability has fallen, and the evidence concerning intra NERM real rates, while weak, suggests a fall. Real rates across the groups have become more variable.

4 The evidence on total real rate variance about a trend is essentially inconclusive. However, the previous strong reduction in intra ERM rate variability is present here also. There appears to be a similar result for intra NERM rates but this is rather sporadic. Inter group variability shows fairly strong signs of an increase. Charts 31 to 34 present further evidence on this point.

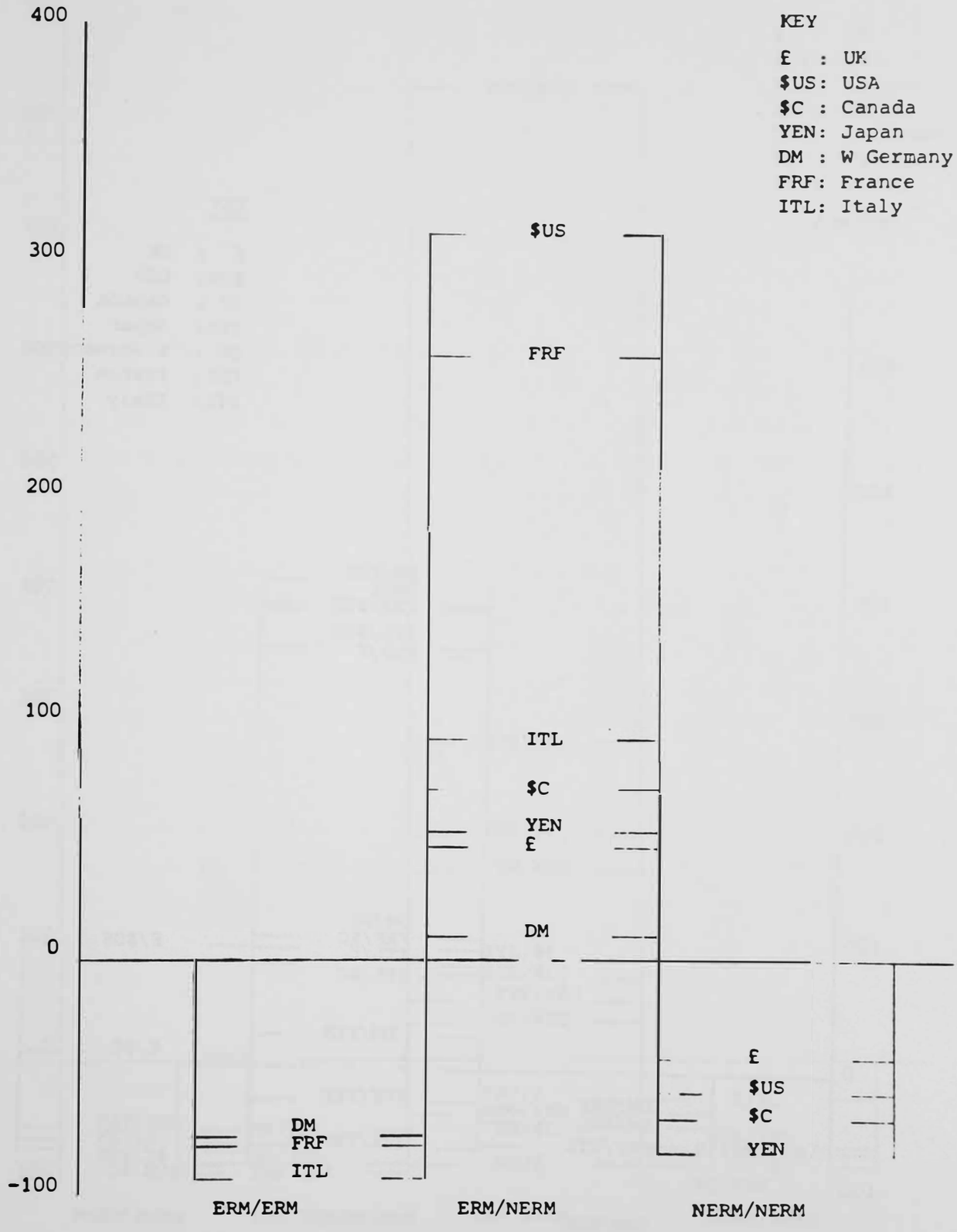
CHART 31 PERCENTAGE CHANGES IN THE VARIABILITY OF NOMINAL BILATERAL RATES BEFORE AND AFTER THE INTRODUCTION OF THE ERM



Variance here is variance about the sample mean.

For each currency, we take the average variance against currencies, (a) in the same group, and (b) in the other group. Hence the ERM/ERM column shows average variance for each ERM currency against the other ERM currencies.

CHART 32 PERCENTAGE CHANGES IN THE VARIABILITY OF REAL BILATERAL RATES BEFORE AND AFTER THE INTRODUCTION OF THE ERM



Variance here is variance about the sample mean.

For each currency, we take the average variance against currencies, (a) in the same group, and (b) in the other group. Hence the ERM/ERM column shows average variance for each ERM currency against the other ERM currencies.

CHART 33: PERCENTAGE CHANGES IN THE VARIABILITY OF INDIVIDUAL NOMINAL BILATERAL RATES BEFORE AND AFTER THE INTRODUCTION OF THE ERM

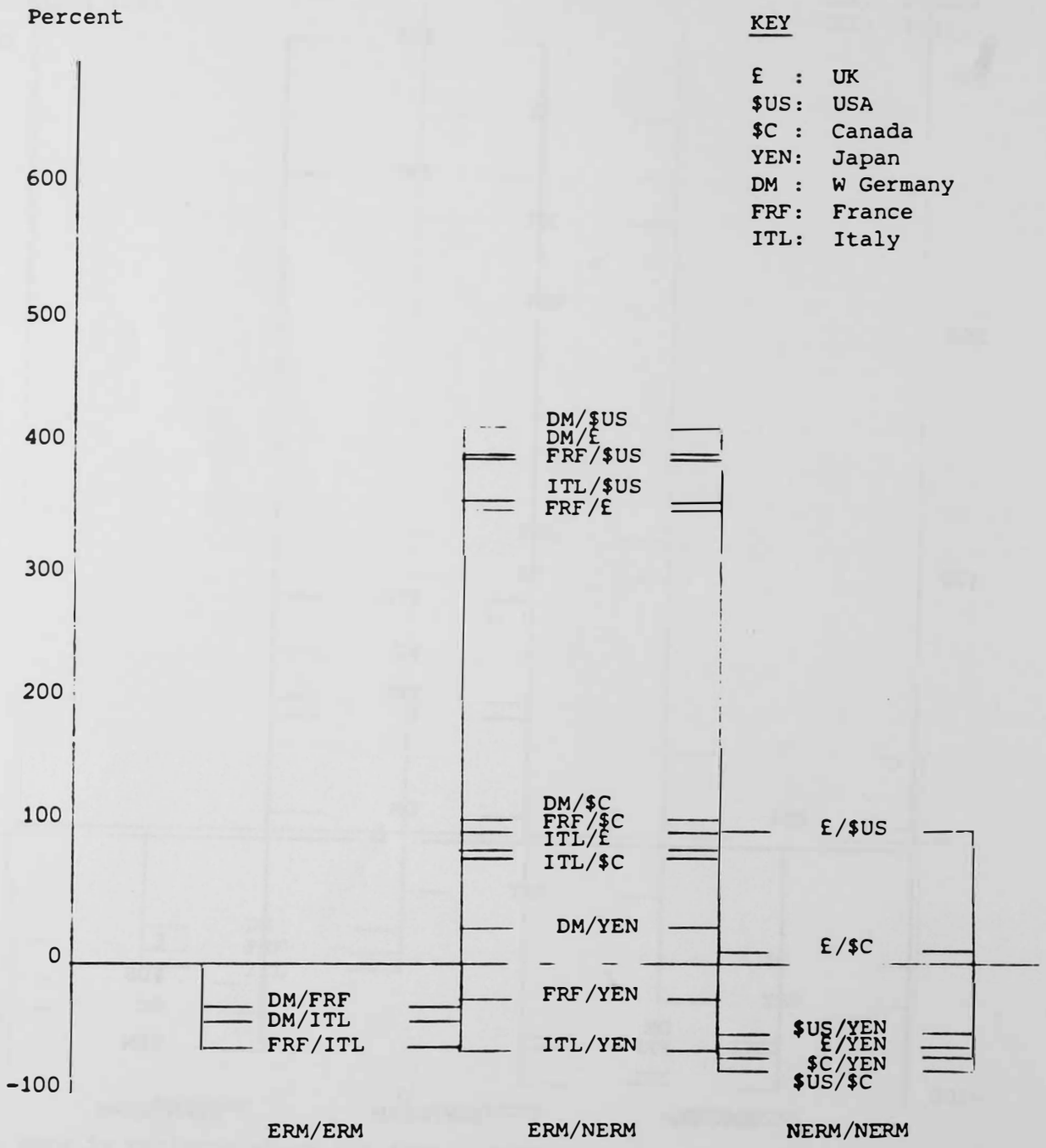
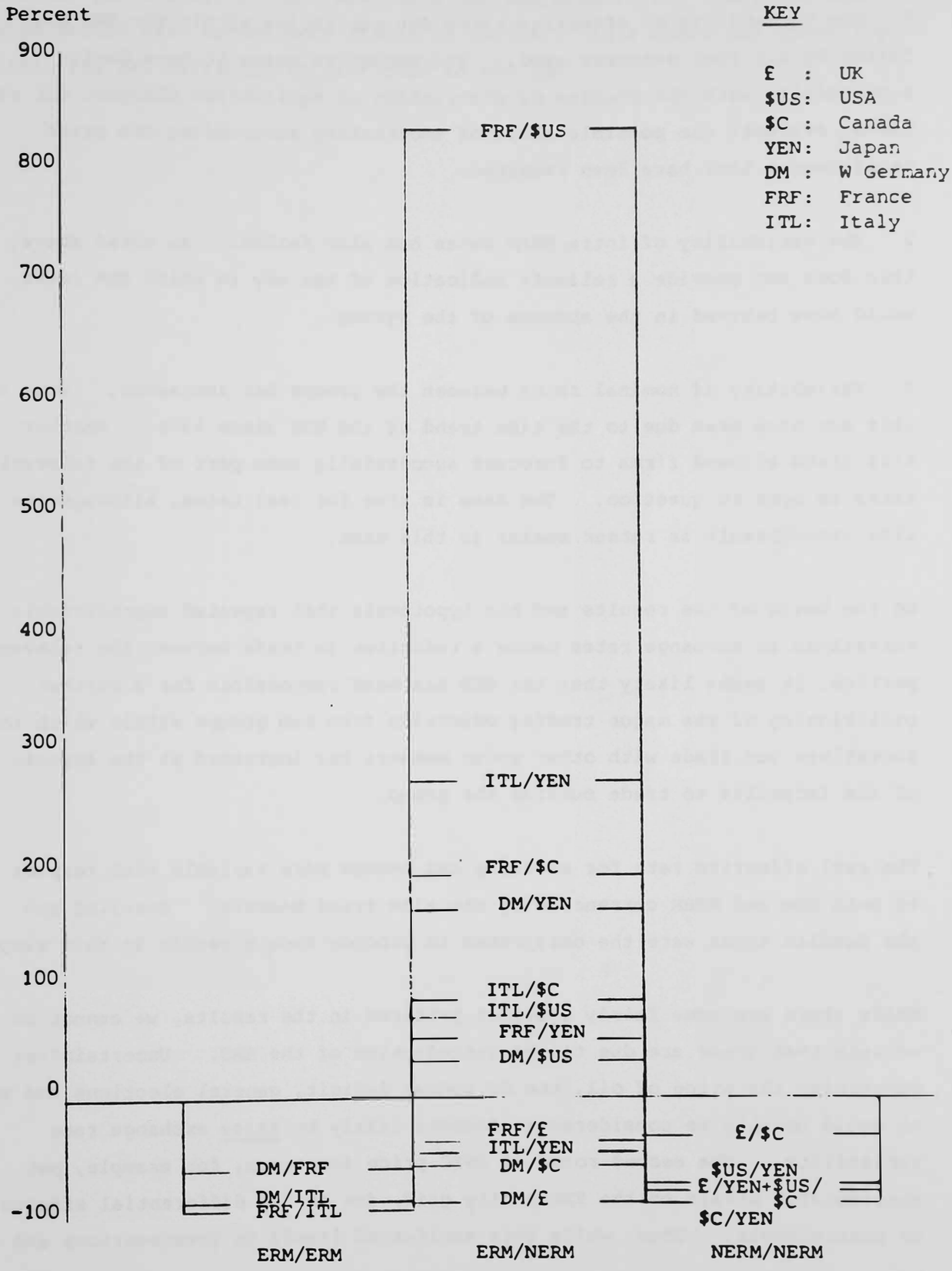


CHART 34 PERCENTAGE CHANGES IN THE VARIABILITY OF INDIVIDUAL REAL BILATERAL RATES BEFORE AND AFTER THE INTRODUCTION OF THE ERM



On the basis of these results, we draw the following conclusions, subject to the caveats explained in the text.

1 The variability of effective rates for currencies within the ERM has fallen by all four measures used. The mechanism seems to have dealt successfully with the problem of obstruction of equilibrium changes, but we cannot evaluate the possible costs of uncertainty surrounding the seven realignments that have been required.

2 The variability of intra NERM rates has also fallen. As noted above, this does not provide a reliable indication of the way in which ERM rates would have behaved in the absence of the system.

3 Variability of nominal rates between the groups has increased. Some of this may have been due to the time trend of the $US since 1979. Whether this trend allowed firms to forecast successfully some part of the relevant rates is open to question. The same is true for real rates, although the time trend result is rather weaker in this case.

On the basis of the results and the hypothesis that repeated unpredictable variations in exchange rates cause a reduction in trade between the relevant parties, it seems likely that the ERM has been responsible for a further partitioning of the major trading countries into two groups within which the incentives for trade with other group members has increased at the expense of the incentive to trade outside the group.

The real effective rate for sterling has become more variable with respect to both ERM and NERM currencies by the time trend measure. Sterling and the Swedish krona were the only rates to produce such a result in this sample.

While there are some fairly distinct patterns in the results, we cannot be certain that these are due to the introduction of the EMS. Uncertainties concerning the price of oil, the US budget deficit, general elections and so on would usually be considered as factors likely to raise exchange rate variability. The second round of OPEC price increases, for example, put considerable strain on the ERM parity grid, due to its differential effects on participants. Thus, while this manifested itself in interventions and

occasional realignments within the ERM, it will probably have tended to increase variability in both NERM/NERM and ERM/NERM rates. Why the NERM rates should have become more stable is unclear; this makes the stability within the EMS difficult to attribute to the ERM.

ANNEX I

MEASURING EXCHANGE RATE VARIABILITY

As noted in the text, there is some disagreement as to the costs of exchange rate variability. Assuming that such costs do exist, there are reasonable grounds for supposing anticipated and unanticipated changes to have different effects. This annex seeks to identify the appropriate variability measure for several generation mechanisms of the exchange rate. We assume firstly that costs are linearly related to the square of anticipated and unanticipated changes in the log of the rate. This is a restrictive assumption but a useful one for the following analysis:

Let

$$C_t = \phi_1 a_t^2 + \phi_2 u_t^2 \qquad \phi_1 + \phi_2 = 1 \qquad \text{(A1)}$$

Where C_t = Cost imposed by a change in the exchange rate from (t-1) to t

a_t = anticipated percentage change

u_t = unanticipated percentage change

ϕ_1, ϕ_2 are weights scaled such that $\phi_1 + \phi_2 = 1$

The use of weights summing to unity means that C is "unit free", ie that it does not measure cost in terms of monetary, labour or any other units. As a result, C itself is of little interest but it can be used to compare costs at different times, ie we can make the statement that C has increased over time by a certain proportion. For example, consider the effects of a 2% change in the rate due to anticipated and unanticipated changes equally. Assume that the cost of the former is £4, of the latter £6, ie:

$$(\text{£}C)_t = 4 a_t^2 + 6 u_t^2 = 10$$

with $(£C)_t$ measured in £. Dividing through by 10 gives:

$$\frac{(£C)_t}{10} = 0.4\ a_t^2 + 0.6\ u_t^2$$

Let

$$C_t = \frac{(£C)_t}{10}$$

Then

$$C_t = 0.4\ a_t^2 + 0.6\ u_t^2$$

where C_t is an index of the cost of variability.

Over a sample period:

$$\frac{\Sigma C_t}{n} = \bar{C} = \phi_1\ \frac{\Sigma a_t^2}{n} + \phi_2\ \frac{\Sigma u_t^2}{n}$$

We now consider four forms of equation that may determine the rate and assume, in each case, that expectations are formed rationally, ie that the equation is used to produce the forecast.

(1) $e_t = \alpha + \beta e_{t-1} + \varepsilon_t \qquad (|\beta| < 1, \varepsilon_t \sim N(0, \sigma^2)$

Let $E_{t-1}\ e_t$ = expectation of e_t formed (rationally) at (t-1)

Then $E_{t-1}\ e_t = \alpha + \beta e_{t-1}$

$$\Rightarrow a_t = e_{t-1} - \alpha - \beta e_{t-1} = (1 - \beta)\ e_{t-1} - \alpha$$

$$u_t = e_t - \alpha - \beta e_{t-1} = \varepsilon_t$$

$$\frac{\Sigma a_t^2}{n} = (1-\beta)^2 \frac{e_{t-1}^2}{n} - 2\alpha(1-\beta)\frac{e_{t-1}}{n} + \alpha^2$$

$$\frac{\Sigma u_t^2}{n} = \frac{\Sigma_t^2}{n}$$

$$\Rightarrow \bar{C}_1 = \phi_1 [(1-\beta)^2 \frac{\Sigma e_{t-1}^2}{n} - 2\alpha(1-\beta)\frac{e_{t-1}}{n} + \alpha^2] + 2\frac{\Sigma\varepsilon_t^2}{n}$$

(2) If we specialise (1) to a random walk by setting $\alpha = 0$, $\beta = 1$

$$e_t = e_{t-1} + \varepsilon_t$$

Then $\bar{C}_2 = \phi_2 \frac{\Sigma\varepsilon_t^2}{n}$

(3) If e follows a time trend

$$e_t = \alpha + \beta t + \varepsilon_t$$

$$E_{t-1}\, e_t = \alpha + \beta t$$

$$a_t = e_{t-1} - \alpha - \beta t = \alpha + \beta(t-1) + \varepsilon_{t-1} - \alpha - \beta t = \varepsilon_{t-1} - \beta$$

$$u_t = e_t - \alpha - \beta t = \varepsilon_t$$

$$\frac{\Sigma a_t^2}{n} = \frac{\Sigma\varepsilon_{t-1}^2}{n} + \beta^2 - 2\beta\frac{\Sigma\varepsilon_{t-1}}{n}$$

$$\frac{\Sigma u_t^2}{n} = \frac{\Sigma\varepsilon_t^2}{n}$$

$$\Rightarrow \bar{C}_3 = 1\,[\frac{\varepsilon_{t-1}^2}{n} + \beta^2 - 2\beta\frac{\Sigma\varepsilon_{t-1}}{n}] + 2\frac{\Sigma\varepsilon_t^2}{n}$$

(4) If e is distributed randomly about the sample mean:

$\beta = 0$ (in (3) above)

$$\bar{C}_4 = \phi_1 \frac{\Sigma\varepsilon_{t-1}^2}{n} + \phi_2 \frac{\Sigma\varepsilon_t^2}{n}$$

Assuming a large sample:

$$\frac{\Sigma\varepsilon_t^2}{n} = \frac{\Sigma\varepsilon_{t-1}^2}{n}$$

and

$$\frac{\Sigma\varepsilon_t}{n} = \frac{\Sigma\varepsilon_{t-1}}{n} = 0$$

Hence:

$$\bar{C}_1 = \left(\frac{1 + \beta(1 - 2\phi_1)}{1 + \beta}\right) \frac{\Sigma\varepsilon_t^2}{n}$$

$$\bar{C}_2 = \phi_2 \frac{\Sigma\varepsilon_t^2}{n}$$

$$\bar{C}_3 = \phi_1^{\ 2} + \frac{\Sigma\varepsilon_t^2}{n}$$

$$\bar{C}_4 = \frac{\Sigma\varepsilon_t^2}{n}$$

In the absence of information on ϕ_1 and ϕ_2, the only case in which we can accurately measure the costs of variability as defined by (A1) above is (4), ie where the rate is randomly distributed about the sample mean, in which case the usual variance measure is appropriate.

The three measures used in the text are:

$$M_2 = \frac{\Sigma(e_t - e_{t-1})^2}{n}$$

$$M_3 = \frac{\Sigma(e_t - \alpha - \beta t)^2}{n}$$

$$M_4 = \frac{\Sigma(e_t - \bar{e})^2}{n} = \frac{\Sigma(e_t - \alpha)^2}{n}$$

These each measure $\frac{\Sigma\varepsilon_t^2}{n}$ in one of the above cases, ie:

$M_2 = \frac{\Sigma\varepsilon_t^2}{n}$ if and only if $e_t = e_{t-1} + \varepsilon_t$

$M_3 = \frac{\Sigma\varepsilon_t^2}{n}$ if and only if $e_t = \alpha + \beta t + \varepsilon_t$

$M_4 = \frac{\Sigma\varepsilon_t^2}{n}$ if and only if $e_t = \alpha + \varepsilon_t$

In cases (2) to (4), if we have $\phi_1 = 0$, $\phi_2 = 1$, the actual cost will be equal to:

$$\frac{\Sigma\varepsilon_t^2}{n}$$

ie we can use the appropriate M statistic to obtain a correct measure of $\bar{C}$. Thus, if anticipated changes are costless, we can measure the cost of variability in each of these cases if we have assumed the correct equation for the exchange rate.

When unanticipated changes are not costless, $\phi_1 = 0$, $\phi_2 = 1$, we cannot obtain $\bar{C}$ (because we do not know the ϕ values) except in case (4), ie when the rate is randomly distributed about a constant. For the remaining cases, we cannot even ascertain whether the appropriate M over or underestimates $\bar{C}$.

In the text, we present M_4 in all cases. However, since trends and random walks are often obtained in time series analyses of exchange rates, we present results based on M_2 and M_3 where this can be done conveniently.

It should be remembered that expectations may be formed using the "wrong" equation. Although it would be possible to use the above analysis to work out the appropriate $\bar{C}$ in each case, we do not do so because the results would simply confirm what we already know, ie that the measures used are only approximate. A final point, related to this, is that we estimate α and β for each measure based on the whole sample period in question. This assumes agents to know more than is reasonable, but to re-estimate α and β for each period would be excessively time-consuming and would, in any case, still leave us facing the problems noted above.

ANNEX II

The effective rates used in this study are geometric averages of bilateral rates, across a population of 18 countries. The weights are based on the MERM model produced in the IMF by Artus and Rhomberg(1973)andare described in an article in the Bulletin for March 1981; they have the property that, in the MERM model, a 1% change in the effective rate of any country has the same effect on that country's current balance, whatever the composition of changes in bilateral rates underlying the effective rate change.

I Denote* the logarithm of the bilateral rate forcountry i's currency in terms of country j's as IJ, and the logarithm of its effective rate as I.

$$I = \sum_j a_J^I \cdot IJ \text{ with } a_I^I = 0 \qquad (1)$$

The variance of I will be denoted V_I

$$V_I = \frac{1}{T} \sum_{k=1}^{T} (I-\bar{I})^2 \qquad (2)$$

$$\text{Where } \bar{I} = \frac{1}{T} \sum_{k=1}^{T} I$$

The expression for V_I can be decomposed into terms in the variance of bilateral rates:

$$V_{IJ} = \frac{1}{T} \sum_{k=1}^{T} (IJ - \bar{\bar{IJ}})^2$$

and the covariances of bilateral rates

$$C_{IJ,IK} = \frac{1}{T} \sum_{k=1}^{T} (IJ - \bar{\bar{IJ}})\ (IK - \bar{\bar{IK}})$$

---

* All exchange rates, both effective and bilateral, have a time index k, which is suppressed for ease of notation.

by inserting the effective rate formula into equation (2) and using the property that Var (x+y) = Var (x) + Var (y) + 2 Cov (x,y). The result is:

$$V_I = \sum_J (a_J^I)^2 V_{IJ} + \sum_J \sum_{K=J} a_J^I a_K^I C_{IJ,IK} \qquad (3)$$

Equation (3) can be made more tractable by noting that:

$$JK = IJ - IK \qquad (4)$$

so that

$$V_{JK} = V_{IJ} + V_{IK} - 2C_{IJ,IK} \qquad (5)$$

This yields:

$$C_{IJ,IK} = \frac{1}{2} (V_{IJ} + V_{IK} - V_{JK}) \qquad (6)$$

which can be used in equation (3). The result is:

$$V_I = \sum_J (a_J^I)^2 V_{IJ} + \frac{1}{2} \sum_J \sum_{K=J} a_J^I a_K^I (V_{IJ} + V_{IK} - V_{JK})$$

Note that:

$$\sum_J \sum_{K=J} a_J^I a_K^I V_{IJ} = \sum_J \sum_{K=J} a_J^I a_K^I V_{IK}$$

Gathering terms in V_{IJ}, the expression for V_I becomes:

$$V_I = \sum_J [(a_J^I)^2 + a_J^I \sum_{K=J} a_K^I] V_{IJ} - \frac{1}{2} \sum_J \sum_{K=J} a_J^I a_K^I V_{JK}$$

This can be further simplified, since by construction:

$$\sum_J a_J^I = 1$$

to give:

$$V_I = \sum_J a_J^I V_{IJ} - \frac{1}{2} \sum_J \sum_{K=J} a_J^I a_K^I V_{JK} \qquad (7)$$

The attraction of this formula is that the variance of each effective rate is shown to be a linear combination of the variances of all the 153 cross rates among the 18 countries in the MERM sample. Each of the cross rates can be allocated to a particular sector according to whether:

- Both currencies involved are in EMS
- One is in EMS
- Neither is in EMS

Accordingly, the variability of currency I's effective rate can be written:

$$V_I = V_1 + V_2 - V_3 - V_4 - V_5$$

where:

V_2 contains all bilateral rates for country I which involve currencies in EMS.

V_1 contains all bilateral rates involving country I and other currencies not in EMS.

V_5 contains all bilateral rates between second and third currencies both in EMS.

V_4 contains all bilateral rates between second and third currencies one of which is in EMS.

V_3 contains all bilateral rates between second and third currencies neither of which is in EMS.

The variance of the effective rate for currency I is thus expressed as weighted sums of the variances of its rates against each other currency ($V_1 + V_2$) minus a set of terms which reflect variability between second and third currencies ($V_3 + V_4 + V_5$). The negative terms demand a degree of explanation. They arise as a consequence of eliminating the covariances, and (as equation x indicates) compensate for an overallocation of these covariances into additional weight given to the variances of currency I's bilateral rates. In heuristic terms, currency I's effective volatility rises if currency J is more volatile, through increased volatility in bilateral rate IJ; but this is offset by increased volatility in all currency J's other bilateral rates - JK, JL and so on.

II A similar decomposition holds good for a different measure of variability, the mean of squared deviations from a time trend.

$$D_I = \frac{1}{T} \sum_{k=1}^{T} (I-I)^2$$

Where $I = E - Fk$

is the set of fitted values for I given by an ordinary least square regression of I on a constant and a time trend.

Two results are needed for the proof to proceed. The first is that the fitted effective rate should have a linear decomposition into fitted bilateral rates:

$$I = \sum_J a_J^I . IJ \qquad (1A)$$

This result holds trivially for the <u>mean</u> effective rate (and is used in reaching equation (3) above); it is easy to demonstrate in this case too.

Let y be a matrix with 2 columns and T rows: the first column is all unity, and the second contains values of k from 1 to T. Then, if a variable x with T values is regressed on y, the fitted value of x is:

$$x = x\,(x'y)\,(y'y)^{-1}\,y = by \qquad (8)$$

Suppose that x is linearly decomposed into n vectors:

$$x = \sum_{i=1}^{n} b_i\, x_i$$

Then

$$x_i = (x'y)_i\,(y'y)^{-1}\,y = b_i\, Y \qquad (9)$$

Since

$$(x'y) = \sum_{i=1}^{n} (x'_i\ y)$$

It follows at once that:

$$x = \sum_{i=1}^{n} b_i\ x_i$$

The only other result required is that:

$$D_{IJ+JK} = D_{IJ} + D_{JK} + 2DC_{IJ,KK}$$

Where

$$DC_{IJ,JK} = \frac{1}{T} \sum_{k=1}^{T} (IJ-IJ)\ (JK-JK)$$

this follows immediately on expanding D_{IJ+JK}

The outcome is:

$$D_I = \sum_J a_J^I\ D_{IJ} - \frac{1}{2} \sum_J \sum_{K=J} a_J^I\ a_K^I\ D_{JK} \qquad (7A)$$

ANNEX III

STATISTICAL TESTING OF THE VARIANCE RESULTS

We use the following method for testing whether the sample variances obtained are sufficiently different for us to be able to reject the hypothesis that the variances of the populations from which the data are drawn are the same.

For two sample variances:

S_1^2 based on n_1 observations

S_2^2 based on n_2 observations

$$F = \frac{S_1^2}{S_2^2} \sim F\ (n_1 - 1,\ n_2 - 1)$$

or, if $S_2^2 > S_1^2$

$$F = \frac{S_2^2}{S_1^2} \sim F\ (n_2 - 1,\ n_1 - 1)$$

Hence, in comparing pre-EMS and EMS results, we have, for the DM/FF rate of change variance:

Pre-EMS $S_1^2 = 0.43$ $n_1 = 75$

$S_2^2 = 0.18$ $n_2 = 45$

$F = 2.39$

The critical value F (74, 44) for a two-tailed 10% test is less than that for F(60, 40) for which the value is 1.64. F therefore exceeds the critical value in this case and we reject the hypothesis that there was no change in the variance.

ANNEX IV

DATA

Throughout the paper, we use logs of all variables. For the real rate, (e_R):

$$\log e_R (i, j) = \log e_N (i, j) - (\log p_i - \log p_j)$$

where e (i, j) is the cost of currency i in terms of currency j.

If i = \$, j = £, taking anti-logs we have:

$$e_R (\$, £) = \frac{e_N (\$, £).p_{UK}}{p_{US}}$$

The price indices are consumer prices.

The exchange rate is the rate at the end of the month.

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	Title	Author
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