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No 4

The impact of exchange rate variability on international trade flows

by

G Justice

December 1983

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The object of this Technical Series of Discussion Papers is to give wider circulation to econometric research work being undertaken in the Bank and to invite comment upon it; any comments should be sent to the author at the address given below.

Mr Justice was a member of the staff of the Bank of England during 1980/83. He is grateful for helpful comments made by Dr I D Saville and other former colleagues at the Bank, but the views expressed are his own, and not necessarily those of the Bank of England. The author would like to thank Miss L A Crockford for research assistance and Miss H Burdett for typing the manuscript.

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Contents

Abstract

This paper investigates how exchange rate variability and risk has affected the price and volume of UK exports of manufactures in the floating rate period. Consideration is given to the definition of exchange rate volatility relevant to UK trade flows. Despite considerable experimentation with different measures of real and nominal exchange rate variability/risk, the empirical tests are unable to confirm that exchange rate instability has had a significant impact on the volume of UK goods exported. They do suggest, however, that exchange rate variability worldwide (ie not just for the UK), by depressing activity and trade worldwide, may have indirectly affected UK exports (though only marginally), and that UK exporters would therefore benefit from a more stable world currency system and international trading environment. The empirical results also indicate that an increase in nominal exchange rate risk lowers UK export prices, suggesting that risk may be borne by UK exporters (possibly due to invoicing conventions). On the other hand, "real" exchange rate variability, ie nominal exchange rate fluctuations adjusted for cost and price differentials, may raise export prices.

1

Introduction

It is now more than ten years since the collapse of the Bretton Woods fixed exchange rate system. Though there are few today who would support a return to fixed parities, it is clear that the floating rate regime has not yielded all the benefits that its early advocates had hoped. The case for floating exchange rates was generally based on the belief that flexible rates, by smoothing the adjustment to changes in national price levels, would help stabilise the balance of payments and at the same time provide for greater autonomy of domestic monetary policies. It was hoped that flexible rates, by placing greater reliance on "market forces", would avoid the disruptions of international trade and investment caused by the large (though relatively infrequent) currency realignments that occurred under Bretton Woods. Against these expectations, the experience of the past decade of generalised floating can be considered something of a disappointment:

"The exchange rate fluctuations experienced since 1973 have been wider, more frequent and more erratic than advocates of free floating ever predicted; these fluctuations are harmful to the world economy in general, and to the western industrialised countries in particular; they demonstrate that markets tend to over-react to external shocks and policy shifts; there is therefore scope for official action with a view to moderating excessive exchange rate fluctuations. My plea for greater stability is to be understood in this sense - not in that of advocating a return to a system of pegged rates". Dr Alexandre Lamfalussy of the Bank for International Settlements (Batchelor & Wood, 1983).

The widespread concern about exchange rate volatility reflects in part a belief that exchange rate fluctuations create additional risk and uncertainty in international transactions and therefore discourage trade and investment flows. However, so far there is little empirical evidence to justify such fears. For example, Makin (1976), in a study of West Germany, Canada, Japan and the United Kingdom, found no evidence to suggest that exchange rate variability had led to a reduction in the volume of trade over the period 1960 to 1973. Hooper and Kohlagen (1978) confirm this result for US and West German bilateral and multilateral trade

flows over the period 1965 to 1975 (though they do find a marginally significant impact of exchange rate variability on US bilateral trade with the United Kingdom). These empirical studies are somewhat out of date, however, only covering a brief part of the floating rate period, and it may be that more recent experience, particularly for the United Kingdom, will yield different conclusions.

In this study, up to date evidence, covering the relatively turbulent exchange rate period during the late 1970s and early 1980s, is looked at, and an attempt is made to quantify the impact of exchange rate variability and risk on UK exports of manufactured goods. The remainder of this section discusses briefly some of the more important issues related to exchange rate volatility: the sources of exchange rate fluctuations, 'real' and 'nominal' exchange rate variability, the role of forward markets and the costs associated with exchange rate stabilisation policies. In the next section, various alternative measures of exchange rate variability and risk are presented and their relative merits discussed. The third section then introduces a simple model of UK exporters' pricing and sales behaviour under uncertainty. In subsequent sections, the empirical results are set out and some conclusions drawn.

1.1 Sources of exchange rate instability

Before proceeding to an empirical investigation of the impact of exchange rate variability on trade, it is important to ask why exchange rates are subject to such wide variations. The exchange rate is both a means by which external influences are transmitted to an economy and a means of adjustment within that economy. In his classic paper, "The case for flexible exchange rates", Friedman (1953) argued that fluctuations in a country's exchange rate largely reflect instability in underlying "economic conditions". In particular, in the longer term, nominal exchange rates tend to move to offset movements in national price levels [1], so that

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[1] When countries have different rates of inflation, competition will tend to ensure that exchange rates will move roughly in sympathy with "relative purchasing power parities", so that the price of a bundle of goods in different countries will tend to be constant when expressed in a common currency. There are well-known problems about just what goods should appear in the relevant bundle, of course.

fluctuations in "nominal" rates may merely be a symptom rather than a cause of changes in national price and cost differentials. Indeed, in an era of widely diverging rates of inflation and increasingly volatile capital flows, flexible exchange rates might be one way to insulate international trade and competitiveness from the effects of differential rates of domestic inflation and monetary growth.

On these grounds, it might be expected that, under a floating exchange rate regime, the "real" exchange rate, that is, the nominal rate adjusted for inflation differentials, would be relatively stable, only changing slowly in response to productivity shifts and changes in underlying "structural conditions"[1]. It is widely recognised, however, that, in the short run, nominal exchange rates have not always moved to offset relative inflation differentials and may have led to a greater degree of volatility than justified by the underlying price or cost movements. This is illustrated in Chart A, which shows that while the real effective exchange rates of the major industrialised countries, whether defined in terms of a country's domestic wholesale prices or its costs relative to those of its major competitors expressed in common currency, have a marked long-run trend, fluctuations about this trend have tended to be wider in the floating rate period.

The most obvious source of exchange rate instability would be "destabilising" speculation in foreign exchange markets [2], though again such speculation may merely reflect the need for the exchange rate to adjust to reflect changes in underlying economic conditions. Recent attempts to rationalise the apparently excessive turbulence observed in foreign exchange markets have placed great emphasis on the role of "news". The exchange rate, like all asset prices, is strongly influenced by expectations of its future value and, therefore, by the information, no matter how "limited", that underlies these expectations. Frenkel (1981), Mussa (1982) and others have shown that, if the continual arrival of this new information on, for example, future monetary conditions, forces the foreign exchange market constantly to revise expectations of future prospects, sharp changes in exchange rates are likely to be the rule rather than the exception.

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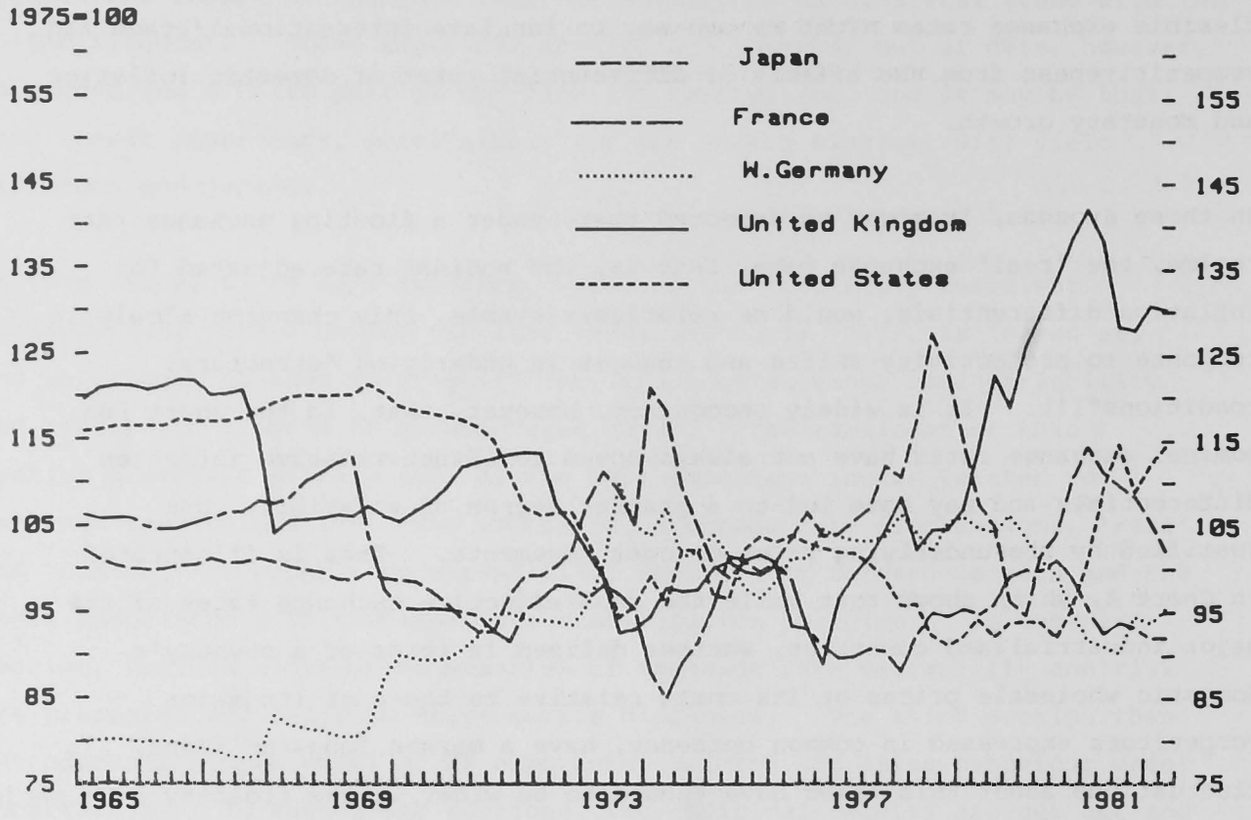
[1] Some have seen the discovery and exploitation of North Sea oil as such a factor. In this case, movements in real oil prices have also been of considerable importance, however, and strong conclusions are difficult to discern. See Bank of England (1982) for a discussion of the issues.

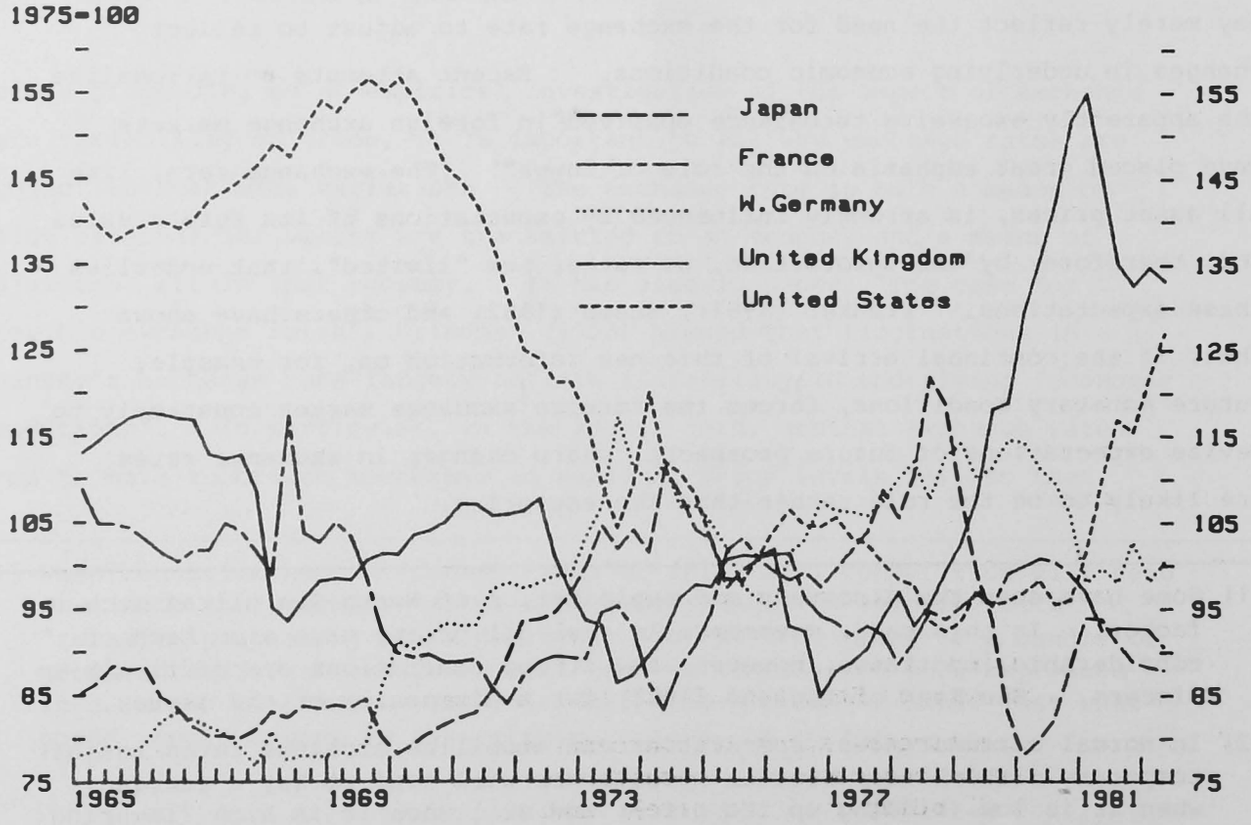
[2] In normal circumstances, speculation can stabilise exchange rates against temporary disturbances because speculators will tend to buy a currency when it is low (bidding up its price) and sell when it is high (lowering its price).

Chart A Real exchange rates

Real exchange rates: Relative wholesale prices in manufactur



Relative Unit Labour Costs In Manufacturing



Destabilising speculation is not the only source of exchange rate volatility. Even where the nominal exchange rate adjusts to correct for an initial shock, it is possible that the exchange rate will overshoot, magnifying the initial distortion. Dornbusch (1976) and Branson (1979) have focused attention on the differential speeds of adjustment in goods and asset markets to explain exchange rate variability. They show that, if financial markets are continuously in equilibrium, and markets in goods only adjust slowly to exchange rate changes, then the real rate will initially overshoot its long-run equilibrium in response to monetary disturbances. The cost is the dislocation of production and investment decisions caused.

1.2 Stability at any price?

Though exchange rate stability is thought desirable, the advantages of stable exchange rates, taken in isolation, have to be weighed against the policy changes needed to maintain them. Moreover, the exchange rate to be stabilised needs careful definition: is it "real", "nominal", "bilateral" or some broader concept of "multilateral" exchange rate stability that is sought? If "real" exchange rate stability is to be achieved, or if "nominal" exchange rate stability is to be lasting, international agreement on common rates of domestic inflation and monetary expansion is likely to be needed. This immediately raises the question of the co-ordination of national economic policies, and the discipline this imposes on domestic monetary and fiscal policies may not always be considered desirable if it interferes with national inflation and employment goals.

Although the period since the abandonment of the Smithsonian parities in the early 1970s is usually referred to as the generalised float, there has not, of course, been a universal free floating system. Many smaller countries have continued to peg their currency to a major currency (or a basket) and the authorities in nearly all the major industrialised countries have frequently intervened to influence exchange rates, (though the European Monetary System is perhaps the only example where major countries' exchange rate policies have been expressed in terms of formal intervention margins[1]). However, while exchange rate stability has often been an important objective of government intervention, the experience of the last decade suggests that some degree of exchange rate flexibility in response to payments imbalances is desirable, if only because the alternatives - for example, trade restrictions and capital controls for balance of payments purposes - involve substantial costs and may themselves lead to a reduction of trade and investment.

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[1] This obviously complicates any attempt to isolate the effect of exchange rate fluctuations on trade flows. In particular, the underlying instability reflected in exchange rate movements may show up in other ways if policies are restructured in an attempt to maintain fixed rates as in the Bretton Woods period.

There have also been doubts expressed about the effectiveness of official intervention. The monetary authorities are not "omniscient", and it is not clear that they are much better at anticipating future exchange rate movements than the "market" (Belassa, 1980). It is even possible that intervention by the authorities may add to instability by introducing uncertainty about their future actions (Batchelor and Wood, 1983). Furthermore, there are severe limitations to what a monetary authority can expect to achieve when the exchange rate is materially out of line with the domestic economy (or market view): any attempt to cling to an over or under-valued exchange rate is likely to incur heavy costs and pressures may eventually build up forcing its abandonment. Indeed, in the turbulent conditions of the 1970s with major structural imbalances between surplus and deficit countries, the OPEC oil price shocks and massive capital flows, it seems unlikely that any sustained attempt to fix exchange rates would have succeeded. It is, however, likely that even sterilised intervention has some, if modest, part to play in smoothing high-frequency fluctuation and helping to maintain an orderly market (Bank of England, 1983).

1.3 Resource allocation costs

It is important to distinguish between the short-run and longer-term costs of nominal and real exchange rate volatility. The short-run costs of exchange rate uncertainty could, in principle, be measured directly by looking at the costs of forward cover, though they may be difficult to separate out from information and other costs empirically (see below). It is harder to assess the impact of variability on longer-term trade flows and investment decisions that cannot be covered by the usual hedging mechanisms. In the short run, fluctuations in "nominal" exchange rates will result in losses or gains to producers on export contracts which are not invoiced in local currency[1] or hedged in the forward market. In the longer term, "real" exchange rate volatility will affect companies' marketing plans, investment in plant and infrastructure and so on, and may result in a shift of resources out of the more exposed traded goods sector.

It is also possible that exchange rate fluctuations have affected the timing of international transactions. Where there are heavy adjustment costs of moving resources between industries producing for domestic and external markets due, for example, to fixed investment in retailing and distribution outlets, producers may be reluctant to alter production and investment decisions in response to exchange rate movements unless relative prices are perceived to have changed "permanently"; that is the speed of adjustment to

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[1] If contracts are in the producer's currency, it is the foreign buyer who takes the gain or loss, of course.

foreign price signals may be slower in periods of excessive currency turbulance. This is thought to be one of the reasons why exchange rate adjustment may have become less effective as a means of bringing about shifts in the current account in the floating rate period, there may have been a fall in the short-run price elasticities of supply of exportables.

1.4 Forward markets, invoicing and diversification possibilities

In most industrialised countries, many of the risks due to increased exchange rate volatility can, of course, be alleviated by borrowing and lending in foreign currencies, or by explicitly covering transactions in the forward exchange market (though the opportunities for covering more than a year ahead are fairly limited). However, there is no reason to expect all exchange exposure to be covered forward. First, a firm may be willing to operate in exchange markets for purely speculative reasons. It will then have formulated a view about the future spot exchange rate and the decision whether to cover its exposure will depend on whether it believes that this has been fully discounted in the forward market. Second, even if a firm is risk averse, forward exchange transactions are not costless - for example, the bid-ask spreads are generally wider in the forward market than in the spot market. Furthermore, McKinnon (1974) has shown that the cost of transactions, as measured by the bid-ask spread, can increase by a factor of 5 to 10 in periods of excessive currency turbulance (though the risk of loss probably still remains small in relation to the total value of transactions undertaken).

Forward markets are not the only way individual firms can avoid exchange rate risk. An exporting firm could perhaps reduce its exposure and shift the burden of adjustment to the overseas importer by invoicing its contract in its local currency. Recent surveys of invoicing behaviour indicate that about 75% of UK exports and 40% of UK imports are invoiced in sterling. Another method of reducing risk is "leading and lagging": the contracts governing the financial side of a transaction are often fairly flexible and allow traders to vary the date at which they make or receive payment (ie the freedom to avoid expected adverse exchange rate movements)[1]. Moreover, some long-term contracts have a renegotiation clause for raw material and other cost changes that occur as a result of exchange rate movements during the period of the contract. However, such measures do not reduce risk for firms as a worldwide whole - unless the result is to produce a closer alignment of the currency <u>composition</u> of receipts and spending for the average firm.

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[1] Carse et al (1980), in a survey of 2,000 firms in the UK, found that, in 1979, about 25% of the value of exports and 40% of the value of imports were settled on 'open account': that is, the buyer is given the freedom to settle the contract at any time within a specified period.

Finally, the impact of adverse exchange rate movements can be mitigated by foreign exchange management. Many of the larger firms engaged in international transactions now use a range of currencies for invoicing, settling contracts and holding assets, thus minimising exchange rate risk by exploiting negative correlations between currency movements (though obviously it may not be possible to predict these ex ante). But freedom to act in this way was severely limited for UK firms by Exchange Controls, until their abolition in October 1979. Prior to that date, UK firms were not generally allowed to make foreign currency retentions for this purpose.

2

Measuring exchange rate variability

The terms "variability" and "volatility" are often used fairly loosely when referring to exchange rate movements, and are frequently used to imply "uncertainty" or "risk", even although an increase in exchange rate variability may not create additional risk if it reflects systematic (ie predictable) exchange rate movements. It is also worth noting that it is not so much the analytical measure of risk and uncertainty that is important for determining a firm's behaviour, as the firm's perception of the risks involved. A firm's attitude towards risk is likely to vary widely depending on its degree of market power (ie its ability to pass on higher costs, due to increased exchange rate volatility, forward to its customers or backwards to its suppliers), access to foreign exchange markets, the development of domestic capital markets and so on.

2.1 Conventional measures of variability

If it is accepted that the conventional measures of variability reflect at least in part movements perceived as being uncertain, there is still considerable disagreement about the way this should be measured. Clearly there are many possible choices about the frequency of the data to be used, the period over which variability is to be measured and the construction of the proxy. In this section, a number of different measures of exchange rate volatility and risk are constructed and several of the 'more' different ones are used in the empirical tests of the impact of exchange rate risk and variability on UK exports that follow.

What is needed is a summary measure that will capture the impact of exchange rate variability on total UK exports of manufactured goods. One possibility is to weight together measures of sterling bilateral exchange rate variability, the weights reflecting the importance of particular bilateral rate movements for total UK exports. Table 1 presents two possible weighting patterns based on:

(a) partner country shares of UK manufactured exports; and

(b) the weights used in the construction of the sterling effective rate index.[1]

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[1] The sterling effective rate weights, derived from the IMF MERM model, reflect the trade balance effects of exchange rate movements. For any given set of exchange rate changes, the index shows that uniform movement against all other currencies that would have an equivalent effect in the MERM model on the UK trade balance. See Bank of England (1981) for a further description and further references.

Table 1

Exchange rate weights

	Manufacturing export shares(1)	Effective rate index
Austria	0.56	1.00
Belgium	5.30	4.04
Canada	1.53	1.51
Denmark	2.09	1.09
France	7.38	10.39
West Germany	10.33	14.08
Italy	3.84	7.18
Japan	1.21	13.67
Netherlands	7.77	4.80
Norway	1.60	2.11
Sweden	3.28	3.73
Switzerland	6.21	3.00
United States	9.43	24.63
Australia	1.65	1.99
Finland	1.06	0.85
Ireland	5.37	4.05
Spain	1.43	1.86

(1) Based on share by value in 1980 (overseas trade statistics basis).

Table 2

Currency invoicing of UK trade (1979)(1)

	Share of UK's exports in:	Share of UK's imports in:
Dollars	17	29
Deutschemarks	3	9
Sterling	76	38
French francs	2	5
Other	2	19

(1) Source: S A B Page, "The choice of invoicing currency in merchandise trade", NIER No 98, November 1981.

As the table shows, the weight given to the US in the sterling effective rate index is considerably greater than our exports to the US would suggest. This largely reflects the importance, for the UK trade balance, of US trade in third markets. Table 2 indicates another possible weighting pattern based on currency invoicing of UK exports. The export currency invoicing weights (with sterling normalised out) may be more appropriate for assessing the short-run impact of exchange rate variability on UK exports because risk for UK producers will only be attached to those export contracts which are not invoiced in local currency.

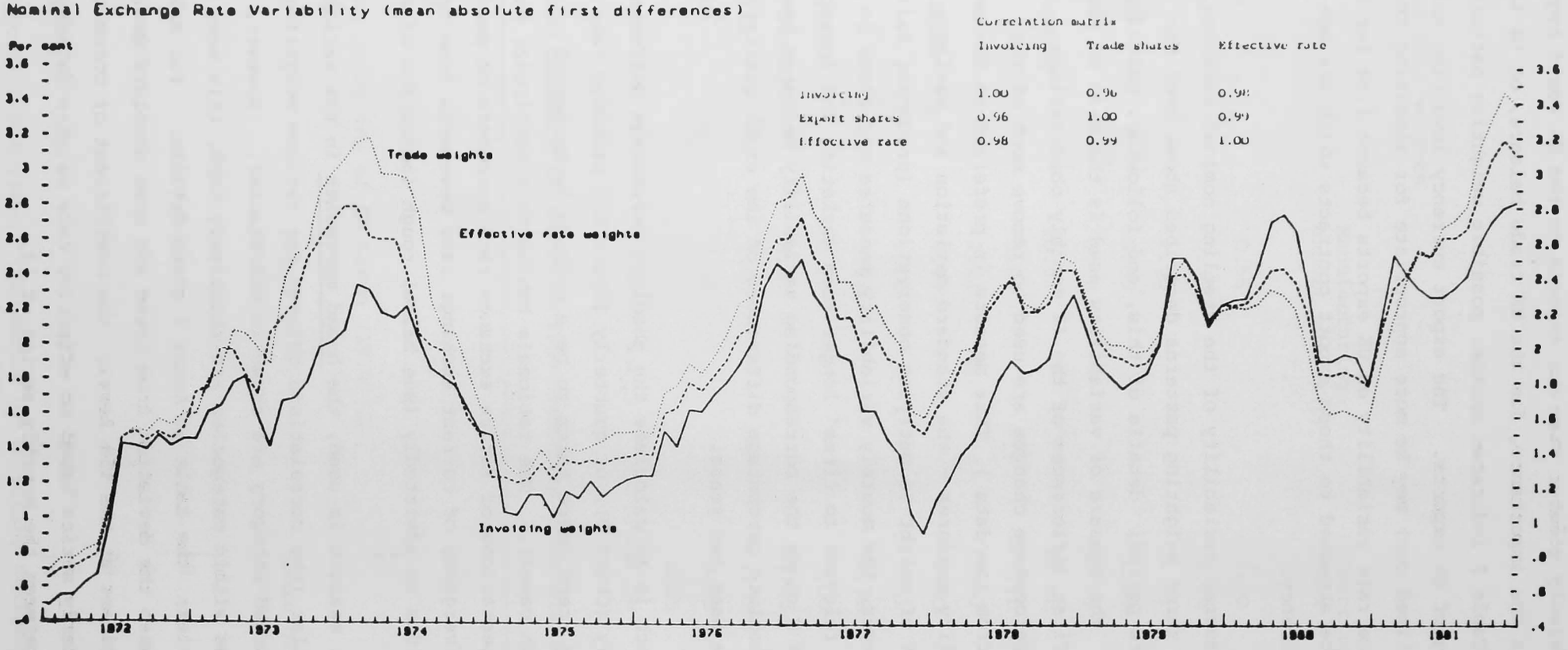
Chart B shows the measured variability of the sterling nominal exchange rate based on each of the three weighting patterns described above over the floating exchange rate period; details of this, and following, calculations are in Appendix 1. The measure of variability used is the mean of the absolute percentage first differences of the 12 monthly observations over the past year (percentage changes are used to remove much of the influence of trends from the data). This measure is preferred to the more conventional variability measures - the standard deviation and variance - as the latter give a lot of weight to outlying observations (producing fairly noisy series). However, the monthly variability measures may focus on too short a period to be relevant to firms' longer term marketing and investment plans. Hence, Chart C shows the corresponding variability measures based on the mean of the absolute percentage differences of the eight quarterly observations over the past two years.

An alternative approach is to calculate the absolute percentage difference of the current monthly (Chart D), or quarterly (Chart E), exchange rate observations from their underlying trend (here taken to be a centred seven <u>period</u> moving average in both cases). The rationale behind this particular measure is that traders base expectations of future exchange rate movements on past trends so that the divergence of current exchange rate movements from their underlying path provides an admittedly (see below) rough indication of risk.

In any case, whatever measure is used, the <u>broad movements</u> in the variability series are quite similar (the correlations between the various weighting schemes within each broad category are shown in the charts). However, while the correlations within categories are relatively high, this does not apply between categories; the table in Annex 1 gives details. For example, the correlations between the deviation from trend and mean absolute deviation series are not significant at the 95% level: the coefficient of correlation between the two quarterly series based on effective rate weights is only 0.05, and the correlation between the monthly series -0.14.

CHART B

Nominal Exchange Rate Variability (mean absolute first differences)



Correlation matrix

	Invoicing	Trade shares	Effective rate
Invoicing	1.00	0.96	0.98
Export shares	0.96	1.00	0.99
Effective rate	0.98	0.99	1.00

Nominal Exchange Rate Variability (mean absolute first differences)

Nominal Exchange Rate Variability (mean absolute first differences)

Correlation matrix

	Invoicing	Trade shares	Effective rate
Invoicing	1.00	0.96	0.99
Export shares	0.96	1.00	0.98
Effective rate	0.99	0.98	1.00

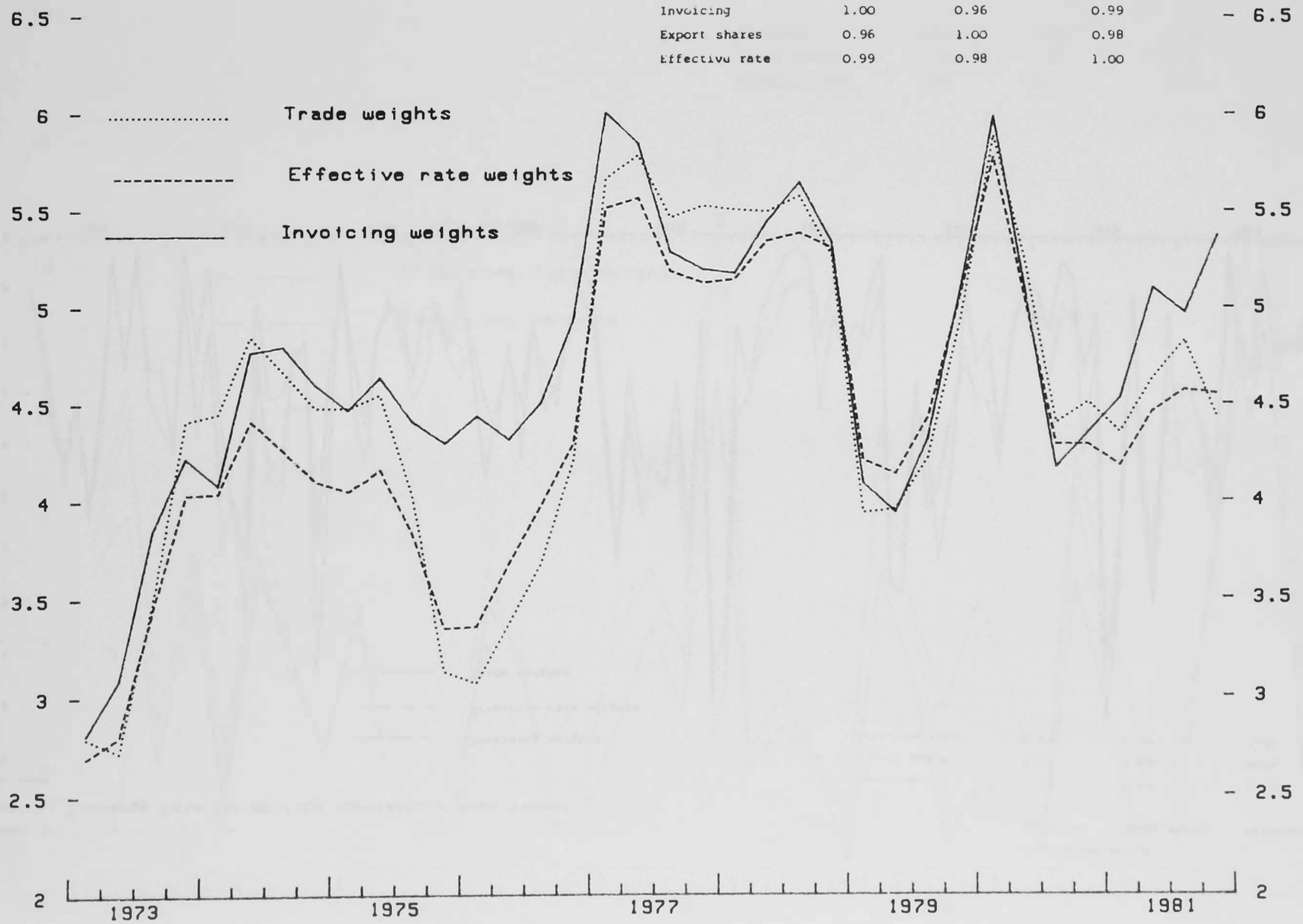
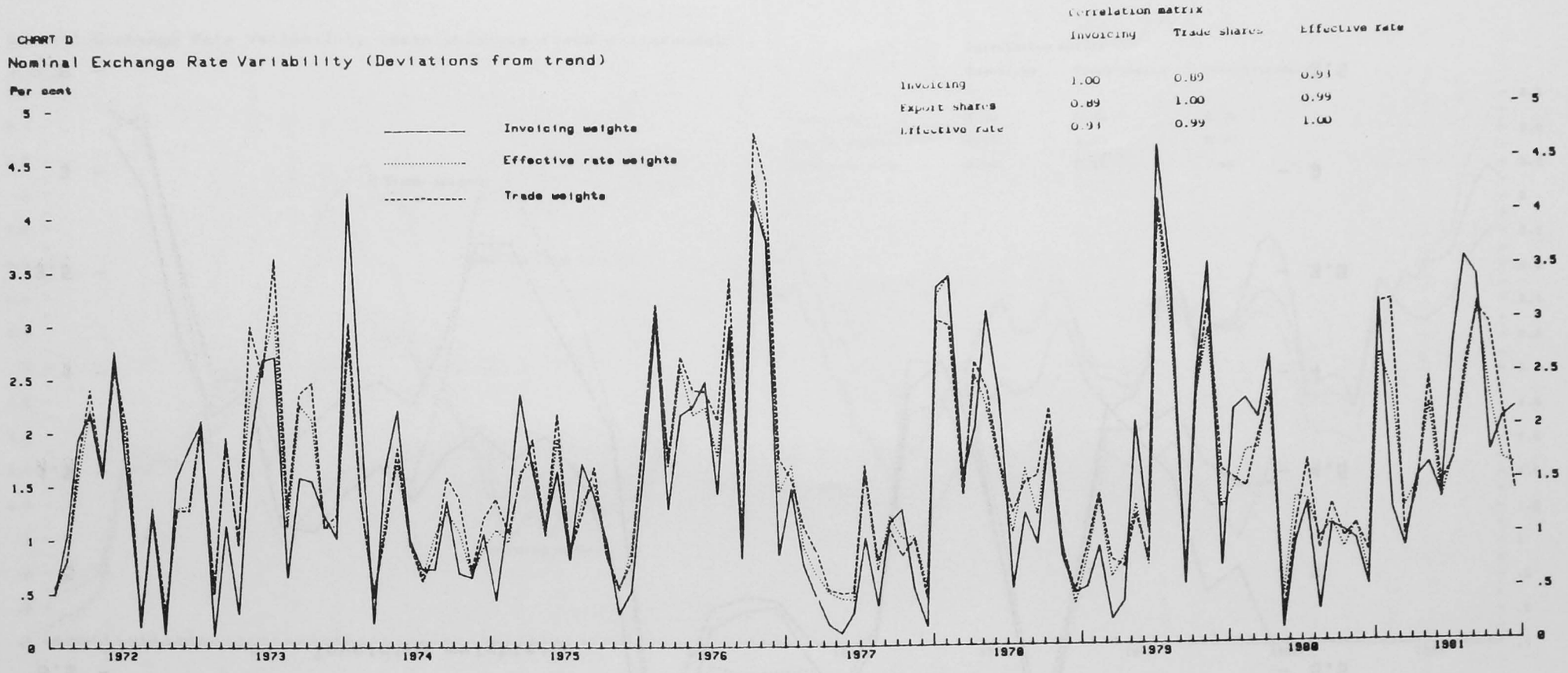


CHART D

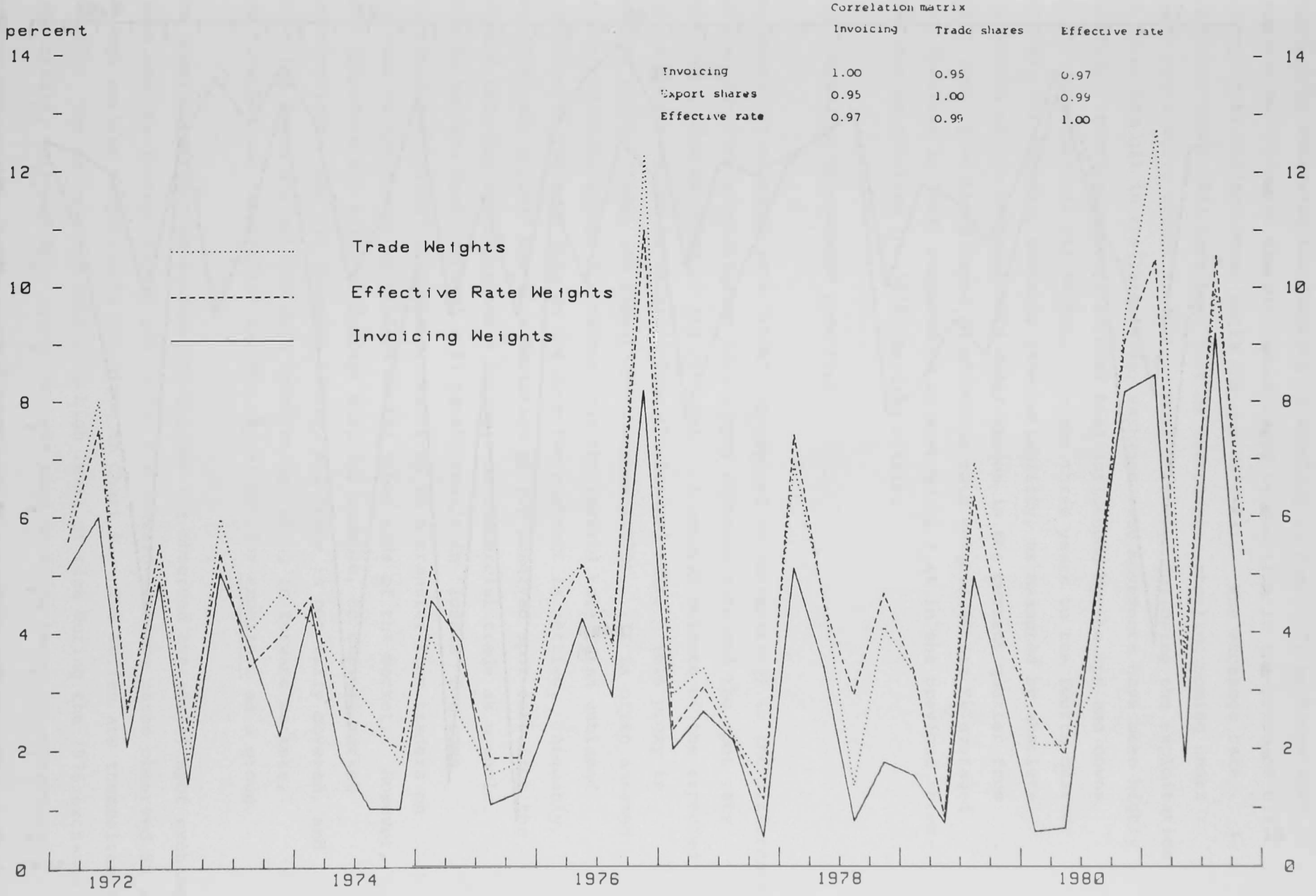
Nominal Exchange Rate Variability (Deviations from trend)



Correlation matrix

	Invoicing	Trade shares	Effective rate
Invoicing	1.00	0.89	0.91
Export shares	0.89	1.00	0.99
Effective rate	0.91	0.99	1.00

Nominal Exchange Rate Variability (deviations from trend)

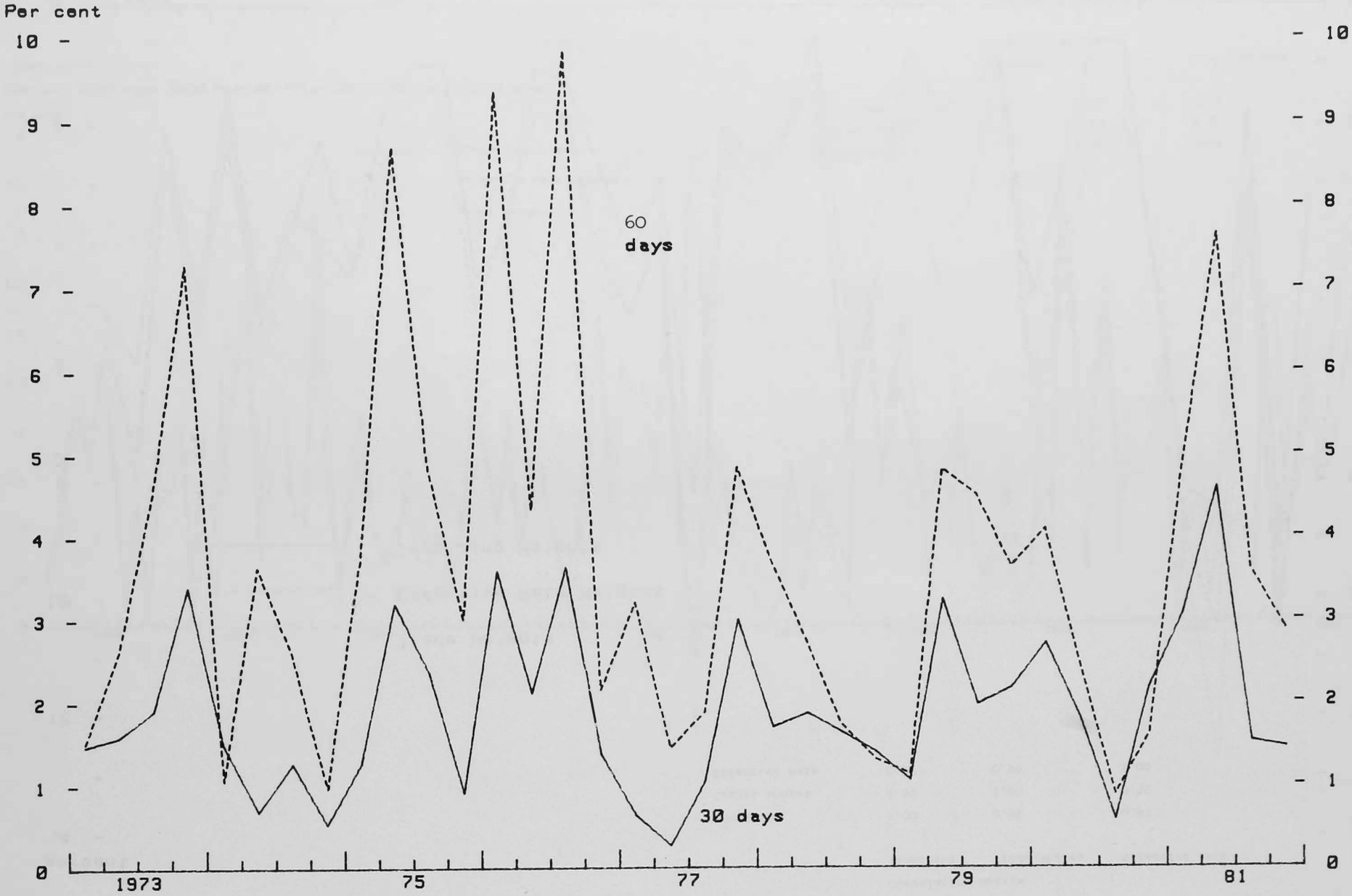


Correlation matrix

	Invoicing	Trade shares	Effective rate
Invoicing	1.00	0.95	0.97
Export shares	0.95	1.00	0.99
Effective rate	0.97	0.99	1.00

CHART F

Forward exchange rate "risk" (mean absolute forecast error)



What the charts do show, whatever measure is used, is that in the period immediately following the floating of sterling in June 1972 exchange rate instability increased sharply, exacerbated by the rise in the price of oil (though this did not occur until the end of 1973). The exchange rate movements since 1974 have been just as turbulent: sterling coming under heavy speculative attack in 1976. More recently, following the exploitation of North Sea oil in the late 1970s, exchange rate movements have been highly volatile; sterling appears to have been influenced by the ups and downs of the international oil market. In the three years to the fourth quarter of 1981, for example, exchange rate variability, as measured by absolute deviations of the exchange rate observations in the current quarter from their underlying trend based on effective rate weights (Chart E) averaged 5.1% (peaking in 1981) compared to an average of 4.4% in the previous three-year period covering the 1976 sterling crisis.

2.2 Measures of exchange rate risk

One proxy for exchange rate "risk" (as opposed to variability) is the difference between the firm's anticipated future spot exchange rate and the spot rate observed at the maturity of its contract. A natural measure of the expected future spot rate can be obtained from the forward rate. This proxy is used by Aliber (1980) and Hooper and Kohlagen (1978). It is often assumed in the efficient market literature that the forward rate is an unbiased predictor of the spot rate on the date the contract is settled. Arguably, any 'forecast errors' due to a deviation of the observed spot rate from the forward rate may not represent a net cost to commercial trade as a whole. This is because such "errors" will merely result in "losses" for some exporters and "gains" for others, resulting in a transfer from traders on one side of the market to traders on the other side of the market. However, such transfers may still be costly, due, for example, to capital market imperfections; and if, as seems likely, all trade is not fully covered, and exporting firms are not the only agencies operating in forward markets, the "losses" and "windfalls" may not cancel out for <u>exporters</u> as a group.

The absolute percentage differences between the observed average[1] spot exchange rates and the average 30-day and 60-day £/$ forward exchange rates observed 30 and 60 days earlier respectively are shown in Chart F. The series are themselves fairly erratic; the pattern - a generally high level of risk during the 1976 exchange rate crisis, followed by a sharp increase when sterling began to appreciate

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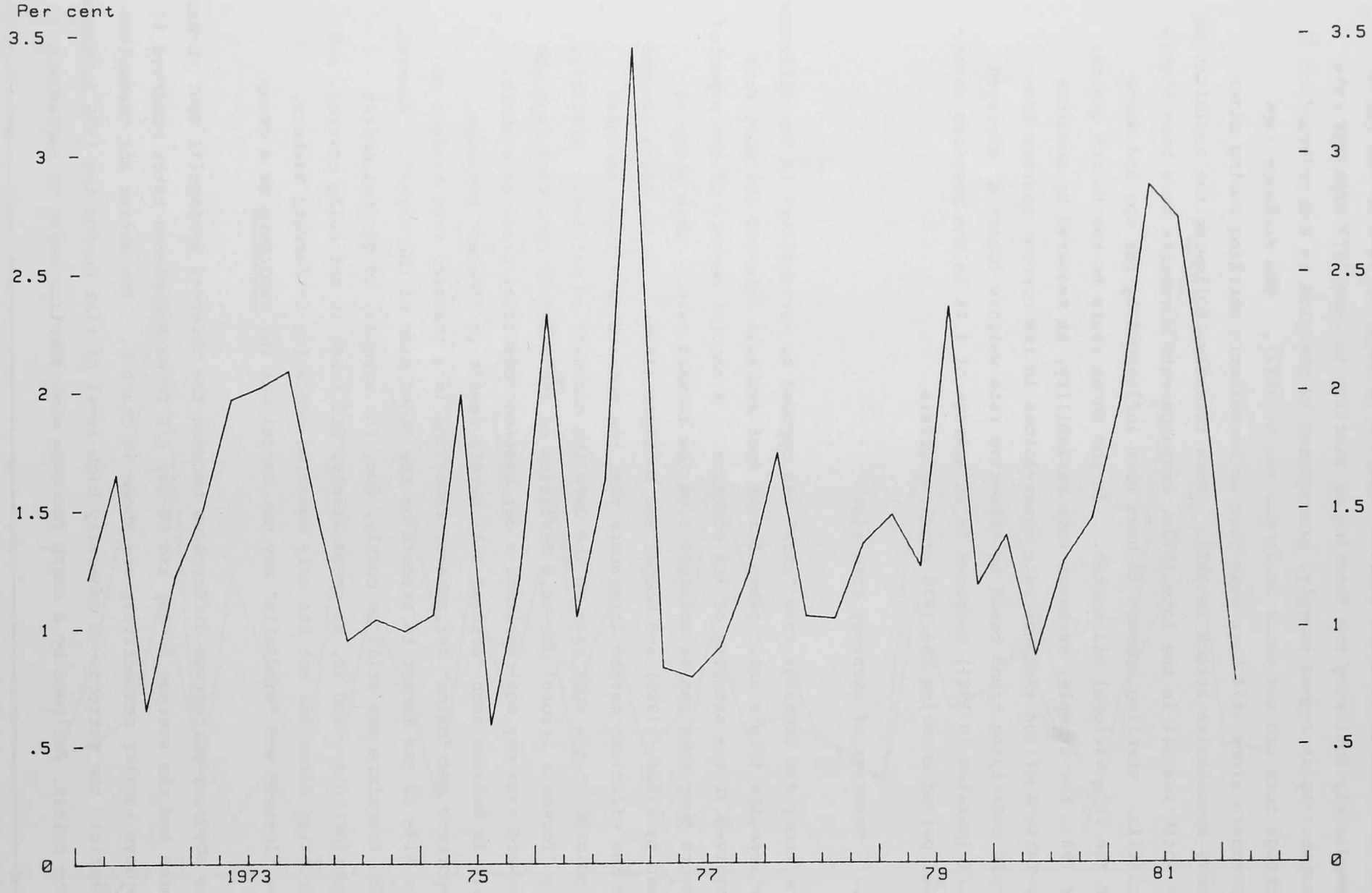
[1] Both are the averages of daily observations over the quarter.

CHART G

Nominal exchange rate risk (deviation from an `ex ante´ trend)



rapidly in 1979, and again when sterling depreciated during 1981 - is broadly consistent with that observed using the more conventional measures of variability. It is also clear that the mean average forecast error is higher the further the forecast horizon. Over the period 1973 to 1981, the absolute difference between the forward rate 60 days ahead and the observed spot exchange rate averaged about 3.7% compared with 1.9% [1] in the corresponding 30-day period - confirming that exporters who face a longer period between the placement of a contract and the settlement date face greater risk.

A difficulty with the conventional measures of exchange rate variability is that they calculate the exchange rate trend ex post over the data observations. This implies that agents are "rational" about the trend but got the noise about the trend completely wrong. One method that avoids this problem is to calculate an ex ante trend from, say, observations 1 to 9 of the monthly data, and use this to predict the observations 1, 2 and 3 periods ahead. These forecast errors can then be averaged in each period to produce an ex ante proxy comparable to the more conventional ex post proxies. The resulting index for total UK exports, based on a MERM weighted average of bilateral measures (and averaged over the quarter), is shown in Chart G. Comparing Chart G with the more conventional ex post deviation from trend measure (Chart D), it is clear that the two procedures produce fairly similar series, though the absolute percentage deviation from the ex post trend is slightly greater (the correlation coefficient between the two series is 0.66).

2.3 Diversification, aggregation problems, and measures of world currency variation

Pigott et al (1975) and others have argued that indices of exchange rate variability based on weighted averages of bilateral variability measures may not adequately capture the potential reduction in risk that may occur by diversifying across countries - this is because movements in any

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[1] In the efficient market literature, evidence of a systematic deviation of forward exchange rates from realised future spot rates has been taken as support for the hypothesis that forward markets are not "efficient" (ie that they overlook relevant information). The mean non-absolute deviations of the forward rates 30 and 60 days earlier from the observed spot exchange rates are 0.5% and 1.4% respectively over the period 1973 to 1981. Although this can be taken as suggesting that markets are not "efficient", the "systematic" component varies significantly in different sample periods and further tests would be needed before any firm conclusions could be drawn. Saville and Fox (1983) offer a survey of the literature, and discussion of the problems.

one bilateral rate may be offset by movements in other bilateral rates. They suggest that a measure of the variability of the sterling effective rate index should be used as this will capture the wide variety of covariance terms that could dampen the effect of the instability of any one bilateral rate on a firm's profits. However, the quarterly exchange rate variability series based on this particular scheme, illustrated in Chart H, is fairly closely correlated with the corresponding measure (Chart E) based on average MERM weighted bilateral rate variabilities (the correlation between the two series is 0.89), though the absolute level of variability is lower. This approach will, however, only be relevant to assessing the total risk faced by any firm if each firm traded exactly like the UK as a whole with other countries.

There is something more to be said for constructing a measure of world currency variation. The argument here is that variability worldwide lowers activity and particularly trade worldwide, and thus UK exports. An aggregate index of world currency variation can be constructed by adding together (albeit rather arbitrarily) measures of effective exchange rate variability for each country included in the IMF MERM index (Table 1), using weights based on each country's share of world trade in manufactures in 1980. Chart H shows the resulting measure of world currency variation based on quarterly data for the period 1972 to 1981. The impact of the first OPEC oil price shock is clear and, as expected, the world index tends to be more stable than the corresponding UK series in the mid-1970s (1976 UK exchange rate crisis).

2.4 "Real" exchange rate variability

The measures of variability and risk discussed above refer to nominal rather than real exchange rates - it may, however, be "real" exchange rate variability that is more important for determining exporters' behaviour [1]. This is because the influence of nominal variability on firms' profits may be offset by changes in cost and price differentials. Chart I and Chart J show quarterly measures of real exchange rate variability, defined in terms of UK unit labour costs and wholesale prices for manufacturing industry relative to an average of its major trading partners cost and price levels respectively (in common currency), over the period 1966 to 1981. The series are based on mean absolute first differences.

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[1] However, nominal variability will affect historic profits in the short run and thus affect businessmen's behaviour (for example, modify capital market oportunities).

Effective exchange rate variability (deviations from trend)

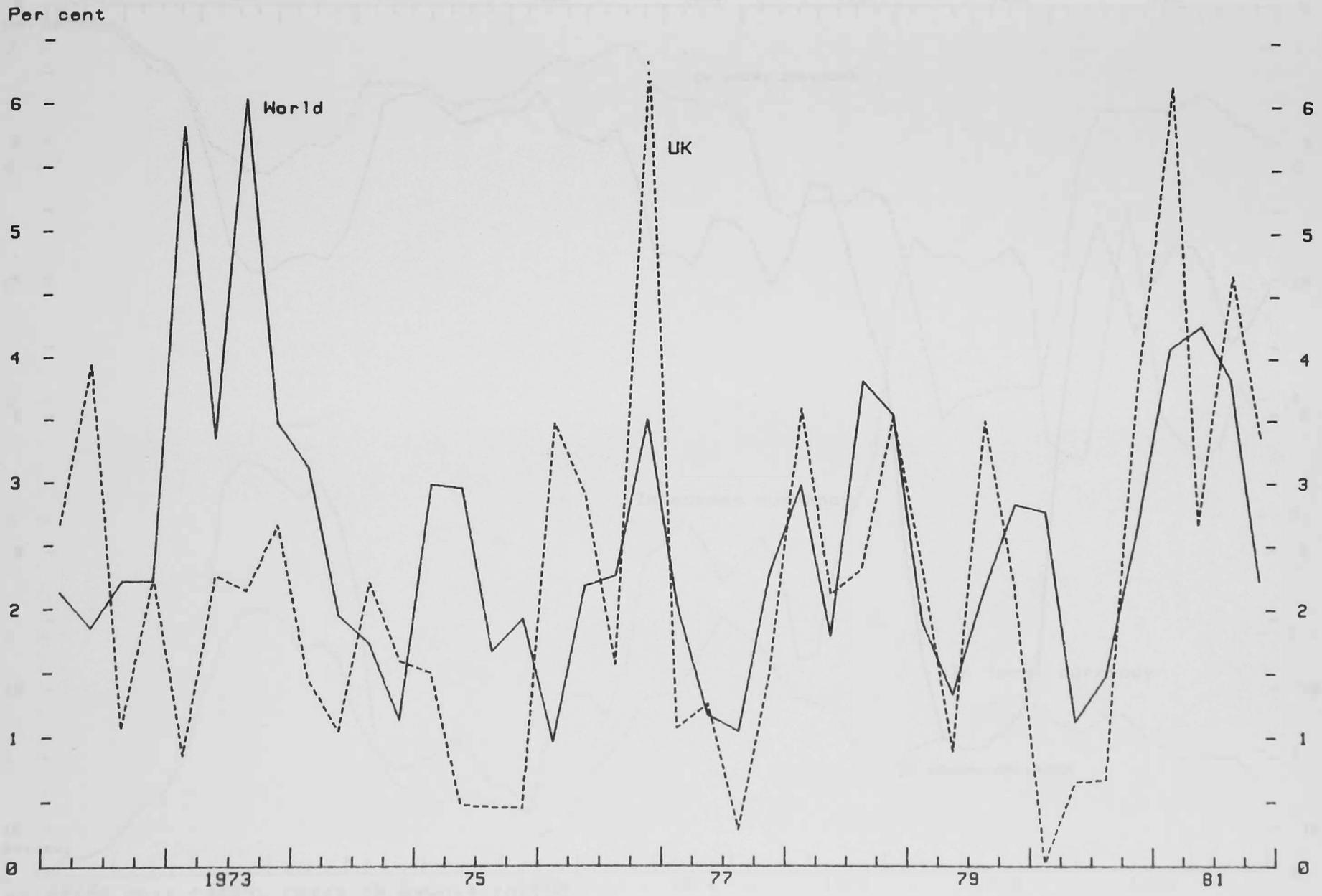


CHART I Real Exchange Rate Variability (mean absolute first differences)

Relative Unit Labour Costs In Manufacturing

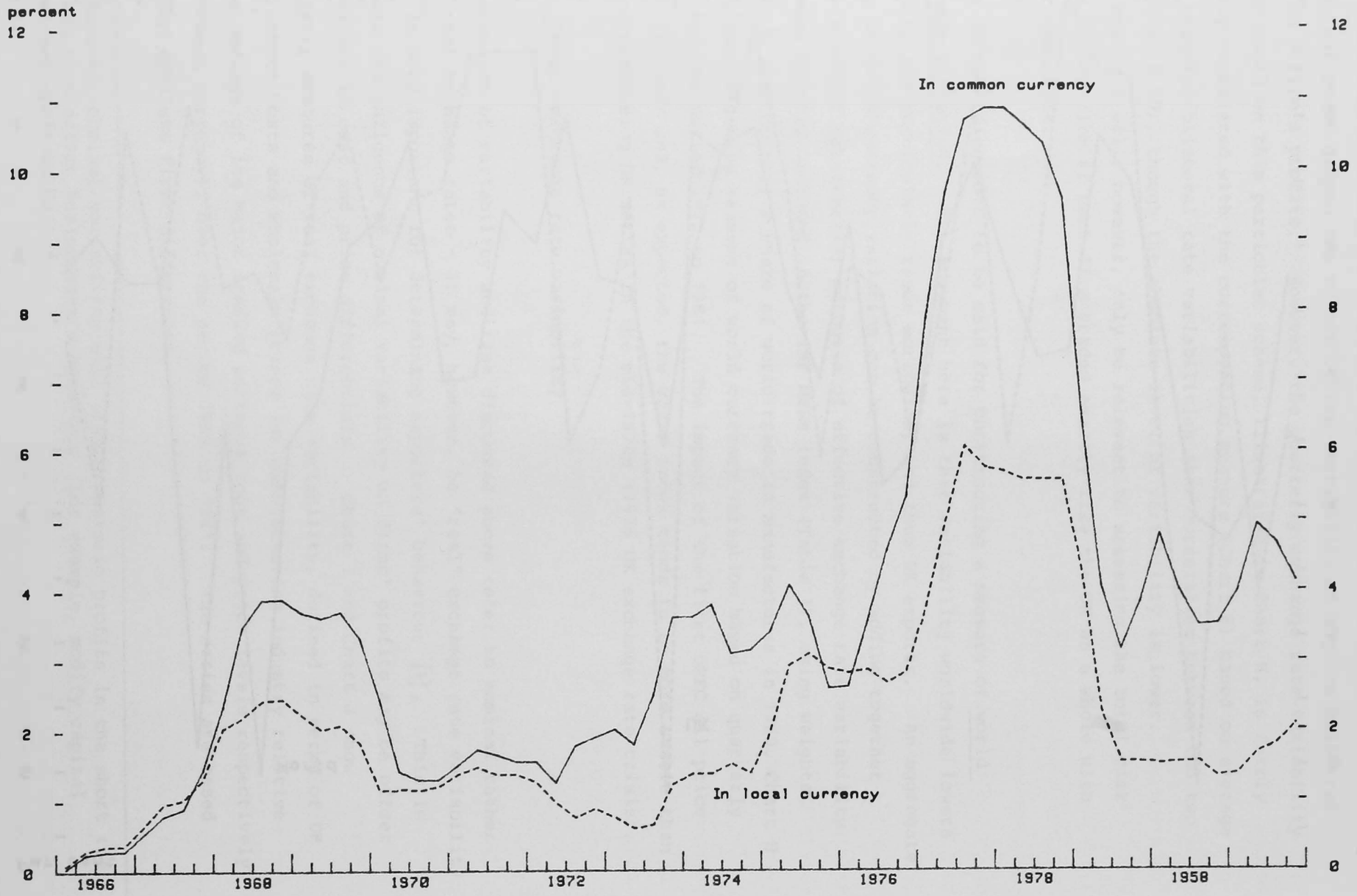
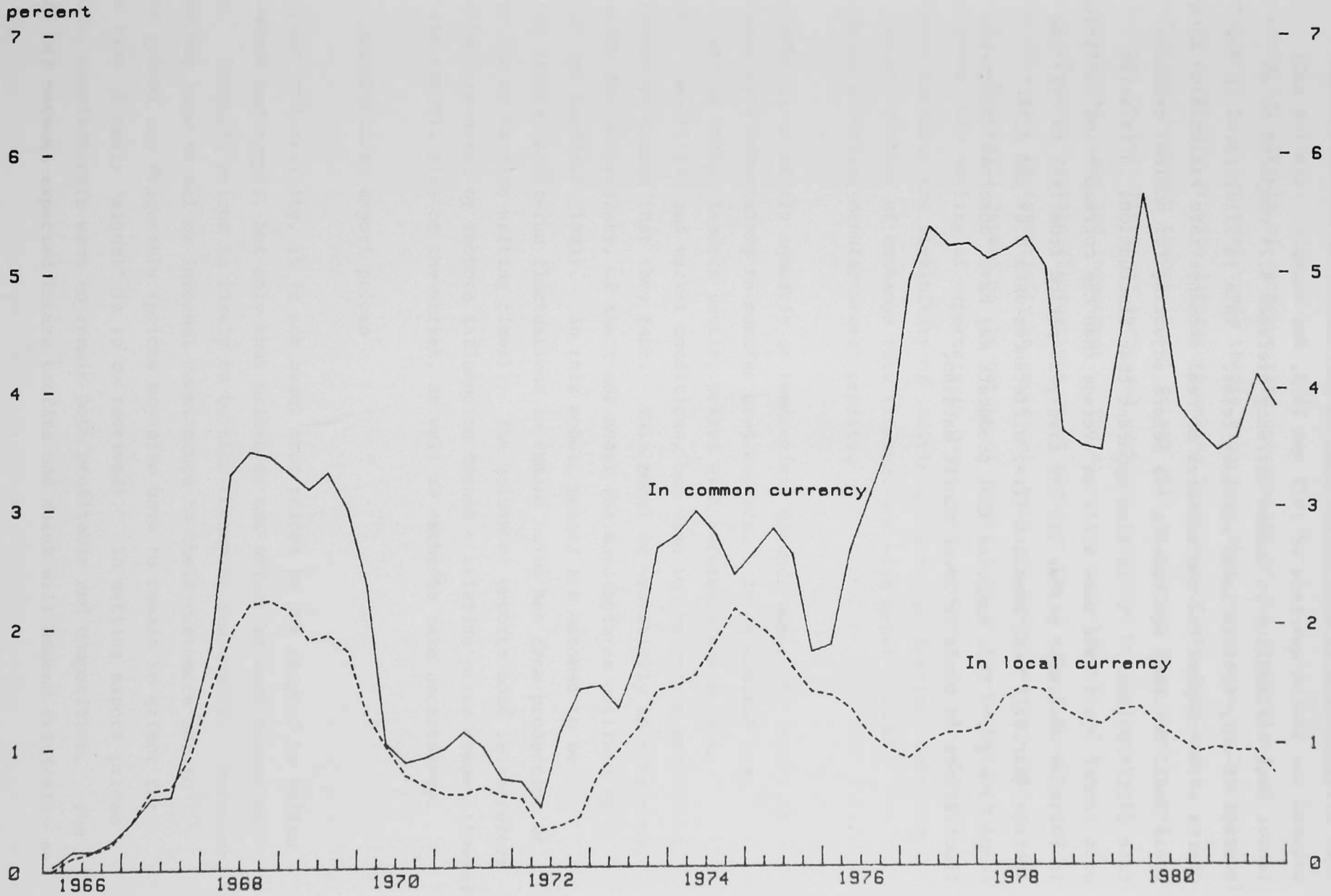


Chart J Real Exchange Rate Variability (mean absolute first differences)

Chart J Real Exchange Rate Variability (mean absolute first differences)

Relative Wholesale Prices Of Manufactures



Nominal exchange rate movements (including the 1967 devaluation) appear on average to have exacerbated movements in underlying relative price and cost differentials in this period and, in particular, in the late 1970s: between the fourth quarters of 1977 and 1979, for example, relative unit labour cost variability in common currency averaged 8.2% compared to an average of only 4.4% in local currency terms. This is illustrated in the charts which compare the two measures of real exchange rate variability with their local currency equivalents (ie before adjusting for nominal exchange rate differentials). It is also apparent that fluctuations in relative unit labour costs have been wider on average than the corresponding variations in relative wholesale prices (in the five-year period from 1977 to 1981 the average quarterly mean absolute first differences were 6.6% and 4.5% respectively). This suggests that producers may have "absorbed" short-run fluctuations in costs in lower profit margins.

3

The impact of exchange rate uncertainty on manufactured exports

The potential effects of exchange rate uncertainty on the predictions of traditional international trade theory have long been recognised. Unfortunately, despite a rapidly growing literature on the behaviour of the firm under uncertainty, economic theory is not as yet able to provide firm theoretical guidelines on the effects of increased exchange rate risk on the level of international trade and investment. The direction and strength of the impact of exchange rate fluctuations on UK manufacturers' export pricing and sales behaviour is essentially an empirical issue and cannot be resolved a priori. Much will depend on the nature of competition in the market being considered, the ability of exporters to cover their exposure on the forward exchange markets, the flexibility of individual firms' production technology and the correlation of exchange rate fluctuations with other economic variables affecting manufacturers' profits.

This section is fairly agnostic on theoretical grounds about the impact of exchange rate uncertainty on manufactured exports. It is assumed that firms act as market leaders setting prices with reference not only to overall competitive and market conditions, but also to the entire stochastic structure of demand that they face. This model is essentially an extension, to allow for uncertainty, of the trade model for manufactures outlined by Hotson and Gardiner (1983). In this model, prices are assumed to be fairly sticky, short-run fluctuations in demand being met from production or stock (or by varying waiting times). The volume of exports sold is therefore largely determined by factors influencing demand - relative price competitiveness and the overall size of the market, as well as exchange rate uncertainty.

3.1 Manufactured export prices

By price inflexibility, it is not meant that prices do not respond to shifts in demand and supply, but only that prices do not adjust at each moment of time. Changing prices is likely to be time-consuming and costly. Moreover, firms may have formal or informal commitments to their customers not to alter prices too frequently (prices may also have to remain in effect for some time if their "signal" is to be received). In setting export prices (UXGM), manufacturers want to remain both profitable and competitive. The trade off between expected future profits and sales will depend critically on

the firm's expected costs of production (COST) and the prices of competing goods overseas expressed in a common currency (WPIM.ERUK):

UXGM = UXGM (COST, WPIM.ERUK, POD, VAR) (1)

Margins on exported goods may also differ according to the degree of capacity utilisation (POD): on occasions when the level of domestic demand is so low as to create an excess supply of manufactures, the profit required from exports may be lowered (at its crudest this would be dumping).

In uncertain markets, the set of attainable margins and level of sales will be determined not only by the expected value of future costs and prices but also by their variability. If it assumed that competitors' prices and input prices are known, then the only source of uncertainty is exchange rate variability. In each period after prices have been set in local currency, firms do not know for sure what the level of demand will be, or, if exports are invoiced in foreign currency, what will be the level of future profits, although it is assumed that they do know a measure of the randomness of the exchange rate (VAR). In this environment, it is not at all certain what the final impact of exchange rate uncertainty on UK export prices will be - this will depend on a number of considerations.

The evidence from the survey of invoicing practices cited earlier suggests that something like 75% of UK exports of manufactures are invoiced in sterling. However, while the direct impact of exchange rate risk can be mitigated by local currency invoicing this merely shifts the burden of adjustment to the overseas importer and, depending on the balance of market forces, domestic producers may still be subject to an indirect risk at least in the somewhat longer run via volume effects on their revenue. Hence, in setting prices, UK exporters may have to take into account the effect of exchange rate variability on demand and, in periods of currency turbulence, they may be forced to drop their sterling prices to maintain their position in the market.

Of course, if the exporter is in a sellers' market, he may simply take the view that the overseas importer must just get on with it as best he can. On the other hand, if UK manufacturers have to compete for their sale, they may prefer to resolve the problem of fluctuating exchange rates for their customers, and gain a competitive edge, by invoicing their contracts in foreign currency. The UK exporters will then bear the burden of exchange risk - an increase in exchange rate instability will directly increase uncertainty about future expected profits. This is the situation most commonly analysed in the

literature (though it is less likely to be representative of the situation facing the majority of UK exporters). Early investigations along these lines include the work of Clark (1973), Coes (1976) and, more recently, Hooper and Kohlagen (1978).

In the simplest versions of the Clark and the Hooper and Kohlagen models, for example, it is assumed that firms operate in competitive markets, produce solely for export and only use domestic inputs to production. Moreover, it is implicitly assumed that the exporting firm is locked into its production decision and cannot alter its output ex post in response to changes in the exchange rate (eg renege on its contract). If exporters are risk averse, then an increase in exchange rate variability will, under these rather stringent conditions, lead to a contraction of supply (and therefore to an increase in price). This is because the exporters' marginal revenue will have to compensate it not only for its expected marginal costs of production, but also for the imputed cost of risk. Once these assumptions are relaxed, however, the impact of exchange rate risk on the price of exported manufactures becomes less certain.

Imported material costs. It is likely that fluctuations in domestic currency receipts due to exchange rate volatility will be associated with fluctuations in input costs (COST) due to changes in the domestic prices of imported raw materials. If fluctuations in input prices vary positively with changes in output prices, then the impact of exchange rate fluctuations on firms' profits will be smaller. However, it is likely that the market prices of many raw materials (which tend to be traded on centralised markets) will respond rapidly to changes in demand and supply. To a large extent, therefore, traders are guaranteed that movements in the exchange rate will be reflected in the price they pay, since they face a world price for the commodity which is not affected by fluctuations in the currency in which that price is denominated. The precise implications of fluctuations in input costs will also depend on whether or not exporting firms use other imported inputs from the same currency area to which they export and on lags in production.

Output flexibility. More serious perhaps (apart from the assumption of competitive markets) is the assumption that firms are not able to modify their output prices or vary their inventory holdings in response to new information on exchange rate movements. If firms can adjust capacity freely and at zero cost and there are no production lags, then, of course, uncertainty about the future exchange rate should not alter current behaviour. It is likely, however, that firms have

made prior commitments to supply goods, output flexibility is limited in the short run, and changes in capacity and inventory holdings involve some cost. In these circumstances, firms have to make pricing decisions that take possible fluctuations in future exchange rates into account.

Forward markets. The impact of exchange rate risk can be alleviated by hedging in the forward market. It should be emphasised, however, that, if a firm is able to cover its exposure in forward markets, this will involve a cost, for example, in higher administrative overheads on foreign exchange dealings and, possibly, through wider spreads in rates quoted on the forward exchange market (though this has not been proved conclusively). This cost must either be passed forward to customers (or backwards to suppliers) or absorbed in lower profit margins (depending on monopoly power). In the real world, of course, firms may be operating in exchange markets for purely speculative reasons. Their decision to cover forward will then be essentially separate from that to export and will depend critically on whether or not the firm's perception of the likely future exchange rate is thought to be fully reflected in the forward market.

3.2 Manufactured export volumes

If manufactured export prices are inflexible in the short run, the underlying level of manufactured exports (XGMA) will be determined by price competitiveness (UXGM/WPIM.ERUK) and the overall size of the market for manufactures (TWIP). If, as suggested above, the bulk of UK exports are invoiced in sterling, this shifts the immediate burden of exchange risk (VAR) to overseas importers who may not have direct access to forward exchange facilities anything like as extensive and varied as in London; an increase in VAR is likely to lead them to switch from foreign supplies at the margin to domestic sources. All trade, and hence XGMA, will fall relative to TWIP as a result. The volume of manufactured exports can therefore be written:

$$XGMA = XGMA\ (UXGM/WPIM.ERUK,\ TWIP,\ VAR) \qquad (2)$$

Given the short-run inflexibility of selling prices with respect to demand simultaneities between the price (1) and volume (2) equations should not pose a serious problem, and the equations can be estimated directly by OLS. However, it should be stressed that this procedure only represents one possible approach to estimation. The price equation could alternatively be substituted into the volume equation to obtain reduced form equations for market equilibrium and price. This is the approach adopted by Hooper and Kohlagen. One interesting feature of their analysis is that they treat the

overseas demand for imports (UK exports) as a derived demand schedule, where UK exports are treated as inputs into the overseas importers production function. However, in uncertain markets, it is not immediately clear that equilibrium in the orthodox sense can meaningfully be defined. Under uncertainty the traditional distinction between supply and demand functions is likely to be blurred. In particular, in formulating its operating policy, an exporting firm will first have to take account of the random structure of demand. For example, in the traditional model with local currency invoicing the effect of an increase in exchange rate uncertainty is to produce a shift in the demand for exports, whereas the ultimate effect may be to produce a shift in the supply curve through increasing non-price competitiveness (eg firms may resolve the problem of fluctuating currencies for their customers by switching their sales into foreign currency and hedging).

3.3 Diversification and real exchange rate variability

The price and volume equations (1) and (2) are strictly applicable to a two country world. Once the analysis is extended to a multi-exchange rate framework, UK manufacturers and their overseas customers decisions will be influenced not only by the variability of particular bilateral exchange rates, but also by their covariance with other rates. This is because the impact of any one bilateral exchange rate on firms' profits may be offset by movements in other bilateral rates. The firm may be able therefore to reduce its risk by exploiting negative currency correlations between countries either by holding a portfolio of currencies or by <u>diversifying</u> across export/import markets (though it is by no means certain that such correlations are stable enough to be predicted ex ante). Furthermore, if the firm is operating in several markets, a change in uncertainty may have allocative effects independent of the volume of goods exported.

It should also be emphasised that, in a multi-exchange rate world, UK exporters and overseas importers do not necessarily face the same risks (this may also be true in a simple two country world depending on what particular definition of risk is used, access to forward markets and so on). When we sum over foreign imports of UK goods, the same set of bilateral rates are relevant as when we sum over all UK exporters destinations: <u>but</u> the relevant set of covariances is different. This is because the UK exporter is interested, for example, in the covariance of the sterling rate against the US dollar and yen, while the foreign buyer in Japan (say) is interested in the covariance of the sterling rate and US dollar against the yen. Unfortunately, it is not

feasible, given limited resources, to construct separate proxies for the risks facing exporters and importers - though the aggregate world exchange rate variability measure described in the last section may serve as a proxy for aggregate uncertainty affecting foreign buyers of UK exports.

Real exchange rate variability. Finally, there are likely to be considerable risks in quoting firm prices for long-term contracts, even in a fixed exchange rate regime. Though forward rates for two or even three years ahead can be quoted, uncertainty due to exchange rate fluctuations may be swamped by other considerations in the longer term. For example, future wage costs, raw material and energy prices cannot be perfectly predicted and will affect the profits of all firms irrespective of whether or not they are engaged in international trade. This suggests that a measure of real rather than nominal exchange rate variability is needed. This is because, in the long term, nominal exchange rate flexibility in response to price and cost changes may provide the firm with a built-in covering mechanism. But it also underlines the prevalence of risks, and the potential dangers of estimating the response to any one uncertainty in isolation.

4

Empirical results

4.1 Exchange rate variability and risk

The simplest and most direct test of the impact of exchange rate fluctuations on UK exports is to substitute proxies for the terms representing exchange rate risk and variability in the manufacturing export volume and price equations discussed in the last section and examine whether the proxies are significant. The discussion in Section 2 raised rather naturally the arbitrariness of the measures to be used. Clearly, there are many choices about the frequency of the data and the construction of the proxy. To test the robustness of our results to changes in the specification of the volatility term, several of the more different variability/risk measures constructed earlier have been used in the empirical tests. Additionally, some of the measures used have been calculated from monthly data, though constructed on a quarterly basis. The specific measures employed in the empirical tests and their correlations given in Appendix 1.

The manufacturing export price and volume equations have been estimated with a rational lag structure to allow for the lagged reactions [1] of UK exports to changes in relative prices and activity:

(5) Manufacturing export volumes (XGMA)

$$\ln XGMA_t = a_0 + \sum_{i=0} a_{1i} \ln \frac{UXGM}{WPIM.ERUK}_{t-i} + \sum_{i=0} a_{2i} \ln TWIP_{t-i}$$

$$+ \sum_{i=0} a_{3i} \ln VAR_{t-i} + \sum_{i=0} a_{4i} \ln XGMA_{t-i-1} + u_t$$

(6) Manufacturing export prices (UXGM)

$$\ln UXGM_t = b_0 + \sum_{i=0} b_{1i} \ln WPIM.ERUK_{t-i} + \sum_{i=0} b_{2i} \ln COST_{t-i} + \sum_{i=0} b_{3i} \ln POD_{t-i}$$

$$+ \sum_{i=0} b_{4i} \ln VAR_{t-i} + \sum_{i=0} b_{5i} \ln UXGM_{t-i-1} + v_t$$

---

[1] There are a number of reasons why the reactions of UK export prices and volumes should lag changes in relative price and activity - for example, lags in production and in expectations formation.

WPIM.ERUK is a UK export-weighted average of competitors' wholesale prices expressed in sterling. The weights do not take into account the importance of each country as a supplier to its own market or its importance as a competing exporter in third markets. (To greatly simplify the empirical analysis we assume that traders' exchange rate expectations are realised so that the actual exchange rate can be used). COST is a weighted average of unit labour costs and wholesale buying in prices, the weights (60:40) reflecting the shares of labour and material costs in total variable unit costs of production. TWIP is an index of UK export-weighted OECD industrial production (in volume terms). POD is an index of domestic capacity utilisation.

The price and volume equations (excluding the variability terms) were estimated in logarithmic form over the floating exchange rate period 1973 I to 1981 IV; the influence of dock strikes on the data having first been removed using prior adjustments provided by the Department of Trade. The lag structures on the price and cost terms in both the price and volume equations were tested using the conventional F-test (Appendix 2): the restrictions (11,10) to (7, 6) on the competitiveness term in the export volume equation are not rejected by the data. The restriction (6,5) is rejected however; domestic costs or competitors' prices lagged one quarter in the export price equation could not be rejected by the data (excluding $COST_t$ and $WPIM.ERUK_t$ improved the overall fit of the equation). Lagged values of the dependent and activity variables of up to two quarters in both equations were also tested sequentially - lags of one quarter on the dependent variable were found to improve the overall fit; no lags on activity were identified. A smooth uni-modal response of export volumes with respect to competitiveness was imposed - the lag structure following a 2nd order Almon process with an end point constraint of zero.

The price and volume equations freely estimated were then augmented with the variability measures: lags of up to three quarters on the variability/risk proxies in the export volume equation (Table 3) and of up to one quarter in the price equation (Table 4) were investigated. In the export volume equation, the restrictions (4,3) to (1,0) could not be rejected at the 95% level for any of the exchange rate risk/variability proxies; so we are unable to confirm that exchange rate volatility as measured has had any significant impact on the quantity of manufactures exported during the floating rate period [1]. However, if the F-test is weakened to the 90% level, the restriction (3,2) on the world currency variation measure (D1) and the restriction (1,0) on the second 'nominal' exchange rate variability measure (A2) are rejected. The resulting equations including these two measures (with Almon lags imposed on the competitiveness and world currency variation terms) are reported in Table 5. Manufactured export volume equations, including contemporaneous values of the other eight variability measures, are also recorded.

The coefficients on the world currency variation and nominal variability (A2) measures are negative and marginally significant at the 95% level, with t-statistics of 1.8 and 1.9% respectively. A possible explanation for the former result is that exchange rate variations worldwide reduce the share of trade worldwide (TWIP) and hence UK exports. This explanation might lead us to expect some correlation between the world activity and world currency variation terms in the export volume equation. However, the long-run coefficient on TWIP (1.3) in the final equation is not noticeably lower than that on TWIP in other equations listed in Table 5.

The results for manufactured export prices are harder to interpret. In the previous section, it was pointed out that the sign on the exchange rate volatility term is ambiguous and will depend on UK exporters' market power. Indeed, the empirical results show that the sign and explanatory power of the variability/risk measures vary widely depending on which proxy is used. Lagged values of one quarter of the various measures in the price equation

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[1] An alternative procedure is to weight the variability proxies by the competitiveness term. This possibility was also investigated but did not produce significantly different results. There is, of course, the additional problem that the competitiveness term may be capturing the influence of volatility on export volumes, but re-estimating the equation excluding in turn the competitiveness and variability/risk terms did not suggest that a serious problem of multi-collinearity exists.

Table 3

Export volume equation

Lag tests on variability/risk terms

Restriction[1] F-test[2] on exchange rate variability term

	Equation										
	(a) Including nominal exchange rate variability proxies				(b) Including measures of exchange rate risk			(c) Including real exchange rate variability proxy		(d) Including measure of world currency variation	
	A1	A2	A3	A4	B1	B2	B3	C1	C2	D1	F(R, T-K)
(4,3)	0.052	2.200	0.016	0.163	0.157	0.365	1.471	0.380	0.018	0.676	(1, 23)
(3,2)	0.085	1.910	0.033	0.161	0.163	0.462	1.625	0.841	1.699	3.017≠	(1, 24)
(2,1)	0.178	0.185	0.171	0.168	0.167	0.271	0.882	0.519	0.294		(1, 25)
(1,0)[3]	1.858	3.324≠	0.352	0.174	0.172	0.273	0.522	0.785	1.123		(1, 26)

* Restriction rejected at 95% level ≠ Restriction rejected at 90% level

(1) (i + 1, j + 1) where i is the longest lag on the unrestricted form
j is the longest lag on the restricted form

(2) The conventional F-test is used, with the null hypothesis that the restrictions hold

$$F = \frac{(RSS_R - RSS_U)/R}{RSS_U/(T-K)}$$

where RSS_U = residual sum of squares in unrestricted equation
RSS_R = residual sum of squares in restricted equation
T = sample size
K = number of regressors in unrestricted equation
R = number of restrictions

(3) ie the variability term is excluded from the restricted equation.

Table 4

Export price equations

Lag tests on variability risk terms

Restriction	F-test equation	on exchange rate variability term									
	(a) Including nominal exchange rate variability proxies				(b) Including measures of exchange rate risk			(c) Including real exchange rate variability proxy		(d) Including measure of world currency variation	
	A1	A2	A3	A4	B1	B2	B3	C1	C2	D1	F(R,T-K)
(2, 1)	0.272	0.273	0.094	0.100	0.281	4.296*	2.23	0.352	4.286*	0.095	(1, 29)
(1, 0)	0.271	0.272	0.935	3.100/	0.968		4.286*	3.002/		0.935	(1, 30)

* Restriction rejected at 95% level

/ Restriction rejected at 90% level

Table 5 Exchange rate variability - Manufactured export volume equations

$TWIP_t$	$\sum_{i=0}^{5}$ (UXGM / WPIM.ERUK)$_{t-i}$	$XGMA_{t-1}$	CNST	$\sum_{i=0}^{n}$ Variability proxy VAR_{t-i}	RSS	SE	$\bar{R}^2$
0.4889	-0.1374	0.6573	1.1962		0.0151	0.022	0.91
(3.5)	(2.3)	(8.0)	(2.9)				
(a) Including nominal exchange rate variability proxies							
0.5585	-0.1573	0.6707	0.9100	-0.0334 A1	0.0141	0.021	0.91
(3.9)	(2.7)	(8.3)	(2.1)	(1.5)			
0.6173	-0.2126	0.4990	2.0823	-0.0948 A2	0.0134	0.021	0.91
(4.2)	(3.1)	(4.4)	(3.5)	(1.9)			
0.4847	-0.1464	0.6688	1.1594	0.0076 A3	0.0148	0.022	0.91
(3.5)	(2.5)	(8.0)	(2.8)	(0.8)			
0.4898	-0.1426	0.6593	1.1967	0.0020 A4	0.0151	0.022	0.90
(3.5)	(2.3)	(.79)	(2.9)	(0.3)			
(b) Including nominal exchange rate risk proxies							
0.4827	-0.1411	0.6652	1.1755	0.0025 B1	0.0151	0.022	0.90
(3.4)	(2.3)	(7.4)	(2.8)	(0.2)			
0.4895	-0.1382	0.6575	1.1954	0.0003 B2	0.0151	0.022	0.90
(3.5)	(2.2)	(7.9)	(2.9)	(0.1)			
0.5040	-0.1449	0.6596	1.1358	0.0045 B3	0.0149	0.022	0.90
(3.6)	(2.2)	(8.0)	(2.7)	(0.8)			

Table 5 (cont)

$TWIP_t$	$\sum_{i=0}^{5}$ (UXGM /WPIM.ERUK)$_{t-i}$	$XGMA_{t-1}$	CNST	$\sum_{i=0}^{n}$ Variability proxy VAR_{t-i}	RSS	SE	$\bar{R}^2$
(c) Including real exchange rate variability proxies							
0.4938	-0.1123	0.5882	1.6130	-0.0114 C1	0.0147	0.022	0.91
(3.6)	(1.8)	(5.4)	(2.7)	(1.0)			
0.4634	-0.1161	0.5622	1.9813	-0.0213 C2	0.0147	0.022	0.91
(3.3)	(1.9)	(4.3)	(2.2)	(1.0)			
(d) Including measure of world currency variation							
0.5713	-0.1335	0.5755	1.4855	-0.0175 D1	0.0144	0.021	0.91
(3.8)	(2.3)	(5.6)	(3.2)	(1.8)			

Estimation period 1973 I - 1981 IV

Table 6 Exchange rate variability - Manufactured export price equations

$WPIM.ERUK_{t-1}$	$COST_{t-1}$	POD_t	$UXGM_{t-1}$	Variability proxy $\sum_i^n VAR_{t-i}$	CNST	SE	RSS	$\bar{R}^2$
0.1169	0.2851	0.1546	0.6057		0.0162	0.010	0.0032	0.99
(3.8)	(5.0)	(2.5)	(9.9)		(0.4)			
(a) Including nominal variability proxy								
0.1203	0.2946	0.1601	0.5948	-0.0044 A1	0.0149	0.010	0.0032	0.99
(3.8)	(4.7)	(2.5)	(8.8)	(0.4)	(0.4)			
0.1068	0.2840	0.1709	0.6094	0.0208 A2	0.0140	0.010	0.0032	0.99
(3.0)	(4.9)	(2.5)	(9.8)	(0.6)	(0.3)			
0.1223	0.2768	0.1453	0.6093	0.0029 A3	0.0111	0.010	0.0031	0.99
(3.8)	(4.7)	(2.2)	(9.9)	(0.7)	(0.3)			
0.1235	0.2861	0.1706	0.5998	0.0049 A4	0.0028	0.009	0.0029	0.99
(4.1)	(5.1)	(2.7)	(10.0)	(1.6)	(0.7)			
(b) Including nominal exchange rate risk proxy								
0.1065	0.2859	0.1524	0.6127	-0.0050 B1	0.0292	0.010	0.0031	0.99
(3.3)	(5.0)	(2.4)	(10.0)	(1.1)	(0.7)			
0.1238	0.2699	0.1457	0.6143	-0.0048 B2	0.0121	0.009	0.0029	0.99
(4.1)	(4.8)	(2.4)	(10.3)	(1.7)	(0.3)			
0.1203	0.3133	0.1652	0.5747	-0.0053 B3	0.0198	0.009	0.0028	0.99
(4.1)	(5.6)	(2.7)	(9.6)	(2.1)	(0.5)			

Table 6 (cont)

$WPIM.ERUK_{t-1}$	$COST_{t-1}$	POD_t	$UXGM_{t-1}$	Variability proxy $\sum_{i}^{n} VAR_{t-i}$	CNST	SE	RSS	$\bar{R}^2$
(c) Including real exchange rate variability proxy								
0.0865	0.3225	0.1768	0.5869	0.0077 C1	0.610	0.010	0.0030	0.99
(2.2)	(5.0)	(2.7)	(9.4)	(1.2)	(1.1)			
0.0899	0.3252	0.1688	0.5710	0.0179 C2	0.0986	0.009	0.0027	0.99
(2.9)	(5.7)	(2.8)	(1.6)	(2.2)	(1.9)			
(d) Including measure of world currency variation								
0.1310	0.2933	0.1575	0.5877	0.0038 D1	0.0074	0.010	0.0031	0.99
(3.8)	(5.0)	(2.5)	(9.1)	(0.9)	(0.2)			

Estimation period 1973 I - 1981 IV

are investigated in Table 4. The response of export prices to "nominal" exchange rate variability is generally weak: the restriction (1,0) (that is, excluding the variability measure altogether) is not rejected for all the proxies at the 95% level, and only rejected for A4 at the 90% level (export price equations including contemporaneous values of these proxies are recorded in Table 6). On the other hand, the restriction (2,1) on the relative price variability measure (C2) is rejected at the 95% level, and the restriction (1,0) on the relative cost variability proxy (C1) at the 90% level. The coefficients on both "real" variability measures are positive (Table 6), which would suggest that exchange rate fluctuations that are not offset by movements in relative inflation differentials may raise export prices. More interesting, perhaps, is the response of export prices to exchange rate risk: the signs on all three measures are negative (suggesting that nominal exchange risk may be borne by the exporter), though the ex ante deviation from trend measure is not significant. Neither measure of forward risk can be rejected by the F-test at the 95% level, the first measure (B2) entering with a lag of one quarter (though the contemporaneous term in insignificant and excluded from the reported equation). It is tempting to regard the econometric estimates as confirmation that forward exchange risk and real exchange rate fluctuations may at least have an influence on export pricing behaviour. However, the results for the broad range of measures investigated here are rather mixed, and depend heavily on the particular measure used.

4.2 Weakening of exchange rate response

The progressive increase in exchange rate volatility in the floating rate period may have weakened the impact of exchange rate fluctuations on trade flows, producers being less ready to alter production decisions when price signals are changing rapidly. More volatile sterling exchange rates may have reduced the competitiveness elasticity in the trade volume equations and lowered the foreign price (exchange rate) weight in the export price

equations. A fall in the foreign price weight (competitiveness elasticity) conflicts with what we would otherwise expect from the increasing openness of the UK economy and could be taken as a tentative support, ceteris paribus, for the hypothesis that the weight attached to foreign price signals has fallen in the floating rate period.

The results of re-estimating the manufactured export price and volume equations (excluding variability/risk proxies) over periods of stable and fluctuating exchange rates are summarised in Tables 7 and 8. Two sets of data period were examined. First, export price and volume equations estimated over the period from 1973 I to 1981 IV, covering the relatively turbulent exchange rate period from 1979 to late 1981, were compared with equations estimated over the period to the fourth quarter of 1978. Second, the possibility that the weight attached to foreign price signals in the floating rate period from 1973 on was significantly lower than in the fixed rate period was investigated. The tests were directed mainly at the proposition about the competitiveness elasticities, though the more general possibility of a structural break in the behavioural relationships determining trade flows between the fixed and floating rate periods was also examined using the conventional Chow test.

If changes in the competitiveness elasticity in the export volume equation (and the long-run foreign price weight in the export price equation) are found, this may, of course, be the result of model misspecification, in which case the parameter estimates may be unstable throughout the sample period. A previous version of the manufactured export volume equation in particular has been shown in published Bank work to be highly sensitive to small variations in the length of the data period. In general, however, it is not at all easy to distinguish between parameter changes due to equation misspecification and changes due to a structural break in the behavioural relationships determining trade flows. One test is to examine whether there is a systematic change in the foreign price (competitiveness) weights as the data period is extended.

Table 7

Split period stability tests: 1977 - 1981
(See Appendix 3 for further details)

1 Manufactured export prices

Long-run weights		Estimation period
Domestic costs	Competitors' prices	
0.8877	0.1123	1973 I - 1978 IV
0.7686	0.2314	1973 I - 1979 IV
0.7194	0.2806	1973 I - 1980 IV
0.7092	0.2908	1973 I - 1981 IV

2 Manufactured export volumes

Long-run competitiveness elasticity	Mean lag	Estimation period
-0.095	1.9	1973 I - 1978 IV
-0.243	2.0	1973 I - 1979 IV
-0.502	2.1	1973 I - 1980 IV
-0.401	1.9	1973 I - 1981 IV

Table 8

Fixed and floating rate periods

1 Manufactured export prices

Long run weights

Domestic costs	Competitors' prices	Estimation period
0.702	0.298	1967 I - 1981 IV
0.709	0.291	1973 I - 1981 IV

2 Manufactured export volumes

Long run competitiveness elasticity	Estimation period
-0.247	1967 I - 1981 IV
-0.401	1973 I - 1981 IV

3 Fixed vs floating period: Chow tests

	F	F $(K_1\ T_1 + T_2 - 2K)$
Manufactured export prices	2.1	(4, 52)
Manufactured export volumes	2.5	(4, 52)

Chow Test

$$F = \frac{\left[\bar{R}SS - (RSS_1 + RSS_2)\right] / K}{\left[(RSS_1 + RSS_2)/(T_1 + T_2 - 2K)\right]} \qquad F\ (K,\ T_1 + T_2 - 2K)$$

Where RSS residual sum of squares over the whole period

RSS_1 residual sum of squares over 1st sub period

RSS_2 residual sum of squares over 2nd sub period

T_1 sample size 1st sub period

T_2 sample size 2nd sub period

K number of regressors

Table 7 summarises the results of the split period analysis covering the volatile exchange rate period from the fourth quarter of 1978. In the case of the manufactured export price equation, the empirical estimates indicate an increase in the weight attached to foreign prices and a corresponding fall in the weight on domestic costs as the data period is extended from 1978 IV to 1981 IV. There has also been an increase in the long-run competitiveness elasticity in the manufacturing export volume equation from -0.10 to -0.40 over the same period. If anything, these two results suggest that the importance attached to competitors' prices has increased, and it may be that, because of the weak state of demand in the UK and abroad, competitive pressures have become more intense. From the results reported in Table 8, it also appears that the competitiveness elasticity in the export volume equation increased with the transition from a fixed to a floating exchange rate regime in the early 1970s [1] though the weights attached to domestic costs and foreign prices in the price equation have only changed marginally (however the Chow tests do not indicate a structural break in the equations).

An alternative interpretation of the above argument is that the adjustment of manufacturing exports to foreign price signals will be slower in periods of exchange rate instability, though the long-run impact may be unchanged. Table 7 shows, however, that the mean lag on the competitiveness term in the manufacturing export volume equation has not increased over the period 1978 IV to 1981 IV. This suggests that the difficulty firms have in distinguishing permanent from transitory exchange rate movements may not have risen significantly.

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[1] This confirms the results of other studies (for example, Clark and Haulk, 1972) which show an increase in the competitiveness elasticity in floating rate periods. It is possible however that the relatively short estimation period from 1967 which has been taken to be representative of the fixed rate regime, and covers the 1967 devaluation, may have distorted these results.

Though the above results appear to provide little support for the hypothesis that increased exchange rate volatility since 1978 has weakened the impact of foreign price signals on exporters' output and pricing behaviour, they have to be treated with caution. In particular, the empirical analysis covers a period in which economic conditions have changed rapidly and the results are sensitive to changes in the specification of the competitiveness and domestic cost terms [1].

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[1] Another possible method of investigating the relationship between the competitiveness elasticity and exchange rate variability is to include an interaction term $\alpha (VAR.COMP)_{t-i}$ in the estimated equations, where COMP is the measure of competitiveness used. The null hypothesis that variability has no impact on the competitiveness elasticity is then $\alpha = 0$. When the equations in Tables 5 and 6 were re-estimated including this measure, the null hypothesis $\alpha = 0$ could only be rejected in one instance (the export price equation including a measure of forward risk, B3). However, this methodology may introduce heteroscedasticity problems and thus OLS estimation may not be appropriate.

5

Concluding remarks

The evidence suggests that sterling exchange rate volatility and risk has not had a significant impact on the volume of UK exports of manufactures in the floating rate period. This is despite considerable experimentation with different measures of exchange rate variability and risk. The empirical results parallel in some ways the findings of those few earlier studies of the impact of exchange rate uncertainty on trade that do exist. Clark and Haulk, in a study of the Canadian float during the 1950s, found that exchange rate variability had little impact on the level of trade. Makin's study, referred to earlier, supports Clark and Haulk's findings for a number of western industrialised countries over the period 1960 to 1973. More recently, Hooper and Kohlagen, in their study of US and West German trade flows, found that exchange rate risk (as measured by the spot/forward differential) had a negligible effect on the level of trade during the period 1965 to 1975.

The present investigation does differ from earlier studies in that it suggests that world currency variation, or multilateral exchange rate instability, may have had a contractionary impact on the quantity of UK exports (though the measure is only marginally significant at the 95% level). The proxy used differs from the other measures considered, in that it is designed to capture the influence of exchange rate variability worldwide on world activity and trade as a whole and thus, indirectly, UK exports (it may therefore capture, albeit in a rather arbitrary way, the wide variety of covariance terms between currency movements that may have offset in part the influence of UK bilateral exchange rate variability on overseas importers' profits, particularly during the 1976 exchange rate crisis). This should not, of course, be taken as indicating that exchange rate volatility is the ultimate cause of reduced economic activity; in particular this measure gives rather a lot of weight to the impact of the 1973 oil price shock on exchange rate movements and the results may be merely a reflection of the turbulent conditions at that time.

While sterling exchange rate variability and risk appear to have had a negligible effect on the level of trade, the empirical tests suggest that real exchange rate variability and risk have influenced pricing behaviour. This discrepancy between export pricing and output behaviour was also found

by Hooper and Kohlagen. They suggest (in the context of their model) that it may possibly be due to the presence of short-run price inelastic export supply in the case of a fall in demand (due to an increase in risk) and short-run inelastic import demand in the case of a reduction in supply. However, the estimates for export prices reported here do vary considerably depending on which particular measure is used, and should therefore be treated with care. Taken at face value, they indicate that an increase in exchange rate risk may be borne by UK exporters (perhaps due to the fact that a high proportion of UK exports are invoiced in sterling). In contrast, "real" exchange rate variability, that is, fluctuations in nominal rates adjusted for relative price (or cost) movements, appears to have raised export prices in the long run.

Index of variables

COST	= Domestic unit costs, cost per unit of output
ERUK	= UK exchange rate against US$
POD	= Capacity utilisation in UK
TWIP	= UK trade weighted OECD industrial production (volume)
UXGM	= Manufactured export UVI
WPIM.ERUK	= Overseas wholesale prices in sterling terms
XGMA	= Manufactured export volume

Appendix A

Summary of real and nominal exchange rate variability/risk measures (VAR_t)

CODE	DEFINITION	VAR_t
	(a) Measures based on weighted averages of bilateral nominal exchange rate variabilities (IMF MERM weights)	
	The measure of variability used is:	
A1	Mean of the absolute percentage first differences of the 12 monthly observations over the past year (averaged over the current quarter)	$\left[\sum_j w_j \left[\sum_{i=0}^{n=11} \left\|(S_{jt-i} - S_{jt-i-1})/S_{jt-i-1}\right\| /n+1\right]\right] * 100$
A2	Mean of the absolute percentage first differences of the 8 quarterly observations over the past two years	As above (n = 7)
A3	Absolute percentage deviation of the current monthly observation from a 7 period centred moving average (averaged over current quarter)	$\left[\sum_j w_j \left\|(S_{jt} - \bar{S}_j)/\bar{S}_j\right\|\right] * 100$ where $\bar{S}_j = (\sum_{i=-3}^{n=3} S_{jt-i})/2n + 1$
A4	Absolute percentage deviation of the current quarterly observation from a 7 period centred moving average	As above
	(b) Measures of nominal exchange rate risk	
B1	Ex ante forecast error. Average absolute percentage deviation of the monthly bilateral exchange rate observations 1, 2 and 3 periods ahead from an ex ante trend calculated over the past 9 monthly observations. The forecast errors for each period are then averaged and the resulting bilateral "risk" series weighted together using MERM weights (and averaged over the quarter)	$\left[\sum_j w_j \left[\sum_{i=1}^{n=3} (S_{jt} - \bar{S}_{jt-i}) / S_{jt-i}\right] /3\right] * 100$ where $\bar{S}_{jt} = (\sum_{i=0}^{8} S_{jt-i})/9$
B2	Forward exchange rate risk (one month forward). The absolute percentage difference between the average observed spot exchange rate and the average quarterly $/£ forward exchange rates 30 days earlier	
B3	Forward exchange rate risk (two months forward). The absolute percentage difference between the average observed spot exchange rate and the average quarterly $/£ forward exchange rates 60 days earlier.	

CODE	DEFINITION	VAR_t
	(c) Measures of real exchange rate variability	
C1	Relative costs. Mean of the absolute percentage first differences of the 8 quarterly observations over the past two years	$\left[\sum_{i=0}^{n=7} \left\| (R_{t-i} - R_{t-i-1}) / R_{t-i-1} \right\| \right] /n + 1 \quad * 100$
C2	Relative wholesale prices. Mean of the absolute percentage first differences of the 8 quarterly observations over the past two years	As above
	(d) Measure of world currency variation	
D1	Weighted average of the absolute percentage deviationsof the current quarterly effective exchange rates of the major manufacturing countries from a 7 period centred moving average (weighted together using 1975 world trade shares, v_j)	$\left[\sum_j v_j \left\| (E_{jt} - \bar{E}_j)/\bar{E}_j \right\| \right] * 100$ where $\bar{E}_j = \left(\sum_{i=-n}^{i=n} E_{jt-i} \right)/(2n + 1)$ (n=3)

Footnotes

S_j jth country's exchange rate against sterling

E_j jth country's effective exchange rate

R appropriate real exchange rate

w_j IMF MERM weights (Table 1)

v_j 1975 world trade share weights

Results of Covariance Procedure

Correlation matrix

Variability proxy		A1	A2	A3	A4
(a) Nominal exchange rate variability	A1	1.00	0.75	-0.14	-0.10
	A2	0.75	1.00	0.06	0.05
	A3	-0.14	0.06	1.00	0.60
	A4	-0.10	0.05	0.60	1.00
(b) Nominal exchange rate risk	B1	0.01	0.12	0.68	0.60
	B2	0.23	0.48	0.29	-0.05
	B3	0.17	0.34	0.31	-0.10
(c) Real exchange rate variability	C1	0.17	0.32	-0.13	-0.08
	C2	0.38	0.54	-0.09	0.01
(d) Measure of world currency variation	D1	-0.16	-0.11	0.36	0.32

		B1	B2	B3
(a) Nominal exchange rate variability	A1	0.01	0.23	0.17
	A2	0.12	0.48	0.34
	A3	0.68	0.29	0.31
	A4	0.60	-0.05	-0.10
(b) Nominal exchange rate risk	B1	1.00	0.43	0.39
	B2	0.43	1.00	0.86
	B3	0.39	0.86	1.00
(c) Real exchange rate variability	C1	-0.24	-0.15	-0.21
	C2	-0.23	-0.10	-0.25
(d) Measure of world currency variation	D1	0.49	0.24	0.11

		C1	C2	D1
(a) Nominal exchange rate variability	A1	0.17	0.38	-0.16
	A2	0.32	0.54	-0.11
	A3	-0.13	-0.09	0.36
	A4	-0.08	0.01	0.32
(b) Nominal exchange rate risk	B1	-0.24	-0.23	0.49
	B2	-0.15	-0.10	0.24
	B3	-0.21	-0.25	0.11
(c) Real exchange rate variability	C1	1.00	0.81	-0.16
	C2	0.81	1.00	-0.23
(d) Measure of world currency variation	D1	-0.16	-0.23	1.00

Appendix B

Lag length tests

1 Manufactured export volume equation

Restriction (a)	F-test	F (R, T-K)
(11, 10)	0.5579	(1,22)
(10, 9)	0.0379	(1,23)
(9, 8)	0.8099	(1,24)
(8, 7)	0.5573	(1,25)
(7, 6)	3.0576	(1,26)
(6, 5)	5.6230	(1,27)

2 Manufactured export price equation

Restriction	F-test	F (R, T-K)
(5, 4)	0.3502	(2,23)
(4, 3)	1.3130	(2,25)
(3, 2)	3.6745	(2,27)

(a) (i + 1, j + 1) where i is the longest lag on the unrestricted form
j is the longest lag on the restricted form

Appendix C Stability tests 1978 - 1981

Manufactured export volumes

$TWIP_t$	$\sum_{i=0}^{5}$ (UXGM /WPIM.ERUK)$_{t-i}$	$XGMA_{t-1}$	CNST	RSS	SE	$\bar{R}^2$	Estimation period
0.3959	-0.0251	0.7366	0.2278	0.0066	0.018	0.93	1973 I - 1978 IV
(3.1)	(0.2)	(9.7)	(0.4)				
0.3853	-0.0686	0.7174	0.8660	0.0094	0.020	0.93	1973 I - 1979 IV
(2.9)	(0.7)	(8.9)	(1.9)				
0.4864	-0.1640	0.6735	1.1955	0.0119	0.021	0.92	1973 I - 1980 IV
(3.7)	(2.3)	(8.3)	(3.1)				
0.4889	-0.1374	0.6573	1.1962	0.0151	0.022	0.91	1973 I - 1981 IV
(3.5)	(2.3)	(8.0)	(2.9)				

Appendix D Stability tests 1978 - 1981

Manufactured export prices

$WPIM.ERUK_{t-1}$	$COST_{t-1}$	POD_t	$UXGM_{t-1}$	CNST	SE	RSS	$\bar{R}^2$	Estimation period
0.0446 (0.6)	0.3526 (3.8)	0.1759 (1.9)	0.6089 (8.5)	0.0274 (0.6)	0.011	0.0022	0.99	1973 I - 1978 IV
0.0888 (1.9)	0.2949 (4.1)	0.0925 (1.2)	0.6194 (8.9)	0.0354 (0.8)	0.011	0.0027	0.99	1973 I - 1979 IV
0.1162 (3.3)	0.2979 (4.7)	0.1504 (2.2)	0.5944 (8.9)	0.0127 (0.3)	0.011	0.0031	0.99	1973 I - 1980 IV
0.1169 (3.8)	0.2851 (5.0)	0.1546 (2.5)	0.6057 (9.9)	0.0162 (0.4)	0.010	0.0032	0.99	1973 I - 1981 IV

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