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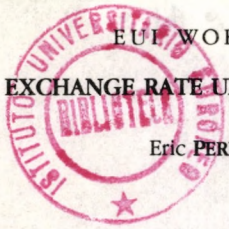

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EXCHANGE RATE UNCERTAINTY AND FOREIGN TRADE

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Abstract

This paper starts with reviewing the existing literature on exchange rate uncertainty and trade flows. It then argues that potential costs of medium term uncertainty in exchange rates and competitiveness are likely to be much larger than that of exchange risk which has been the focus of the existing literature. Two measures of medium term exchange rate uncertainty are constructed. One is a weighted function of the magnitude of past movements in nominal exchange rates and the current deviation of the exchange rate from 'equilibrium', while the second depends on both the duration and the amplitude of misalignment from 'equilibrium' exchange rates. The empirical evidence reported in the paper suggests that when exchange rate uncertainty is defined over a medium term period it does affect adversely trade flows of the industrial countries under review, with the notable exception of the United States.

1. Introduction.

Initial proponents of flexible exchange rates stressed the gain of an additional degree of freedom as compared to fixed exchange rates. Flexible rates were seen as taking care of balance of payments equilibrium allowing policy to operate on domestic objectives without being constrained by external factors. Any perturbation in the rest of the world (ROW) was thought to be offset in the exchange market thus insulating each economy from shocks in the ROW. This proposition, while never correct in its extreme form, relies heavily on maintained purchasing power parity (PPP). Experience has shown, however, that departures from PPP under flexible exchange rates are regular phenomena, which can be of long duration and of large amplitudes. Even worse, exchange rates cannot be relied upon to always contribute to reducing PPP gaps. As Dornbusch (1976) and others have demonstrated exchange rates may overshoot and contribute, rather than always amortize, "misalignment".

As long as exchange rates follow closely PPP there is not more uncertainty in foreign trade than in domestic activity. However, with misalignments foreign trade is exposed to uncertainty additional to the unavoidable one created by relative price and aggregate demand variations.

This paper focuses on exchange rate uncertainty[1] and its possible effects on foreign trade, and therefore resource allocation. There exists already a sizeable and growing literature in this field. Why, therefore another paper ? For one, because the literature, synthetised in section 2, is not conclusive. Most research is unable to demonstrate empirically a significant relationship between variations in exchange rate risk and foreign trade. The reason might be, and this is the second motivation for this paper, that most researchers have focused on short term exchange risk instead of long

term uncertainty. Short term risk can easily, albeit not costlessly, be hedged in financial markets, through appropriate asset-liability management, and in particular in forward exchange markets.[2]

It is much more difficult to hedge risk beyond a one year horizon as forward markets are virtually nonnexisting for periods beyond one year, and as exchange needs are not known with precision. Thus, the question whether to invest and augment export capacity at a time when the exchange rate is undervalued on the basis of some imperfectly known stochastic equilibrium rate, relates to medium-run uncertainty which needs to be faced and cannot be hedged at low cost. This uncertainty appears to be the appropriate concept on which this paper is centered.

The next section reviews the available literature and assesses critically its relevance, thereby placing the current research in perspective. Section 3 elaborates the methodology applied in section 4 to export performance of some selected industrial countries. The concluding section summarizes the main findings of the paper and discusses some avenues for further research.

2. The Existing Literature.

The simplest approach to incorporating a measure of risk into a foreign trade equation proceeds as follows. Consider a firm whose total output is exported and whose profit function is:

$$\tilde{\Pi} = (\tilde{p} - c) x , \qquad (1)$$

where $\tilde{p}=p^{*}.\tilde{e}$, p^{*} is the given world market price, e is the nominal

exchange rate and a ~ denotes a random variable. The export price in domestic currency is random if either p^* or e, or both, are random. Unit costs are assumed constant and denoted by c; the level of production is x. The utility function of the firm is assumed concave; for illustration take:

$$V(\tilde{\Pi}) = -e^{-\lambda\tilde{\Pi}} , \qquad (2)$$

where $\lambda>0$ measures absolute risk aversion. All assumptions so far only serve simplicity and can easily be relaxed: price-taking, specialization in export activity and even risk aversion. Concavity of the firm's utility function is all that is required.

If p is normally distributed then expected utility is:

$$EV(\tilde{\Pi}) = -e^{-\lambda(\mu_\pi - \frac{1}{2}\lambda\sigma_\pi^2)} , \qquad (3)$$

with $\mu_\pi = E(\tilde{\Pi}) = (E\tilde{p}-c)x$, and $\sigma_\pi^2 = E[(\tilde{p}-E\tilde{p}).x]^2 = x^2\sigma_p^2$.

In this notation σ_π^2 is the variance of profits and σ_p^2 the variance of export prices. Maximization of $EV(\tilde{\Pi})$ with respect to x yields:

$$x = (E\tilde{p}-c) \,/\, \lambda.\sigma_p^2 ,$$

or in logs,

$$\ln x = \ln \tfrac{1}{\lambda} + \ln (E\tilde{p}-c) - \ln \sigma_p^2. \qquad (4)$$

It is readily seen from (4) that an increase in either risk aversion or exchange risk reduces exports while an expected increase in profit margins stimulates exports.

Most empirical research is based on some version of equation (4). Since Farell (1983) and IMF (1984) have discussed extensively the literature available until the early eighties, we mainly concentrate our discussion on the most recent evidence.

Strict application of equation (4) in empirical estimations leads to approximation of exchange risk by the standard deviation of the relevant exchange rate. But as Arrow and Pratt have shown, identification of variance with risk is only consistent with the expected utility maximization hypothesis if either (i) the distribution of the random variable is completely characterized with its first two moments, restricted to finite values (the normal distribution) or if (ii) utility is function of only the first two moments. Exchange rates generally fail to be normally distributed according to Farber *et al.* (1977), Westerfield (1977), Coes (1981) Rana (1981), and Friedman and Vandersteel (1982).[3]

To overcome this problem Coes (1979) uses the stochastic dominance approach and derives a quantifiable index of risk based on higher moments of the probability distribution from which observations are drawn. While this approach is more general and not open to the mean-variance critique, it turns out that variance assumes a very large weight in these indexes and is therefore highly correlated with any index using higher central moments. These considerations reduces therefore the potential bias of analyses considering only the second central moment as proxy for risk.

Exchange rate variability can be measured by using either nominal or real exchange rates, and there are persuasive arguments to be made for the use of either of these concepts. The empirical literature can be divided along this distinction.

Akhtar and Hilton (1984a,b) approximate exchange risk with the standard deviation of a daily nominal effective exchange rate index for each quarter. They argue that this measure is a lower bound for the true exchange rate risk because ex-post variability is likely to understate ex-ante risk. They estimate volumes and prices of both exports and imports of manufacturing for Germany and the United States over the period 1974I-81IV, including lags up to eight quarters on the real exchange rate and the variability indexes. Their estimations show a significant dampening effect on German imports and exports and US exports. Using various benchmarks for an evaluation of cumulative trade losses induced by the increased risk during 1977-81, they find that the trade loss ranges from 1 to 3 per cent for the United States and 2 to 14 per cent for Germany. However, Gotur (1985) has rejected the robustness of these results by extending the approach to other countries, modifying the sample period and the estimation techniques. Bailey *et al.* (1986) also use a proxy derived from nominal effective exchange rates and examine the evolution of aggregate export volumes for the seven main industrial countries. The distinguishing element in their analysis is the incorporation of real oil revenues of oil-exporting countries as an additional regressor. In none of their estimations is the exchange risk proxy significant.

The papers mentioned so far, like most of the studies published previously, focus on exporters concerned with revenues in home currency under the assumption that they will consider a variation in exchange rates as equivalent to a variation in foreign prices (neither risk can be hedged). If exchange risk can be hedged then foreign price variations are even a more serious problem. Some authors therefore devote their attention to real rather than nominal exchange risk. Cushman (1983) extends the Hooper-Kohlhagen (1978) approach by recognizing that both prices and exchange rates are random and he therefore focuses on real exchange rates. Expected real exchange

rates are assumed stabilizing to close PPP gaps. The standard deviation of these expectations are used as a proxy for real exchange risk. His estimation of bilateral trade flows among industrial countries provide some support for a negative effect of real exchange rate risk on trade flows. In a more recent paper, Cushman (1986) examines the robustness of his previous results and concludes that they are not significantly altered with the extension of the sample period.

Cushman examines an additional question which is of considerable interest. Since the advent of floating exchange rates, variability among the major currencies has increased considerably. It could conceivably be argued that the relative variability between more than two currencies could play a role in affecting the pattern of bilateral trade flows. Consider as an example the case of a potential exporter of country A who sells to countries B and C. Exchange rate variability increases against the currencies of both B and C but the increase is smaller vis-a-vis country B. This means that the relative risk of exporting to country B as compared to exporting to country C is reduced and that one cannot rule out the possible redistribution of exports toward country B even in the case of increased bilateral exchange risk. Therefore, in the case of bilateral trade flows omission of third-country exchange risk may show a positive influence of exchange risk because of an underlying change in the geographical pattern of trade resulting from variation in relative exchange risk. The empirical evidence supports this argument and in all estimations the third-country effect plays a role. This helps to explain why some researchers have found a rather puzzling positive association between bilateral trade flows and bilateral exchange rate risk.

Ex-post measures of exchange rate variability do not discriminate between anticipated and unanticipated changes in exchange rates. Given the poor forecasting accuracy of exchange rate models [Meese and

Rogoff (1983), among others], this is probably not a severe drawback. Kenen and Rodrick (1986) construct proxies of exchange risk depending on forecast errors from simple time-series models of real exchange rates (AR(1) processes and log-linear trends). On the whole, their results support the hypothesis of a deterring effect of increased exchange rate risk on aggregate trade flows.

As is well known from the literature on international price dynamics [e.g. Steinherr and Morel (1979), Flood (1986), Dornbusch (1987)], exchange rate changes do not affect uniformly prices of traded goods. Market structures, industrial concentration, share of fixed costs in total costs, share of production exported, stockability of output to name a few key elements play a crucial role. Coes (1979) presents evidence that the effects of exchange risk are not uniform across sectors in the case of Brazil for the period 1958-75. In a more recent study, Maskus (1986) examines this issue in the case of the United States. His results support the twin hypotheses of negative and non uniform influences of exchange risk on sectoral trade flows. In addition, the differences in responses closely correspond to structural differences, i.e. the less concentrated, the less 'multinationalized', and the more open the sectors are, the more they are affected by exchange risk.

De Grauwe and de Bellefroid (1986) adopt a radically different approach from all other papers. They retain a long run measure of exchange risk and use it in cross-data analysis of bilateral trade flows among the ten major industrial countries for the fixed exchange rate period 1960-69 and for the flexible exchange rate period 1973-84. Exchange risk is measured by the standard deviation of the yearly growth rates of exchange rates around the mean for each periods. Alternatively, the mean absolute change is used. The major finding of the paper is that independant of the measure employed, long run exchange variability explains about 20 to 30 per cent of the decline

of growth of international trade among industrialized countries during the flexible rates period.[4]

Cross-section analysis has advantages such as structural differences (e.g., influences of membership in regional trade associations). It has, however, also serious shortcomings. Risk as approximated by the standard deviation for a period of ten years, say, is an ex-post measure that may never have been relevant for decision-makers.

This survey of the recent contributions to the literature demonstrates a number of shortcomings and difficulties.

First, all contributions belong to a partial equilibrium world in which risk is restricted to foreign prices. The covariance structure of different random variables is therefore neglected. This is a serious drawback as domestic prices and financial returns are likely to be correlated with foreign prices.

Second, the measure of risk itself is an unresolved difficulty. As argued before short run measures may be less relevant than long run ones. In either case decisions are influenced by expected variability and not past variability. Whether variability is a good proxy will be discussed in more detail in the next section.

Third, most of the empirical research postulates a linear or log-linear relationship between risk and trade. It is however more likely that this relationship is non-linear.

Fourth, aggregate trade equations neglect industrial structure and market structure. Time series estimation on an aggregate basis is therefore likely to suffer from a variable underlying structure.

3. Proposed Methodology.

It is of course always simpler to point out shortcomings than to offer solutions. This paper focuses on the problem of approximating meaningfully exchange rate uncertainty without tackling other shortcomings. In particular, the approach in this paper remains partial equilibrium and assumes unchanged underlying structure.

Our rejection of using the variance of exchange rates as a proxy for risk is motivated by considerations other than those discussed in the previous section. In view of our interest in long run uncertainty we have to find a measure for projections several years into the future. Variances over past periods are of very limited relevance for appreciating uncertainty over periods of several years in the future. Given the impossibility of long run misalignment forecasts and our ignorance of the distribution function governing nominal and real exchange rates we are in fact in a Knightian world of uncertainty rather than risk.[5] This state of affairs is not limited to the flexible exchange rate period. Even with fixed but adjustable exchange rates long term forecasts of devaluation or of real exchange rates changes suffer from similar difficulties and historical measures of variability are of no use and are perfectly arbitrary.

We are therefore led to look for measures that are able to capture uncertainty on the basis of historical experience. Some arbitrariness is unavoidable although it is difficult to compare degrees of arbitrariness with more traditional measures. The only basis for evaluation will be empirical usefulness.

We experiment with two alternative measures, both variations on a common theme. Consider the measure:

$$V_t = V_t^1 + V_t^2 = \frac{\text{MAX } X_{t-k}^t - \text{MIN } X_{t-k}^t}{\text{MIN } X_{t-k}^t} + \left[1 + \frac{|X_t - X_t^p|}{X^p} \right]^2, \quad (5)$$

where X_t is the nominal exchange rate at time t; MAX X_{t-k}^t and MIN X_{t-k}^t refer to maximum and minimum values of the nominal exchange rate over a given time interval of size k up to time t; and X_t^p is the 'equilibrium' exchange rate.

Our empirical work uses annual data for the period 1960-85. Maximum and minimum values are either computed for periods t-1960 or for 10, 5, and 3 years back, the shorter the time interval the more rapid is the decay of memory. Our estimation results suggest that decay is significantly (in a statistical sense) more rapid in some countries (e.g. Belgium) than in others but we are unable to offer a theoretical explanation. For this reason only the results for a uniform ten years horizons are discussed in section 4.

V^1 captures accumulated experience. Instead of assuming that uncertainty at time t is approximated by variance or the mean absolute change at time t-1 we postulate that the largest spread observed over some relevant past period is conditioning uncertainty. For example, if the exchange rate in t-1 remains constant but had achieved in previous years a record fall or rise then we postulate that agents will not have high confidence in exchange rate stability. Thus, while the deep fall of the dollar from 1970 until 1979 was certainly not anticipated, as agents were conditioned by this experience of relatively stable exchange rates during the sixties, progressively exchange rate movements of such magnitudes were not seen as improbable for the future: hence, uncertainty increased.[6]

V^2 adds more recent information to the historical component V^1. It postulates that as misalignment grows linearly uncertainty increases exponentially. While V^1 is clearly a proxy for uncertainty so that V^1 is expected to be negatively correlated with trade, the interpretation of V^2 is less clear. V^2 may proxy uncertainty but may also capture nonlinear responses of misalignment. If the second interpretation dominates then the correlation of V^2 with trade can be positive or negative.

A drawback of measure V is that it does not incorporate the duration of misalignment. It could be argued that uncertainty increases when both the degree and duration of misalignment increase. A proposed second measure of uncertainty designed to capture this effect uses the integral of misalignment over a relevant past period:

$$U_t = \left[\sum_{i=t-10}^{t} \frac{| X_i - X_i^* |}{X_i^*} \right] \cdot \left[1 + \sum_{i=t-k}^{t} \frac{| X_i - X_i^* |}{X_i^*} \right]. \qquad (6)$$

The first term is the sum of the absolute values of exchange rate disparities over the ten years preceding t. To give more weight to recent periods the first bracket is multiplied with the second bracket that contains the same integral over a shorter period of time. In the empirical work we have used k=5.

Whilst in measure V only current misalignment is taken into account, in combination with nominal exchange rate movements, measure U focuses on misalignment (past and present). The measure of misalignment becomes therefore crucial. Unfortunately there is no generally accepted measure but, in order to go beyond simple deviations from PPP, we prefer to use a more sophisticated approach for the computations of the equilibrium exchange rate X^*. During the fixed exchange rates period we assume that PPP provides a reasonable

basis for equilibrium exchange rates. Most of the structural shifts have indeed occurred during the flexible exchange rate period. For the flexible rate period equilibrium exchange rates are approximated by a trend passing through the 1970 value of the previous trend and the equilibrium rates in 1984 as computed by Williamson (1985, p.82).[7]

Table 1 presents the numerical values of V and U on a bilateral basis for each currency against the US dollar. The numerical values of the uncertainty proxies V presented in the tables are computed with a decay of memory of 10 years. Table 2 provides the same measures with effective exchange rates. Opposite movements of two bilateral exchange rates would at least partly offset each other in the measure of uncertainty based on effective exchange rates. In the limit, the effective exchange rate could be stable in spite of movements in bilateral rates and therefore in uncertainty in each market. If exporters are unable to shift resources costlessly across markets uncertainty as measured by the effective rate would be downward biased. A weighted average of bilateral uncertainty, by contrast, may result in an upward bias if resources can be shifted across markets at a low cost. Table 3 lists the results based on such a measure (in the spirit of the concept of effective variation proposed by Lanyi and Suss (1982)).

The general intuition seems to be that exchange rate uncertainty has reached record levels in the 1980s. The proposed measure U is indeed coherent with this intuition. By contrast, measure V deviates from the expected time profile: three countries in the sample reach a maximum for the uncertainty during 1978-1980. To see whether the measure V is yielding reasonable results or not we interpret in more detail the case of the DM-dollar rate on the basis of measures V and U, breaking the former into its components V^1 and V^2.

Graph 1 reproduces the market price of the dollar in deutchemark and V^1. The maximum for V^1 is reached in 1980 because between 1970 and 1980 the dollar depreciated continuously from about DM 4 to a level below DM 2. The fact that agents experienced for the first time since the begining of the Bretton-Woods system such a massive and uninterrupted depreciation demonstrated the real possibility -unexpected previously- of drastic exchange movements. It seems quite intuitive to argue that uncertainty reached an unprecedented level as there was no obvious floor for the dollar and, at the same time, the possibility of a U-turn. Graph 2 shows indeed that the deviation from PPP also reached a maximum in 1980 building up pressures for correction.

During the subsequent period of dollar appreciation both V^1 and V^2 declined sharply. V^1 declined because our 10 year memory eliminates gradually the initial high levels of the dollar whilst the recently achieved minimum remains in memory. This can be interpreted quite reasonably: although a strong dollar appreciation was considered possible the exchange rate prevailing during the early seventies were increasingly dismissed as relevant ceilings. As to V^2 a gradual reduction of the PPP gap lowered the rational expectations of exchange rate movements from a long-run equilibrium perspective. V^1 increases again after 1984 when the dollar reached a new maximum over the previous ten years. Will the dollar pursue its appreciation or is it only temporarily overshooting ? The further the dollar appreciated the wider became the range of possible future dollar movements. V^2 attenuates the contribution of V^1 because until 1984 the PPP gap was gradually closed. Of course, this raises the question whether the PPP gap is properly measured (we assumed parity in 1960 and neglect structural shifts) and whether PPP is at all the relevant concept.[8]

Measure U is depicted in graph 3 together with the dollar rate and the equilibrium rate based on Williamson's computations for

1971-1985. PPP and Williamson's measures yield very different equilibrium rates. In addition, nominal exchange rate gyrations play no role anymore. Uncertainty reaches a first maximum in 1980, before reaching a second maximum at an even higher level in 1985. The reason is clearly that Williamson's calculations result in an equilibrium exchange rate for 1984 at about DM 2 so that the dollar is overvalued by 50 per cent in 1985, whereas our PPP computations, used in the V^2 measure, yielded an equilibrium rate close to the market rate in 1985. Therefore, wheter measure V or U is to be prefered depends to a considerable extent on one's view of what equilibrium rate are, and whether nominal or only real rates matter. Both questions have not received definite answers in the literature and hence these ambiguities are also reflected in our proposed measures.

An interesting piece of information is provided in Graph 4 where the weighted average of bilateral uncertainties (as measured by the σ proxy) of the United States, United Kingdom, Belgium, and Germany are disaggregated by geographical areas. While uncertainty has generally increased over time for all areas, the increase has been much less dramatic for areas with relatively high internal trade intensity. Due to European monetary cooperation (Snake and EMS) uncertainty of the Belgian and German exchange rate vis-a-vis other European currencies has increased only moderately, as compared to the Japanese Yen and the Canadian and US dollars. The same holds for the US dollar against the Canadian currency. The relatively independent floating strategy adopted by the British authorities reflects itself in a marked increase of our uncertainty proxy against all areas. Barr (1984) and Maskus (1986) provide some evidence that this was generally the case for shorter term volatility as well. For comparison Graph 5 provides computations of disaggregated variability of real exchange rates for the same sample of countries.[9] The fact that only a small part of trade relations is subject to large exchange rate risks may explain

some of the lack of consistent effects in risk in empirical tests.

As an additional piece of information, table 4 presents the geographical pattern of trade of the three main industrialized blocks. It is readily seen that they are markedly different. Even when one neglects intra-EEC trade, one can see that most of European exports are shipped to other European countries. In the case of the United States the EEC as a whole is the main trading partner but Canada is the single country to which the United States export most in absolute numbers. Among major trading nations, only Japan has been unable sofar to join a currency area or to create a Yen zone. With respect to trade with LDC, each area has its privileged markets.

An additional comment on market and production structure is in order. Once allowance is made for imperfect competition the effect of exchange rate uncertainty will depend on strategic behavior of firms (Owen and Perrakis (1986)). The structure of firms and the type of goods produced will also play a decisive role in the transmission mechanism of exchange rate changes and of uncertainty as has been recently emphasized by Flood (1986a), and Lipsey and Kravis (1986). Moreover, foreign trade is for all firms a way to diversify their risks, and even if external trade may entail some risk it is not a priori clear whether this additional risk will be of such magnitude that it will prevent them from increasing or even holding their level of activity with foreign countries, especially when the domestic environment becomes more uncertain (Willett (1986)).

4. Empirical Results.

We have estimated export equations on an aggregate and on a bilateral basis. The general functional form is quite traditional:

$$E_t = \alpha_0 + \alpha_1 . Y_t^* + \alpha_2 . R_t + \alpha_3 . W_t + \alpha_4 . T_t + \zeta_t \ ,$$

where E_t is exports deflated by exports unit values; Y_t^* is a proxy for world demand (volume of world trade) in aggregate export equations and US GNP is used in equations for exports to the United States; R_t is the real exchange rate; W_t is the uncertainty proxy, measured either by V_t or U_t; T_t is the terms of trade or the ratio of export prices to GNP deflator as proxies for supply effects; ζ_t is the error term with the usual Gaussian properties assumed. All variables are in logs except the uncertainty proxies and the dummy variables introduced in some equations. Appendix C provides a complete data description.

The countries retained in the sample are the United States, Japan, and the United Kingdom as examples of major countries with flexible exchange rates; Germany and Belgium represent a large and a small member of the EMS. We have used annual data for the period 1960-1985, even if some have argued [i.e. Kenen and Rodrik (1986)] that tests of exchange rate uncertainty should be restricted to the flexible exchange rates era. This is a convincing argument when one analyses short run exchange risk. But when the focus is on long run exchange rate uncertainty this does not hold anymore. Fixed adjustable parities are not free of exchange rate uncertainty, and therefore we do not focus exclusively on the flexible exchange rate period.

By construction the uncertainty variable does not require lags while other explanatory variables are known to exert their influence over periods exceding one year. With the exception of the real exchange rate which has been systematically lagged by one year, we have abstained from adding lagged variables, given the usual arbitrariness of the procedure and the limited degrees of freedom

available.

Tables 5 and 6 present the estimation results for yearly aggregate export volumes with the uncertainty proxies V and U, respectively. For both uncertainty variables estimations were made with the variable computed from effective exchange rates and from a weighting of bilateral exchange rates. In all cases, real exchange rates and uncertainty proxies have been computed with wholesale prices.[10]

Several features common to all regressions merit a comment. Our measures of exchange rate uncertainty are not orthogonal to other explanatory variables. For example, increased worldwide uncertainty is expected to have a negative effect on world trade, a regressor in aggregate export functions, and therefore on real income in major trading countries, such as US GNP, the scale variable in bilateral export equations. In other words, exchange rate uncertainty is not a truly exogeneous variable but a function of macroeconomic fundamentals. In few cases this induces relatively high correlation between estimated coefficients. This fact, which is not rejoicing but not fatal either, is bound to exist in this kind of partial equilibrium analysis. We are not entitled to attribute too much precision to the estimated coefficients, but the rather consistent significance of the uncertainty variable suggests that uncertainty does play a role. Neglect of the uncertainty variable would attribute to demand and price elasticities a dimension which does not belong to them.

Looking more closely at the estimation results of tables 5 and 6, one observes that demand and price elasticities are rather reasonable in size and across countries. Their order of magnitude is close to the values usually found in similar analyses. In some cases, the coefficient of the supply proxy has not the a priori expected sign.

Inspection of the time profile of this series indicates clearly that a negative sign should not be surprising, as it can be traced back to the effects of the two oil shocks of the seventies on the terms of trade.

Depending on the way the uncertainty variable is defined results change somewhat but not in a dramatic way. In the case of the United States the uncertainty variables are never significant and very far from reaching any conventional level of significance.

The reasons for this asymetry do not seem to be econometric but rather economic and we attempt some conjectures. One plausible explanation is related to the fact that the overwhelming share of American exports is invoiced in US dollar and that therefore most of the uncertainty is borne by the buyers of American goods. Of course, if the exporter is able to transfer the risk to the buyer by invoicing in his own currency, one would reasonably expect that the latter will seek to get some compensation, i.e. price reductions, for bearing this risk. If this is the case profitability of exports and therefore supply will be reduced. But this effect should be captured by price variables. In other terms, there may be a negative covariance between uncertainty and export prices. Another argument is that US companies are more diversified, and above all benefit from a very large domestic market which permits them to compensate more easily exchange rate uncertainty.

Estimations for the other countries yield in most cases significant negative coefficients for the uncertainty variables. In the regressions for the United Kingdom, we have introduced a dummy variable to capture the effect of oil exports. As already said there are some collinearity problems: in the UK case when we use *UBB* (as can be seen from the change of the value of the constant term), and in the German equation when uncertainty is measured by *V*. The Belgian

equation with *VBE* is also affected by collinearity between the constant, the real exchange rate and the uncertainty proxy; this explains the very large absolute value of the coefficients of these variables. On the whole estimations perform reasonably well and there is no severe problem of autocorrelation of the residuals. With the exception of US exports, uncertainty appears to affect exports negatively.

Turning our attention to bilateral trade flows, that is exports to the United States as reported in Tables 7 and 8, we see that demand and real exchange rate elasticities increase significantly as is to be expected.

A comment is in order before we go to a more careful examination of the results. Deflation of bilateral exports poses a problem as export unit values are not available on a bilateral basis. Most researchers deflate by aggregate exports unit values [for an exception see Hooper and Kohlhagen (1978)]. We choose to deflate exports to the United States by US import values. This choice is motivated by the assumption of the law of one price and the fact that the structure of US imports covers better the structure of exports to the United States of the countries in the sample than their export unit values would do. As a glance at Table 4 indicates, for no country in our sample is the US the predominant market; it is therefore plausible to expect a greater homogeneity of price behavior of exporters in the US market than of price behavior on all export markets for each country.

We have used two measures for real exchange rates, a multilateral and a bilateral one. In most cases price elasticity increases when the effective exchange rate is used, with the notable exception of Japan. This results is due to the fact that the United States have a very large share in the weighting of the Yen's effective exchange rate (see Appendix A).

Unlike for aggregate exports, the supply variable has the expected coefficient in all equations except in the German case. For the latter we have used the ratio of export prices to GNP deflator rather than the terms of trade which generated a serious problem of serial correlation of the residuals. The UK equations are only reported to witness the problem we have had with estimation. A look at Tables 7 and 8 shows that all coefficients are unstable and the results rather meaningless.

On the whole, the empirical evidence based on exports to the United States supports the intuition that as uncertainty increases, trade flows are discouraged. The evidence is less clear-cut in the case of Japan. However, it should be noted that the elasticity of the real exchange rate increases substantially in those equations for Japanese exports to the United States where the uncertainty is statistically not significant.

5. Conclusions.

Experience with flexible exchange rates has reopened the debate on whether exchange rate uncertainty or variability may dampen external trade. Unlike most of the literature which has focused on short term exchange risk we have examined this question in a medium term perspective. The reason for adopting this perspective is rather obvious. Even if short term volatility implies risk there are many possibilities for industrial corporations to cope with it. By contrast, changes in competitive positions lasting for periods of several years are more difficult to hedge.

The empirical evidence reported in the paper suggests that

exchange rate uncertainty exercises negative effects on the volume of trade among industrial countries and, therefore, may have non negligible effects on the allocation of resources. However, in the case of the United States, our measures are never significant at any conventional level for reasons relating to specific features of the US economy.

Our results should nevertheless be considered as only tentative because there remain obviously many question marks waiting for further research.

First, of our measures of uncertainty none consistently dominates the other. Therefore we have not come up with "the" proper measure of uncertainty. However, both measures have one thing in common: the importance of exchange rate movements in the past (whether nominal or real) over a relatively long period of time. This result should not be a surprise: in the absence of observable frequencies agents need to form subjective probabilities and there cannot be, by definition, a uniform and stable process. Our two basic measures of uncertainty differ mainly in the weights attributed to real misalignment and to nominal exchange rate swings. As evident from the existing literature no firm grounds exist for eliminating one for exclusivity of the other. All empirical measurement issues, such as choice of price variables for PPP or uncertainty of effective rates as compared to weighted uncertainties of bilateral rates, turned out to be of secondary importance. In addition, the extent to which traders face uncertainty depends among other on structural characteristics such as market power, product and market diversification, and the availability of a vehicle currency. The effects of uncertainty in export equations can therefore be expected to vary significantly from country to country and even the most useful measure of uncertainty is not likely to be the same for all countries.

Second, the question of whether global world trade or only its geographical distribution is affected by protracted exchange rate swings should be adressed carefully. Furthermore, as pointed out by McCulloch (1983) and Willett (1986), an interesting question is to analyze simultaneously the impact of the increase of both exchange risk and domestic risk on the allocation of resources in industrial countries. Such an extension would, however, require a much more comprehensive general equilibrium approach and incorporation of financial markets.

Finally, the yardstick we have used to measure exchange rate uncertainty is somewhat arbitrary. It would be interesting to extend our approach by working with conditional variability and it may be useful to distinguish between transitory and permanent changes in the exchange rates. These extensions would make the analysis more general and allow for changes in underlying fundamental equilibrium exchange rates and economic policy conditions.

Footnotes.

[1] As will become clearer in subsequent parts of the paper we use the term uncertainty to emphasize our attention on medium term swings in real exchange rates as opposed to exchange risk which generally refers to short term variability.

[2] There exists an ample amount of evidence showing the adoption by industrial corporations of more aggressive financial management to cope with short term exchange risk. The phenomenal increase in turnover in forward exchange markets and the burgeoning of foreign exchange option markets over the last decade witness this fact. Group of Thirty (1986) provides a careful description of how large business corporations have adjusted to cope with short term exchange risk.

[3] The question of whether statistical considerations should prevail over more intuitively meaningful economic considerations or not is debatable. See for example Brodsky (1984) and Rana (1984) for diverging views on this point.

[4] Furthermore, in their estimations measures of short term variability of either nominal and real exchange rates are never significant.

[5] As convincingly argued by LeRoy and Singell (1987), Knight's distinction between risk and uncertainty is not different from the modern distinction between objective and subjective probability. When the distribution function can be verified through empirical observation or experimentation markets for insuring risk become available. When this verification is not possible insurance markets cannot develop and agents will have to rely on their subjective probabilities. This is the sense in which we use the term uncertainty.

[6] In a world where inflation rates permanently diverge between countries and nominal exchange rates adjust so as to maintain PPP, our measure will overstate uncertainty. It can nevertheless be argued that the likelihood of protracted misalignments is larger when required changes in the nominal exchange rates are larger. The introduction of decay of memory weakens the potential for the above criticism.

[7] Bilateral 'equilibrium' exchange rates derived from Williamson's study are given in Appendix B.

[8] PPP calculations obviously depend crucially on the base period. In the case of the US dollar any base period from the period 1960-1970 would leave V^2 unaltered. By contrast, any base year chosen from the second half of the seventies would show a massive overvaluation of the dollar in the sixties and therefore reverse completely the time profile of V^2. This is not limited to the DM-dollar rate but holds for all currencies vis-a-vis the dollar as shown by Lothian (1986). We have deliberately chosen not to search for different PPP base periods for each bilateral exchange rate in order to preserve internal consistency of the measure.

[9] Variability is measured by the coefficient of variation of real exchange rates over the previous twelve quarters.

[10] Estimations using the consumer price index as deflator for the computation of real exchange rates and of uncertainty proxies yield essentially the same results and are therefore not reported here.

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Appendix A.
Adjusted MERM's weighting Scheme

	U	K	B	D	F	G	I	N	S	C	J
U	-	.2918	.1790	.2970	.2547	.2521	.2287	.2184	.3023	.7067	.5513
K	.0589	-	.0233	.0882	.0465	.0555	.0559	.0363	.0000	.0214	.0460
B	.0284	.0479	-	.0223	.0554	.0565	.0335	.0725	.0261	.0115	.0215
D	.0163	.0130	.0155	-	.0131	.0191	.0107	.0222	.0140	.0085	.0122
F	.1176	.1230	.2071	.1033	-	.1938	.1983	.1571	.1304	.0512	.0899
G	.1514	.1669	.2555	.1388	.2253	-	.2521	.2283	.1657	.0554	.1461
I	.0869	.0851	.1020	.1294	.1761	.1451	-	.1363	.1127	.0423	.0496
N	.0377	.0569	.1028	.0432	.0468	.0708	.0411	-	.0337	.0159	.0291
S	.0197	.0355	.0215	.0140	.0258	.0411	.0304	.0162	-	.0089	.0157
C	.2359	.0179	.0136	.0558	.0340	.0199	.0236	.0355	.0433	-	.0386
J	.2472	.1620	.0797	.1080	.1223	.1461	.1257	.0772	.1718	.0782	-

Notes : 1. Country symbols are respectively : U=United States, K=United Kingdom, B=Belgium, D=Denmark, F=France, G=Federal Republic of Germany, I=Italy, N=The Netherlands, C=Canada, and J=Japan.

2. Each coefficient xy gives the share of the country x variable in the computation of country y effective variable.

3. Given that use a smaller sample than the original one all coefficients have been rescaled to add up to unity.

Source : ARTUS J.R. and A.K. McGUIRK, (1981), A revised Version of the Multilateral Exchange Rate Model, **IMF Staff Papers** 28(2), Table 7, pp.305-6.

Appendix B.
Bilateral 'Equilibrium' Exchange Rates (1984)

	U	K	B	D	F	G	I	N	S	C	J
U	1.	1.56	.023	.129	.152	.493	.00069	.424	.569	.83	.00557
K	.64	1.	.015	.082	.097	.316	.00044	.272	.365	.53	.00357
B	42.80	66.80	1.	5.510	6.490	21.090	.02960	18.140	24.370	35.70	.23800
D	7.78	12.13	.182	1.	1.180	3.825	.00539	3.294	4.425	6.49	.04330
F	6.59	10.28	.154	.847	1.	3.243	.00457	2.793	3.752	5.50	.03669
G	2.03	3.17	.047	.261	.308	1.	.00141	.861	1.157	1.69	.36690
I	14.43	22.52	.337	1.856	2.189	7.099	.01	.611	8.214	12.03	.08030
N	2.36	3.68	.055	.304	.358	1.161	.00164	1.	1.344	1.97	.01314
S	1.76	2.74	.041	.226	.267	.864	.00122	.744	1.	1.46	.00978
C	1.20	1.87	.028	.154	.182	.590	.00083	.508	.680	1.	.00668
J	1.80	2.80	4.200	.231	.273	.883	.12500	.761	1.023	1.49	.01

Notes : 1. Country symbols are respectively : U=United States, K=United Kingdom, B=Belgium, D=Denmark, F=France, G=Federal Republic of Germany, I=Italy, N=The Netherlands, C=Canada, and J=Japan.

2. Each coefficient XY indicates the number of units of currency of country X per unit of currency of country Y.
3. Williamson gives only the bilateral exchange rates of the British Pound, French Franc, German Mark, and Japanese Yen against the US Dollar. Other bilateral exchange rates were computed under the assumption that the equilibrium exchange rate of the Canadian Dollar vs. the US Dollar is 1.2 and that EMS central rates were at their equilibriumlevel in 1984.
4. Rows for Italy and Japan were divided by 100.

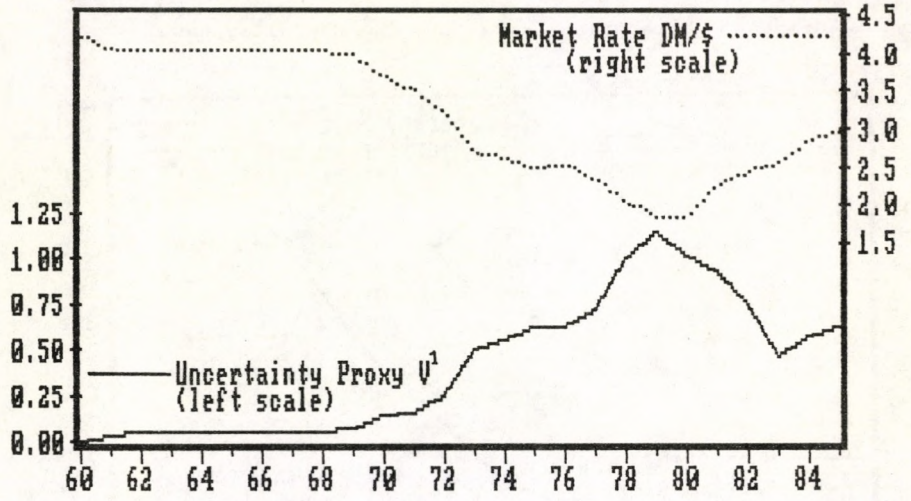
Source : WILLIAMSON J. (1985), **The Exchange Rate System**, (Institute for International Economics : Washington, D.C.), 2nd edition, Table 14.

Appendix C.
Data Definition and Sources

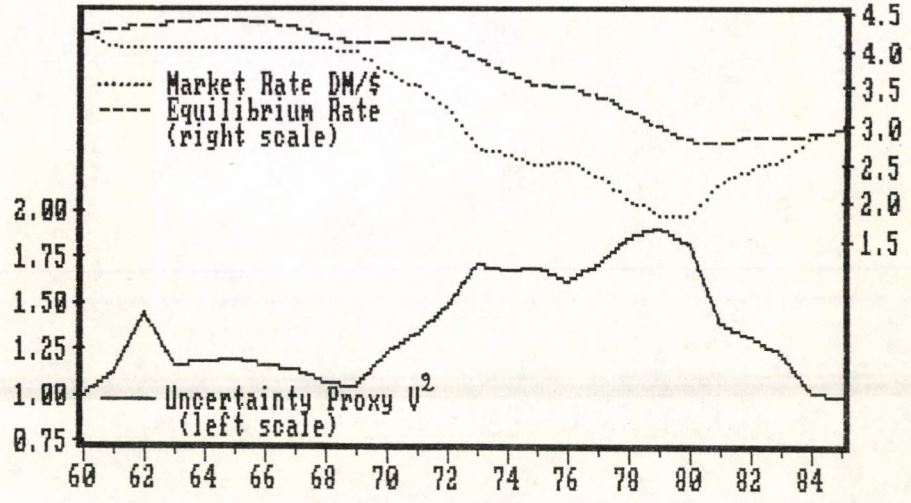
This appendix described the data and definitions employed in the empirical computations in the study. Unless in the case of bilateral exports to the United States, which are taken from **Direction of Trade Statistics** (IMF), all data are from **International Financial Statistics** (IMF). All variables except uncertainty proxies are indexed as 100 in 1980. All effective variables were computed with the weighting scheme derived from the MERM matrix of weights which is given in Appendix A.

LWT = Volume of world trade (Sum of line 001.70d divided by 001.74d and line 001.71d divided by 001.75d).
LUGNP = US GNP at constant prices (line 99ar).
LXV = Export volumes (line 72 of **IFS** for aggregate exports and Value of bilateral exports in US dollar from **DOTS** deflated by US import unit values in bilateral trade flows).
LREE = Real effective exchange rate (computed with exchange rate of line rf and wholesale prices of line 6.3).
LBRE = Real bilateral exchange rate vis-a-vis the US dollar computed with wholesale prices.
LPXPM = Ratio of export unit values (line 74) to import unit value (line 75).
DOIL = Dummy variable taking the value 1 from 79 on and 0 otherwise.
VBE = Uncertainty proxy as given by equation (5) with effective exchange rate (Table 2).
VBB = Idem but as weighted average of bilateral uncertainties (Table 3).
VBU = Idem vis-a-vis the US dollar (Table 1).
UBE = Uncertainty proxy as given by equation (6) with effective exchange rate (Table 2).
UBB = Idem but as weighted average of bilateral uncertainties (Table 3).
UBB = Idem but vis-a-vis the US dollar (Table 1)

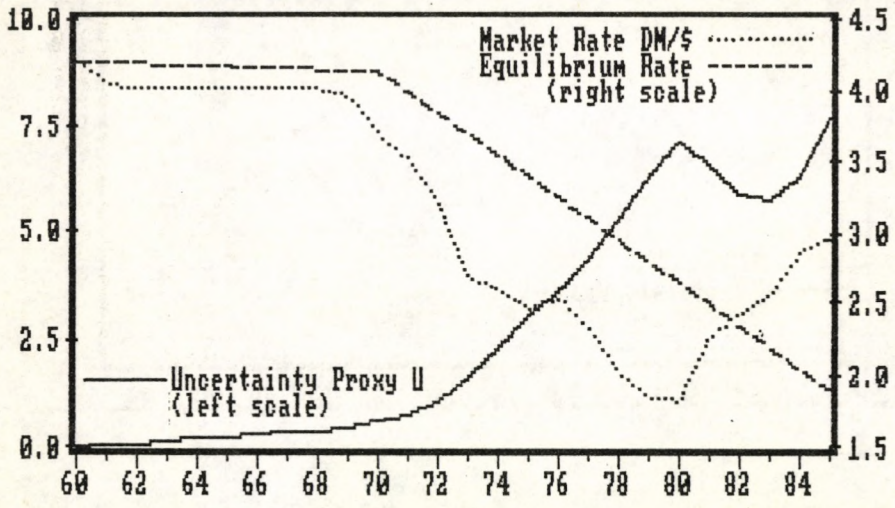
Graph 1. Uncertainty Proxy V^1 : The DM-dollar case.



Graph 2. Uncertainty Proxy V^2 : The DM-dollar case.

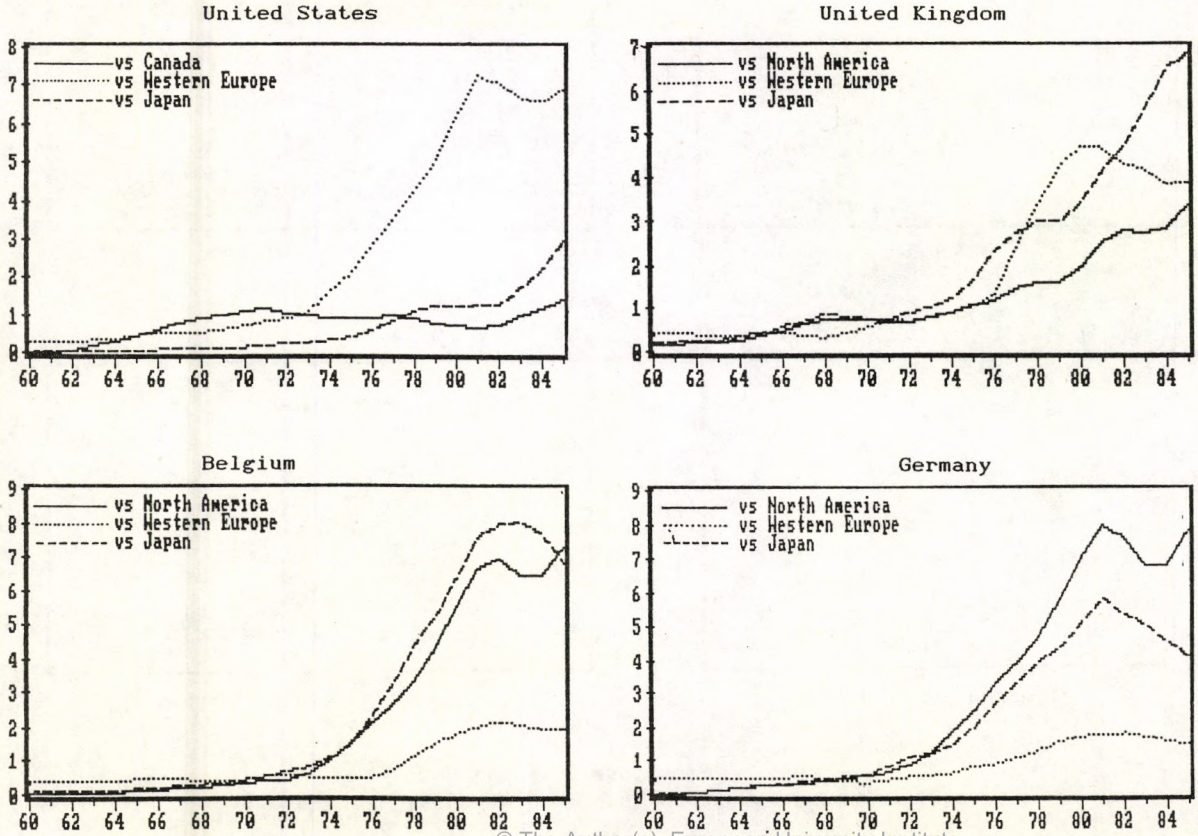


Graph 3. Uncertainty Proxy *U* : The DM-dollar case.



Graph 4.

Geographical Disaggregation of the Exchange Rate Uncertainty Proxy *U*
(Computed with wholesale prices)



Graph 5.

Geographical Disaggregation of Exchange Rate Variability.
(Computed with wholesale prices)

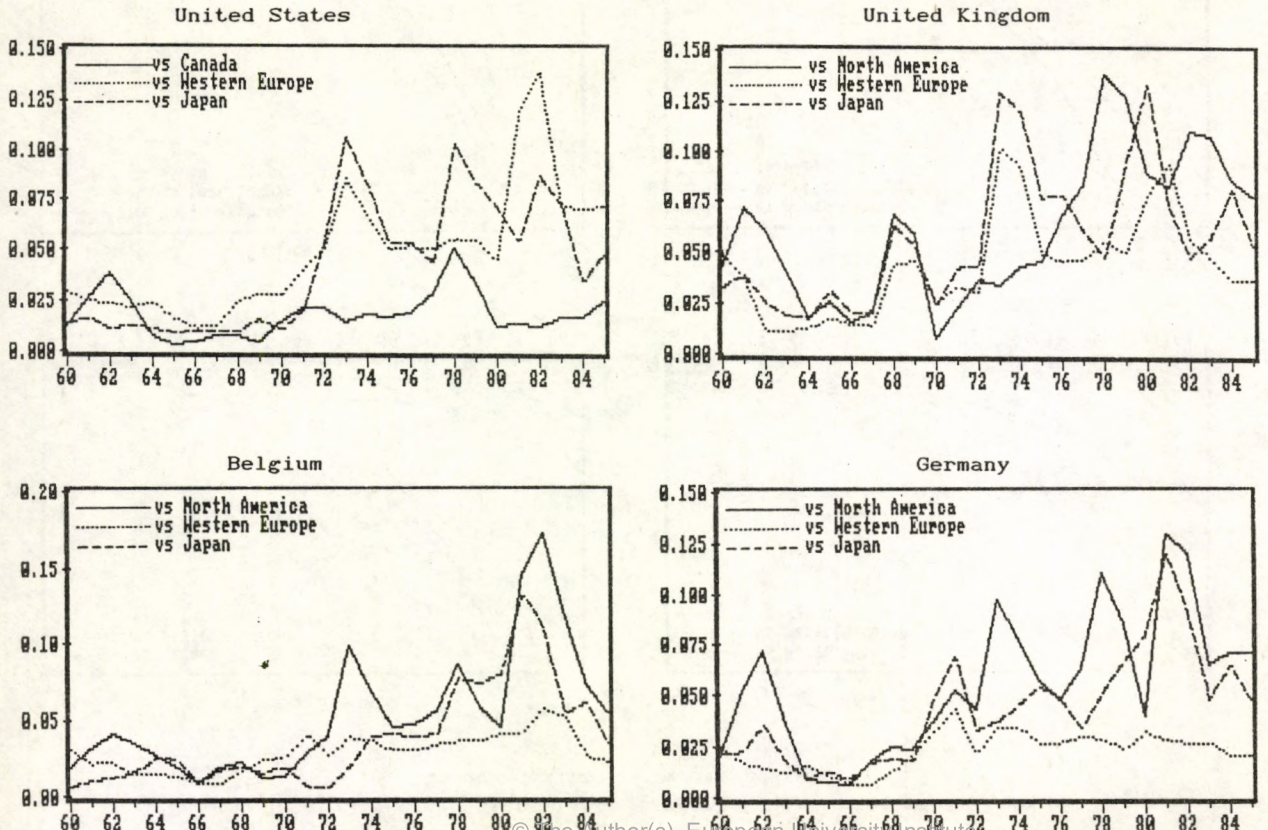


Table 1.

Numerical values of the uncertainty proxies vs the US dollar.

Measure V					Measure U				
Year	UK	Belgium	Germany	Japan	Year	UK	Belgium	Germany	Japan
1960	1.0000	1.0000	1.0000	1.0000	1960	.1750	.0443	.0184	.0221
1961	1.0534	1.0016	1.1577	1.0244	1961	.1750	.0443	.0184	.0221
1962	1.0943	1.0161	1.1955	1.0142	1962	.1874	.0487	.0586	.0245
1963	1.1182	1.0694	1.2121	1.0290	1963	.2185	.0580	.1083	.0293
1964	1.1808	1.1611	1.2337	1.0290	1964	.2724	.0725	.1591	.0368
1965	1.2108	1.1441	1.2405	1.0081	1965	.3535	.0926	.2108	.0471
1966	1.2040	1.1188	1.2099	1.0123	1966	.4684	.1190	.2631	.0604
1967	1.2097	1.0952	1.1873	1.0181	1967	.5448	.1357	.2986	.0690
1968	1.2288	1.0512	1.1256	1.0122	1968	.6208	.1579	.3293	.0804
1969	1.2284	1.0703	1.1269	1.0472	1969	.6145	.1912	.3594	.0974
1970	1.1757	1.0911	1.3809	1.0502	1970	.5981	.2361	.4099	.1200
1971	1.2947	1.0844	1.5027	1.1005	1971	.5712	.2932	.5739	.1487
1972	1.3668	1.3962	1.7427	1.3319	1972	.5883	.3591	.7222	.1818
1973	1.2208	1.7666	2.2033	1.7296	1973	.6838	.5572	.9705	.2698
1974	1.2360	1.7382	2.2271	1.7880	1974	.8256	.9543	1.5212	.4626
1975	1.4306	1.7754	2.3196	1.6428	1975	.9464	1.3944	2.1520	.4982
1976	1.6026	1.7250	2.2595	1.6488	1976	1.0217	1.9876	2.8150	.5115
1977	1.6983	1.8384	2.4457	1.7799	1977	1.0505	2.4916	3.3470	.5960
1978	1.7696	2.0948	2.8569	2.4144	1978	1.0352	3.0855	3.9457	.5602
1979	1.9336	2.2413	3.0539	2.2533	1979	.9912	3.8891	4.6672	.7703
1980	2.1047	2.1060	2.8267	2.2481	1980	1.2263	4.9275	5.5233	.8984
1981	1.8399	1.7692	2.3075	2.1110	1981	1.7682	5.9351	6.0884	.8691
1982	1.6715	2.0552	2.0745	1.6495	1982	2.0362	6.1608	5.6856	.8208
1983	1.6536	2.4792	1.6950	1.6440	1983	1.9251	5.4024	4.9296	1.1715
1984	1.9205	2.9843	1.5848	1.5931	1984	1.8415	4.9347	4.9027	1.3788
1985	1.9231	3.1328	1.6244	1.5694	1985	1.9765	5.1814	6.0199	2.0930

Note : Measure V is defined by equation 5 in the main text, measure U is defined by equation 6.

Table 2.

Numerical values of the uncertainty proxies
with effective exchange rates.

Measure V						Measure U					
Year	USA	UK	Belgium	Germany	Japan	Year	USA	UK	Belgium	Germany	Japan
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1960	.0538	.2010	.1348	.0807	.1121
1961	1.0433	1.0192	1.0886	1.1290	1.0257	1961	.0538	.2010	.1348	.0807	.1121
1962	1.0350	1.0549	1.0936	1.1625	1.0761	1962	.0618	.1917	.1523	.1134	.1224
1963	1.0731	1.0458	1.0745	1.1341	1.0507	1963	.0661	.1928	.1718	.1475	.1399
1964	1.1051	1.0785	1.0250	1.1104	1.0743	1964	.0721	.2132	.1922	.1754	.1658
1965	1.0962	1.1181	1.0385	1.1284	1.0943	1965	.0816	.2555	.2158	.1956	.2013
1966	1.0798	1.1249	1.0526	1.1043	1.1059	1966	.0942	.3214	.2388	.2082	.2464
1967	1.0863	1.1345	1.0651	1.0836	1.0687	1967	.0878	.3411	.2057	.1761	.2545
1968	1.0444	1.3037	1.0626	1.0727	1.0648	1968	.0839	.3574	.1705	.1460	.2680
1969	1.0326	1.2913	1.0288	1.0954	1.0951	1969	.0870	.4030	.1524	.1330	.3019
1970	1.0767	1.2927	1.0747	1.3851	1.1457	1970	.1000	.4564	.1560	.1398	.3559
1971	1.1453	1.1962	1.1446	1.5025	1.1963	1971	.1339	.5175	.1782	.2625	.4332
1972	1.3956	1.3120	1.0939	1.5245	1.1686	1972	.1803	.5301	.1823	.3110	.5148
1973	1.6825	1.7944	1.0599	1.7459	1.2941	1973	.3314	.5535	.1640	.2923	.5998
1974	1.7062	1.8683	1.1065	1.7630	1.3642	1974	.6318	.6895	.1576	.3399	.7876
1975	1.6604	1.8539	1.1440	1.8499	1.1973	1975	.9247	.8122	.1716	.4122	.9420
1976	1.6140	2.3093	1.1289	1.9212	1.2552	1976	1.2503	1.0129	.2023	.4069	1.2052
1977	1.6550	2.2998	1.1461	2.1180	1.3823	1977	1.4662	1.4813	.2483	.4102	1.4899
1978	1.8794	1.9562	1.2312	2.2576	1.9322	1978	1.6485	2.0607	.3793	.4623	1.6537
1979	1.9056	1.7896	1.2628	2.3544	1.6573	1979	1.9781	2.5342	.5859	.5084	1.9344
1980	1.8593	1.9522	1.3609	2.1071	1.6778	1980	2.3675	2.7486	.8821	.5716	2.2554
1981	1.5597	1.9169	1.5090	1.8092	1.8166	1981	2.6894	2.4794	1.2034	.4993	2.4872
1982	1.3581	1.7724	1.7015	1.8868	1.5448	1982	2.6558	2.2521	1.3720	.5461	2.3510
1983	1.3669	1.4498	1.8040	1.7279	1.7058	1983	2.4699	2.0232	1.2861	.6295	2.6748
1984	1.5600	1.5207	1.8430	1.5181	1.8654	1984	2.2920	1.6556	1.2427	.6825	2.6991
1985	1.6311	1.3475	1.8803	1.4895	1.8756	1985	2.5489	1.4949	1.1838	.7959	2.8778

Note : Measure V is given by equation 5 in the main text, measure U is given by equation 6.

Table 3.

Numerical values of the uncertainty proxies
as weighted average of bilateral uncertainties.

Measure V						Measure U					
Year	USA	UK	Belgium	Germany	Japan	Year	USA	UK	Belgium	Germany	Japan
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1960	.1455	.2932	.2565	.2292	.0168
1961	1.0794	1.0545	1.0757	1.1291	1.0493	1961	.1455	.2932	.2565	.2292	.0168
1962	1.1302	1.0825	1.0932	1.1585	1.0769	1962	.1545	.2938	.2623	.2566	.0333
1963	1.1625	1.0861	1.0993	1.1328	1.0868	1963	.1705	.3025	.2734	.2831	.0561
1964	1.1945	1.1110	1.0986	1.1442	1.1123	1964	.1960	.3294	.2965	.3089	.0846
1965	1.1904	1.1340	1.1070	1.1529	1.1102	1965	.2323	.3829	.3333	.3426	.1195
1966	1.1829	1.1435	1.1119	1.1473	1.1137	1966	.2784	.4604	.3771	.3874	.1621
1967	1.1685	1.1517	1.1084	1.1382	1.0952	1967	.2746	.4500	.3269	.3461	.2100
1968	1.1403	1.3055	1.0963	1.1398	1.0807	1968	.2750	.4321	.2770	.3112	.2533
1969	1.1528	1.2939	1.0964	1.1583	1.1136	1969	.3021	.4687	.2783	.3270	.3021
1970	1.1947	1.3048	1.1897	1.3678	1.1656	1970	.3525	.5224	.3108	.3726	.3550
1971	1.2258	1.3558	1.2533	1.4628	1.2355	1971	.4203	.5871	.3819	.4952	.4390
1972	1.4112	1.4225	1.2910	1.5155	1.3564	1972	.4864	.6398	.4343	.5905	.5664
1973	1.7629	1.8429	1.3866	1.7437	1.6061	1973	.5983	.7482	.4823	.6867	.6122
1974	1.8018	1.9271	1.4272	1.7951	1.6437	1974	.8611	.8977	.5450	.8981	.6557
1975	1.7951	1.9141	1.4952	1.8984	1.6352	1975	1.0755	1.0490	.6368	1.2039	.8925
1976	1.7428	2.3174	1.5428	2.0032	1.6473	1976	1.4414	1.2780	.7638	1.4474	1.2965
1977	1.8932	2.3551	1.6635	2.1802	1.7717	1977	1.6909	1.5744	.9006	1.7164	1.7287
1978	2.3469	2.2762	1.8139	2.3622	2.2037	1978	1.8813	1.8652	1.1343	2.0693	2.1393
1979	2.3836	2.1811	1.8046	2.4292	2.1033	1979	2.3120	2.0335	1.4215	2.3965	2.1614
1980	2.3110	2.1669	1.8022	2.2315	2.0885	1980	2.9222	2.2863	1.7761	2.7332	2.3474
1981	1.9728	2.0777	1.8424	2.0594	2.0556	1981	3.4812	2.5418	2.0953	2.9232	2.6030
1982	1.8459	1.9528	2.1747	2.1250	1.7844	1982	3.3847	2.6543	2.2651	2.7896	2.5304
1983	1.8170	1.8650	2.3355	1.9678	1.8462	1983	3.3458	2.6457	2.1205	2.5511	2.8372
1984	1.8874	1.9588	2.4040	1.8927	1.9527	1984	3.1770	2.5524	1.9472	2.2503	3.1949
1985	1.9376	1.8758	2.4806	1.8827	1.9624	1985	3.3308	2.5433	1.8544	2.1865	3.0917

Note : Measure V given by equation 5 in the main text, measure U given by equation 6.

Table 4.

Trade flows by main geographic areas.
(As per cent of total exports of each zone in 1980)

To the industrialized countries (intra-EEC trade excluded)

	Industrial Countries	EEC(10)	EFTA	USA	Canada	Japan	Others
EEC(10)	51.8	--	25.5	12.1	1.6	2.1	10.6
USA	58.5	24.2	3.5	--	15.3	9.6	5.9
JAPAN	47.5	13.2	2.7	24.4	1.9	--	5.3

To Less Developed Countries and the Eastern Block

	LDCs	Africa	America	Asia	Eastern Block
EEC(10)	38.2	14.0	6.5	17.5	8.5
USA	35.9	2.9	17.7	15.2	3.6
JAPAN	45.4	4.3	6.6	33.9	7.1

Source : EUROSTAT, Foreign Trade Statistics.

Table 5.

Aggregate export equations for the period 1960-1985.

	United States		United Kingdom		Belgium		Germany		Japan	
C	5.705 (9.06)	5.426 (7.37)	1.931 (3.84)	1.872 (3.82)	8.561 (2.29)	.348 (.27)	1.165 (1.45)	.958 (.97)	3.411 (2.17)	.576 (.33)
LWT	.712 (23.92)	.701 (24.12)	.487 (5.39)	.472 (5.22)	1.262 (56.23)	1.324 (44.71)	1.221 (49.70)	1.236 (38.03)	.805 (3.03)	1.109 (3.96)
LREE(-1)	-.583 (5.72)	-.543 (5.81)	-.214 (2.31)	-.232 (2.33)	-2.225 (3.99)	-.758 (5.03)	-.593 (3.50)	-.595 (3.66)	-1.051 (3.12)	-.555 (1.69)
VBE	-.018 (.40)	----	-.067 (2.11)	----	-.897 (3.54)	----	-.022 (.65)	----	.044 (.49)	----
VBB	----	.011 (.26)	----	-.098 (2.08)	----	-.262 (4.54)	----	-.027 (.69)	----	-.201 (2.11)
LPXPM	-.369 (4.10)	-.351 (3.33)	----	----	.370 (1.22)	.468 (1.89)	.138 (1.35)	.173 (1.69)	-.359 (3.05)	-.349 (3.29)
DOIL	----	----	.084 (3.10)	.099 (3.19)	----	----	----	----	----	----
LXV(-1)	----	----	.317 (2.34)	.377 (2.68)	----	----	----	----	.516 (3.80)	.430 (3.31)
R2	.995	.995	.994	.994	.997	.998	.998	.998	.995	.996
S.E.R.	.028	.028	.026	.026	.029	.026	.023	.023	.059	.054
D.W.	1.81	1.67	1.97	2.04	1.76	2.04	1.92	1.92	1.77	1.95
F Sta.	1189	1184	833	829	2004	2499	2744	2752	994	1212

Notes : (1) All variables in log except the constant, DOIL, and the uncertainty proxies (VBE and VBB). Estimation using ordinary least squares. R2 is coefficient of determination adjusted for degrees of freedom, SER is standard error of the regression, DW is Durbin-Watson statistics, t-ratios in parentheses.

(2) VBB is lagged one period in the UK and Belgium equation, VBE is lagged one period in the Belgium equation, in German equations the supply variable LPXPM is replaced by LPXPD.

(3) Data definitions and sources are given in Appendix C.

Table 6.

Aggregate export equations for the period 1960-1985.

	United States		United Kingdom		Belgium		Germany		Japan	
C	5.233	5.082	1.449	3.004	4.656	3.159	1.931	1.174	2.936	2.369
	(6.60)	(7.44)	(3.21)	(5.42)	(3.80)	(2.24)	(5.43)	(2.44)	(2.15)	(1.73)
LWT	.702	.697	.413	.324	1.118	1.196	1.229	1.242	.947	.869
	(27.55)	(27.07)	(4.70)	(2.49)	(17.47)	(17.62)	(48.68)	(49.97)	(4.35)	(3.70)
LREE(-1)	-.600	-.665	-.138	-.262	-.584	-.488	-.623	-.463	-.908	-.719
	(5.43)	(5.21)	(1.74)	(3.59)	(2.88)	(3.60)	(7.17)	(4.29)	(3.18)	(2.25)
UBE	.014	----	-.035	----	-.038	----	-.120	----	.340	----
	(.55)		(1.86)		(.37)		(2.12)		(2.20)	
UBB	----	.022	----	-.004	----	-.064	----	-.042	----	-.449
		(1.06)		(.08)		(1.56)		(2.75)		(2.35)
LPXPM	-.255	-.159	----	----	-.539	-.373	-.245	-.369	----	----
	(1.17)	(.74)			(4.39)	(2.33)	(3.57)	(3.75)		
DOIL	----	----	.107	.075	----	----	----	----	----	----
			(3.68)	(2.13)						
TIME	----	----	----	----	----	----	----	----	.092	.099
									(3.95)	(3.98)
LXV(-1)	----	----	.406	.367	----	----	----	----	----	----
			(3.21)	(3.62)						
R2	.995	.995	.996	.996	.996	.998	.998	.998	.995	.995
S.E.R.	.028	.028	.024	.022	.034	.032	.019	.018	.060	.059
D.W.	1.76	1.87	2.35	2.14	1.72	1.76	1.80	1.78	1.52	1.56
F Sta.	1198	1246	973	1002	1515	1689	3933	3803	1233	1266
Rho(1)	--	--	--	--	--	--	--	.156	--	--

Notes : (1) All variables in log except the constant, DOIL, and the uncertainty proxies (UBE and UBB). Estimation using ordinary least squares. R2 is coefficient of determination adjusted for degrees of freedom, SER is standard error of the regression, DW is Durbin-Watson statistics, Rho(1) is coefficient of first order autocorrelation, t-ratios in parentheses.

(2) In Belgian equations real exchange rate appears without lag and the supply variable LPXPM is replaced by LPXPD.

(3) Data definitions and sources are given in Appendix C.

Table 7.

Export volumes to the United States for the period 1960-1985.

	United Kingdom		Belgium		Germany		Japan	
C	-10.468	-9.371	-12.363	-17.137	1.099	3.557	-10.589	-9.988
	(13.31)	(4.15)	(2.87)	(4.21)	(.32)	(1.31)	(3.33)	(2.57)
LUGNP	2.319	2.796	1.205	1.537	1.953	2.526	3.143	3.434
	(16.14)	(10.21)	(4.13)	(5.30)	(5.20)	(15.56)	(6.10)	(6.35)
LREE(-1)	-.250	----	-3.103	----	-.492	----	-.879	----
	(.87)		(4.22)		(.66)		(2.21)	
LBRE(-1)	----	-.832	----	-1.072	----	-.811	----	-.835
		(3.51)		(5.02)		(2.24)		(1.95)
VBU	-.513	-.363	-.269	-.164	-.233	-.139	-.182	-.076
	(5.32)	(2.44)	(2.01)	(1.49)	(2.77)	(1.33)	(2.97)	(.69)
LPXPM	1.313	1.231	5.759	4.367	-.877	-1.400	.911	.410
	(4.30)	(3.54)	(5.05)	(4.96)	(2.23)	(3.77)	(5.55)	(1.73)
TIME	----	----	----	----	----	----	.046	----
							(2.65)	
LXV(-1)	----	----	----	----	.324	----	----	.203
					(2.66)			(1.75)
R2	.975	.979	.637	.697	.976	.972	.990	.989
S.E.R.	.055	.066	.142	.129	.084	.090	.070	.074
D.W.	2.17	2.19	2.07	1.90	2.29	1.76	1.82	1.94
F Sta.	237	226	12	15	192	210	476	421
Rho(1)	--	.519	--	--	--	--	--	--

Notes : (1) All variables in log except the constant, TIME, and the uncertainty proxy (VBU). Estimation using ordinary least squares. R2 is coefficient of determination adjusted for degrees of freedom, SER is standard error of the regression, DW is Durbin-Watson statistics, t-ratios in parenthesis.

(2) In UK equations exchange rates are unlagged, in German equations the supply variable LPXPM is replaced by LPXPD.

(3) Data definitions and sources are given in Appendix C.

Table 8.

Export volumes to the United States for the period 1960-1985.

	United Kingdom		Belgium		Germany		Japan	
C	-8.867	-8.999	-4.857	-11.147	1.994	5.765	-5.838	-2.998
	(5.58)	(5.68)	(.75)	(1.50)	(.32)	(1.32)	(1.79)	(.76)
LUGNP	.984	1.442	1.425	1.749	2.973	1.608	2.602	3.642
	(4.48)	(5.73)	(5.45)	(7.39)	(5.85)	(3.56)	(4.17)	(7.62)
LREE(-1)	-.989	----	-2.533	----	-.989	----	-1.528	----
	(3.01)		(3.97)		(1.81)		(3.66)	
LBRE(-1)	----	-.519	----	-.893	----	-.643	----	-1.532
		(3.05)		(4.02)		(3.77)		(7.17)
UBU	.039	-.100	-.138	-.110	-.126	-.059	.049	-.171
	(.63)	(1.70)	(3.34)	(2.53)	(3.39)	(2.07)	(.58)	(1.75)
LPXPM	2.596	1.769	3.317	2.688	-1.274	-1.450	.939	-.411
	(5.64)	(2.91)	(1.69)	(1.47)	(1.84)	(2.68)	(4.67)	(1.15)
TIME	----	----	----	----	----	----	.055	----
							(2.27)	
LXV(-1)	.342	.309	----	----	----	----	----	----
	(3.33)	(2.91)						
R2	.962	.962	.772	.775	.961	.969	.986	.986
S.E.R.	.069	.069	.112	.112	.088	.078	.084	.088
D.W.	2.09	2.03	1.79	1.63	1.87	1.90	1.95	1.80
F Sta.	122	123	21	22	119	153	329	376
Rho(1)	--	--	--	--	421	--	--	--

Notes : (1) All variables in log except the constant, TIME, and the uncertainty proxy (UBU). Estimation using ordinary least squares. R2 is coefficient of determination adjusted for degrees of freedom, SER is standard error of the regression, DW is Durbin-Watson statistics, Rho(1) is coefficient of first order autocorrelation, t-ratios in parenthesis.

(2) In Belgian and British equations real exchange rate appears without lag, the supply variable LPXPM is replaced by LPXPD in German equations and the Japanese using the bilateral real exchange rate.

(3) Data definitions and sources are given in Appendix C.

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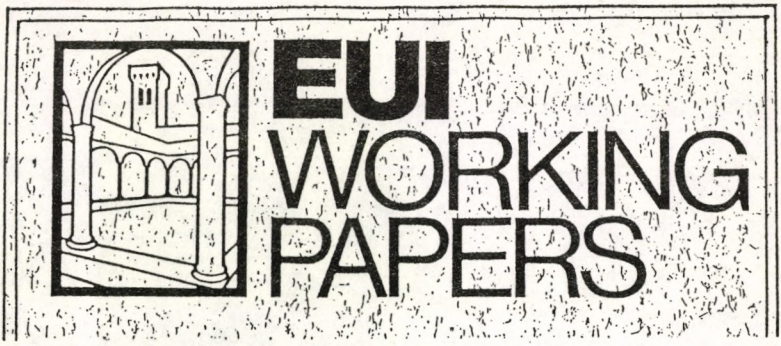

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