Exchange Rate Variability
and
EU Trade

by

Khalid Sekkat[*]
(Université Libre de Bruxelles)

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0. Introduction

Exchange rate variability is a central theme in the debate on the performance of exchange rate regimes. The consequences of this variability for economic activities have always been a major concern of policy makers. After World War II, the Bretton Woods agreements created the International Monetary Fund and set up a world-wide system of fixed exchange rates. One objective of this system was to foster international exchanges of goods and services.

In 1973, the Bretton Woods system was abandoned and many countries allowed their exchange rates to float. The consequence was an increase in exchange rate variability. Hence, the debate on the optimal management of exchange rates attracted renewed attention. It was enhanced by the possibility of a causal link between this increased variability and the observed decline in the growth rate of trade. Advocates of a regime of fixed rates emphasised its merits in terms of co-ordination, discipline and credibility of economic policies, as well as its role in stimulating international trade. The supporters of flexibility put forward its advantages in terms of increased autonomy in pursuing domestic policy objectives.

In Europe, policy makers seemed to have been much more convinced by the merits of a regime of fixed rates. In 1972, they created the Snake, a system of fixed exchange rates among member countries. The Snake experienced a number of realignments and the entry and exit of various member countries, which substantially weakened its credibility. A new system of fixed rates was therefore set up in 1979 : the Exchange Rate Mechanism of the European Monetary System (the ERM of the EMS). Despite several realignments during the early eighties, the ERM has succeeded in stabilising exchange rates between member countries. After 1983, realignments become smaller and rarer, and between 1987 and 1992 there was almost no realignment.

The stable environment (with respect to exchange rates) during the period 1987-1992 was favourable to the concept of creating Economic and Monetary Union (EMU) in Europe. Some economists argued that the move to EMU should pose no problems because within the ERM, realignments were no longer needed.

To illustrate the European experience with exchange rate management, Figure 1 presents the variability of the nominal effective exchange rates (NEER) of four currencies (those of Belgium, Germany, France and Italy) between 1970 and 1995. The variability is computed as the yearly standard deviation of monthly percentage changes in nominal effective exchange rates. Comparing the pre-ERM period to the ERM period, it appears that member countries experienced lower variability in the ERM period. Even during the ERM crisis in the early 1990s, variability is lower than during the pre-ERM period for member countries. The most stable period is clearly 1987-1991. Figure 1 shows that during the ERM period, a non-member country (i.e. the UK) experienced a significantly higher level of variability than the ERM countries [1]. Hence, the ERM may clearly be credited for having reduced exchange variability among participating countries.

Figure 1 : NEER Volatility
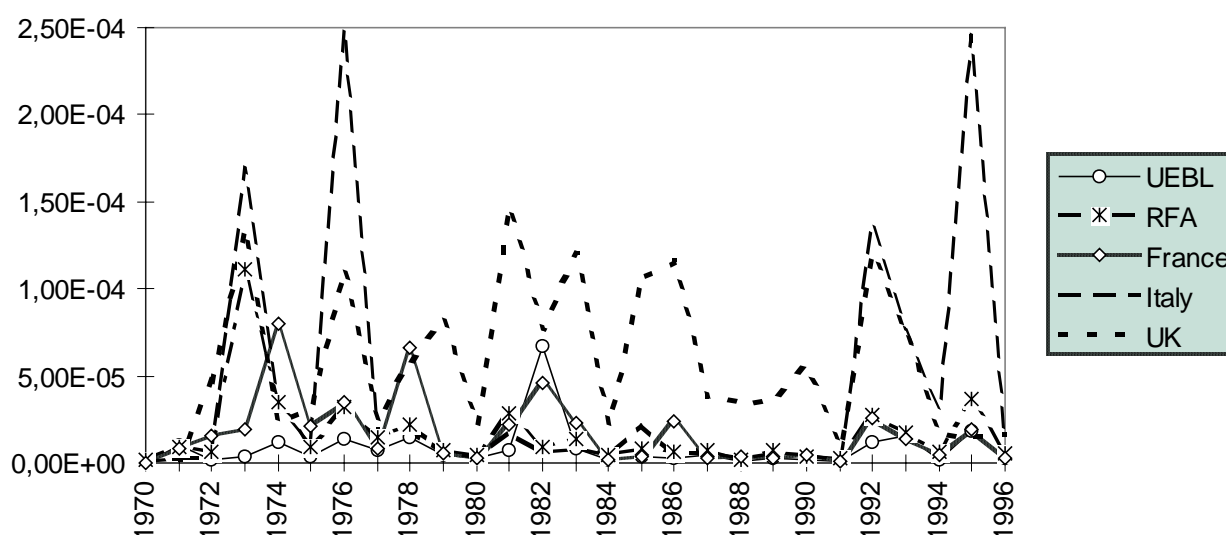
An abundant empirical literature has analysed the recent European experience of fixed exchange rates. The conclusions of such analyses are of prime importance when examining the potential impact of EMU in Europe. The analyses investigate various aspects of the ERM experience : transmission of shocks, nominal and real convergence, policy co-ordination, international trade, etc.

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[1] Disregarding the variability of the lira after 1991 for obvious reasons.

The present study focuses on international trade. The aim is to construct a small econometric model allowing the evaluation of the impact of variability on European trade.

The report is organised as follows. Section I offers a conceptual analysis of the impact of exchange rate variability on trade. Section II presents previous empirical findings for Europe. The theoretical model relating variability to trade is constructed and analysed in Section III, while Section IV presents the empirical analysis and discusses the major findings. Section V sets out the conclusions.

I. A conceptual analysis

Over the last two decades, numerous papers have studied the theoretical relationship between exchange rate regimes and international trade performance (Cushman (1983), Dixit (1989), Gagnon (1993), Hooper and Kohlhagen (1978), et al.) This relationship follows from the impact of exchange rate variability on trade. Instead of exchange rate change at a given point in time, the central role is assigned to variability, defined as exchange rate fluctuations over a relevant period of time. While there is a consensus on the impact of exchange rate changes on trade, the effect of variability is much more controversial. Variability is blamed not only for decreasing trade volume, but also for affecting the relationship between exchange rate and trade variables. It is seen as detrimental to the process of current balance adjustment.

Variability is defined as fluctuations of exchange rate around its equilibrium level. Two types of fluctuation are considered. One type concerns frequent and non-persistent fluctuations : at time t, the exchange rate goes above its equilibrium level, at time t+Δt, it goes below this level, and so on. This type of fluctuation is labelled 'volatility'. In statistical terms, the exchange rate may be represented here as an *iid* (independent and identically distributed) random process. Even if the fluctuations are not persistent, the variance of the random process may be substantial.

The second type of fluctuation concerns less frequent and more persistent swings : the exchange rate departs from its equilibrium level for many periods. This second type of

variability is labelled 'misalignment'. Here, the exchange rate might be represented as a random walk process.

An important difficulty with the measurement of variability is the identification of the equilibrium level of exchange rates. There exist various theoretical models aimed at determining this equilibrium level. However, none of these models has been found empirically superior to the others. Moreover, empirical evidence suggests that even a simple random walk is better suited to exchange rate fluctuations than structural economic models (Meese and Rogoff (1983)). Finally, given that the equilibrium level of the exchange rate evolves over time and is not observable, there are difficulties in distinguishing empirically between misalignment and changes in the level of equilibrium exchange rate.

The two types of variability create uncertainty for economic agents operating on international markets. Each type of variability induces a different type of uncertainty and has a different impact on international trade. While in reality both types of variability coexist, separate analyses of their impacts will be conducted for the sake of simplicity.

Let us consider first a static economic environment where economic agents' decisions are not related over time (no specific investment, no learning effect, etc.) The uncertainty related to exchange rate volatility is induced by a potential delay between production (or sales) decisions (made at time t) and payment (made at time t + Δt). In this case, a producer does not know with any certainty at time t how much it will get for its output at time t + Δt. It will, therefore, incur additional expenses to hedge this risk. The trade volume may decrease and trade prices increase.

In a dynamic environment where economic agents' decisions are related over time, exchange rate misalignment brings important new implications. For instance, a car producer contemplating an expansion of its network of dealers in a foreign market may incur expenses which are (at least partly) non-recoverable. It should, therefore, be able to render this investment profitable over several periods of time. The same preoccupation faces a computer producer which lowers its prices in order to enter a new market. Such a strategy consists also of an investment which is non-recoverable and should be rendered profitable over several periods of time. The problem here is not only due to the delay between production (or sales)

and payment, it also concerns the medium-term profitability of present decisions. It is, therefore, crucial for the producer to determine whether the present level of exchange rate (leaving aside volatility) is sustainable in the future. The connection with misalignment is the following. Let us assume that exchange rates cannot depart permanently from equilibrium levels. Hence, during a period with substantial misalignment, economic agents expect the exchange rate to revert to its equilibrium level. They consider the present exchange level as temporary and anticipate its reversion. Economic decisions will be affected.

The analysis of the impact of exchange rate variability is divided into two separate categories. One concerns the impact of variability on the evolution of the price and the volume of trade. The other concerns the impact of variability on the response of the volume and the price of trade to changes in exchange rates. The latter focuses on the process of trade adjustment by examining the extent of exchange rate pass-through.

Early research works concentrated on the impact of volatility on the evolution of the price and the volume of trade. Associating volatility with uncertainty and assuming that economic agents are risk averse, theoretical analysis generally predicted a negative impact of volatility on trade volume. The impact of volatility on trade prices may be either positive or negative, depending on whether the risk is borne by exporters or importers. If the risk is borne by importers, increased uncertainty shifts the demand curve downward and, hence, decreases the equilibrium trade price. If the risk is borne by exporters, increased uncertainty shifts the supply curve upward (i.e. reduces supply) and hence increases equilibrium trade prices. Empirical tests on the impact of volatility on the price and volume of trade have been inconclusive. According to Frenkel and Goldstein (1989), the difficulty in identifying a significant link between volatility and trade variables might reflect the availability of hedging instruments against exchange rate risks.

During the eighties, researchers argued that uncertainty should affect trade variables not because of increased volatility but because of exchange rate misalignment. In contrast with volatility, misalignment generates uncertainty against which there is little possibility of insurance. Empirical evidence reported along these lines supported the adverse effects of misalignment on trade.

The interest of economists in the response of trade variables to exchange rate changes was motivated by the evolution of the dollar in the 1980s. The failure of the US trade deficit to improve despite a large depreciation of the dollar after 1985 generated a new body of research aimed at determining the impact of exchange rate variability on trade balance adjustment. Variability seems to impact the ability of exporters to pass through exchange rate changes into dollar import prices. Most of the work in this area was conducted in terms of misalignment. Both static and dynamic imperfect competition models were set up. They led to the introduction of two new concepts : 'pricing to market' and 'hysteresis'.

The concept of pricing to market (PTM) concerns firms' pricing strategies across markets. It was introduced by Krugman (1986), but Dornbush (1987) was the first to develop a formal model where the impact of exchange rate changes on export prices varies across sectors depending on the degree of competition. The notion of PTM has received empirical support in several studies (Man (1986), Knetter (1989) and Martson (1989)). With PTM the story is, however, still not complete. First, the role of misalignment remains unclear, and second, the static nature of the theory seems unrealistic. A permanent dollar appreciation would have the same impact on exports as an appreciation followed by a depreciation in the next period. This is implausible.

The notion of hysteresis incorporates the role of dynamics. It is based on the cost of reversing changes in foreign market shares. Two types of dynamic imperfect competition model have been used to show that exchange rate changes may not be passed through into trade prices, due to concerns about market share. Supply-side models by Baldwin and Krugman (1989) and Dixit (1989) postulate that firms face non-recoverable fixed costs (sunk costs) of entry into foreign markets. An exporter of cars wishing to expand sales on the German market should enlarge the dealer network, launch an advertising campaign, and so on. In order for these non-recoverable expenses to be profitable, the appreciation of the German currency should continue to hold in the future. Otherwise, the exporter would not incur such costs. Demand-side models, introduced by Froot and Klemperer (1989), assume that, due to consumer switching costs (network externalities, learning effect, etc.), firms' future demands depend on current market shares. In this context, an exchange rate depreciation will not lead to an increase in export price unless it is perceived as permanent. The exporter may prefer

holding its export price (in foreign currency) constant if depreciation is temporary, in order to preserve its market share.

The dynamic models share the prediction that the degree of pass-through depends on whether exchange rate changes are perceived as temporary or permanent. In a period of substantial misalignment, economic agents expect the exchange rate to revert to its equilibrium level. Hence, they consider further movements, away from equilibrium, as temporary and would not pass through them into trade price.

Empirical tests of the impact of exchange rate variability on trade variables rely on various measures of variability. A commonly used measure of volatility is the standard deviation of exchange rate changes computed with high frequency data (monthly, weekly or even daily data). Such a measure has been criticised. It gives actual volatility, while the relevant measure (from a theoretical point of view) concerns economic agents' expectation of volatility. To compute this relevant measure, economists use more or less sophisticated regression techniques such as the variance of the residuals of the regression of the exchange rate on a time trend or a GARCH modelisation of exchange rate behaviour. From an empirical point of view, however, the various measures are highly correlated and the actual standard deviation measure performs as well as more sophisticated measures in this context (see Kenen and Rodrick (1986) and Grobar (1993)). The measurement of misalignment is much more problematic because it requires the existence of data on the equilibrium exchange rate level. Such an equilibrium level is not observable, and there exists no consensus among economists for its estimation. Various solutions are adopted in the literature. Some authors (De Grauwe (1987), De Grauwe and de Bellefroid (1989)) rely on the standard deviation of exchange rate changes over a long period of time computed with low frequency data (i .e . annual data). Some other authors (Froot and Klemperer (1989), Sapir and Sekkat (1995)) adopt an indirect solution which consists of using measurements of the consequences of misalignment rather than measurements of misalignment. As discussed above, misalignment induces economic agents to perceive that a further move in the exchange rate, away from its equilibrium level, is temporary. Hence, measurements of economic agents' expectations concerning exchange rates are used to capture some of the consequences of misalignment.

II. Empirical evidence in Europe

This section[2] reviews the main empirical findings concerning the impact of exchange rate variability on trade in Europe. This is not an easy task, however. Indeed, existing papers are exclusively concerned with the US bilateral trade flows, or they study only aggregate trade (i.e. without distinction among partners). Only a few papers offer a disaggregated analysis. These papers belong to a growing literature concerned with the performance of the ERM, and will constitute the main focus of this section. Possible lessons from the Bretton Woods system are also incorporated when available.

The exposition follows the distinction adopted in the previous section in terms of types of variability (volatility and misalignment) and in terms of their consequences (the evolution of trade variables and the responsiveness of trade variables to changes in exchange rate).

1. Variability and the evolution of trade variables

a. Volatility

To assess the impact of volatility on trade, four papers are presented. Two of them draw on the experience of the Bretton Woods (fixed rates) period, as compared to the post-Bretton Woods period (flexible rates). One focuses on volatility in nominal rates (Hooper and Kohlhagen, 1978), while the other focuses on volatility in real rates (Cushman, 1983). Two other papers draw on the ERM experience. One studies the impact of nominal volatility on trade volume (Stockman, 1994), while the other (Frankel and Wei, 1993), examines the impact of both nominal and real volatility on trade volume.

The empirical investigation by Hooper and Kohlhagen (1978) studied the relationship between trade volume and volatility controlling for the impact of domestic and foreign costs, income, capacity utilisation and exchange rate. It used various measures of exchange rate volatility. The same relation was tested for trade prices. The test was conducted on bilateral

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[2] This section draws on Sapir et all. (1994).

flows, from 1965 to 1975, among five exporters (Germany, Japan, UK, US and Canada) and six importers (the five exporters plus France). The impact of exchange rate volatility depended on whether price equations or volume equations were considered. Volatility seemed to be affecting price, much more frequently than volume.

When price equations were considered, volatility variables had a negative coefficient for US exports, and for German export and import equations. The coefficient was significant in the intra-Community (Germany-France) equation and in 50% of the extra-Community cases. Theses results suggest that the risk was borne by importers, and that increased risk depressed import demand and caused market prices to fall. In the case of US imports, the coefficient of volatility was positive. It was significant in two cases out of four. These positive coefficients tended to confirm the special status of the US, i .e. US import was quoted in dollars. With US import invoiced in dollars, most of the risk was faced by the exporter ; and an increase in risk induced an increase in export price.

The effect of exchange rate volatility was not significant in volume equations, for all bilateral flows but one : the US-UK situation. Several variants of the equation were tested and none of them showed significant volatility impact on trade volume. The contrasts between the results of price and volume equations were striking. Hooper and Kohlhagen (1978) suggested that it might be due to very low levels of elasticity for export supply or import demand, in relation to prices, at least in the short term. So the price change due to volatility was not reflected in volume.

Concerning the other variables, the results showed that domestic demand and foreign costs exhibited significant expected effects for both price and volume equations. Capacity utilisation did not have any significant impact. Finally, the exchange rate variable was generally of the sign expected, but was significant in only a few cases.

The coefficients in price or volume equations measured the dependent variable sensitivity to a change in explanatory variables. Nonetheless, the total effect may have been large if the magnitude of the change in the explanatory variable was sufficiently large. Therefore, Hooper and Kohlhagen (1978) estimated the total effect of exchange rate volatility on prices and volume. To do this, they compared the levels of price and volume which would have existed

without volatility, to those prevailing with volatility. Comparisons were made for two sub-periods. The first sub-period, 1966-1967, was representative of stable exchange rates and low volatility (the Bretton Woods era). The second sub-period, 1973-1974, experienced much more exchange rate volatility. Results showed that, in the first sub-period, volatility had very little impact on either volume or price. In the second sub-period, however, the impact of volatility was important for both price and volume. For instance, in 1974 (third quarter), volatility reduced export volume from the US to the UK by as much as 6%, when compared to zero volatility level.

While Hooper and Kohlhagen (1978) investigated the effect of nominal exchange rate variability on trade, Cushman (1983) focused on real exchange rate variability. The use of real instead of nominal exchange rate data was thought to be more appropriate because price change might offset nominal rate variability, and then reduce real rate variability. So Cushman studied the effect of real exchange rate volatility on trade volume and price. He controlled for the effect of a set of variables, comparable to those used by Hooper and Kohlhagen (1978), expressed in real terms. The sample involved the same set of bilateral trade flows over the period 1965-1977.

Concerning the effect of exchange rate volatility on trade, the results showed a significant negative effect on volume in the intra-Community equation, and in six (out of thirteen) extra-Community equations. The coefficient of volatility in price equations was significant, with either positive or negative signs, in only four cases. It was not significant for the intra-Community price equation. Thus, in contrast to the findings of Hooper and Kohlhagen (1978), these results showed a more pronounced effect on quantity than on price. Cushman (1983) suggested that this contrast might still be explained by reference to volume low elasticity to price in the short term. Since he incorporated various lag structures into the equations, Cushman captured some long-term effects at work.

Estimated coefficients for the importing country's income, the exporter's and importer's costs and real exchange rates were generally significant and had the expected signs in both the price and volume equations for extra-Community trade. Capacity utilisation coefficients had both negative and positive signs across all equations. Thus, no particular interpretation could be placed upon this variable. For intra-Community trade (Germany-France), cost coefficients,

although exhibiting the right sign, were not significant in volume equation. The exchange rate coefficient was significant neither in volume equation nor in price equation. In contrast, the capacity utilisation coefficient was significant, with the expected sign in both equations.

Like Hooper and Kohlhagen, Cushman went beyond estimating volume and price sensitivities to volatility. He provided an assessment for the magnitude of the volatility effect on trade volume. A distinction was made between two sub-periods : 1965-66, a stable sub-period, and 1974-1975, a more unstable sub-period in the post-Bretton Woods era. The results showed that, while estimated sensitivity might be low, measured volatility was very high, especially for the sub-period 1974-75. So during this sub-period, the percentage differences between fitted quantities and fitted-without-risk quantities ranged between 7.2% (for intra-Community trade) and 23.8% (Japan-US trade). In the remaining cases during the period 1974-75, the differences lay between 9% and 16%. Finally, during the Bretton Woods sub-period 1965-1966, the magnitude of the volatility effect was almost negligible.

A recent paper by Stockman (1994) focuses on the ERM experience. The author argues that the failure of empirical investigations to find a systematic and significant impact of volatility on trade is due the aggregate level of the data. Hence, he examines the relationship between volatility and the volume of intra-EC trade at a sectoral level. The aim of the analysis is to identify the role of the ERM in fostering intra-EC trade.

A sample covering five exporters (Germany, France, Italy, Belgium and the Netherlands) and five sectors (food and beverages, crude materials and oils, chemicals, manufactures, and machinery and transport equipment) was constructed. A separate equation is considered for a given country and a given sector. It relates intra-EC exports to the GNP of the EC, to relative prices and to nominal exchange rate volatility. The five equations for each country are simultaneously estimated using a seemingly unrelated regression method and quarterly data between 1980-1990.

With respect to the impact of volatility on trade volume, Stockman's results are radically different from previous findings. Estimated coefficients of volatility exhibit the anticipated sign and are highly significant in 90% of cases. This is striking. One possible explanation may be that the dependent and the explanatory variables used in the regression are all defined

in levels. Given that such variables are likely to be non-stationary, the author should have tested for cointegration before analysing the impact of volatility on trade volume. Otherwise the possibility that the apparent link between volatility and trade volume is "spurious" cannot be ruled out.

Given the estimated coefficients, Stockman was, of course, able to show that the ERM noticeably stimulated intra-EC trade. He reported that if the pre-ERM level of volatility had prevailed during the period 1987-1990, exports from Germany, Belgium and Italy would have been lowered by 4.4%, 3.9% and 3.8% respectively. The estimated impacts for France and the Netherlands are 2.5% and 0.5% respectively.

Like his estimated coefficients for volatility, Stockman's assessment of the total impact of volatility on trade is far above other findings in the literature concerned with the ERM experience. For instance Frankel and Wei (1993) examined the impact of both nominal and real exchange rate volatility on trade volume with cross-section equations. They used a gravity model which included a measure of volatility and dummy variables to capture the effect of trade blocs. They estimated three separate equations for 1980, 1985 and 1990 trade flows over a sample of 63 countries.

Regarding nominal exchange rate volatility, Frankel and Wei (1993) found that it had a significantly negative impact on trade in 1980, no significant effect in 1985, and an unanticipated positive effect in 1990. The results were essentially the same for real volatility, except that the 1990 effect was significantly negative.

The estimates were used to compute the scale of the impact of volatility on trade. In 1980, the elimination of the prevailing volatility would have increased intra-EC trade by 0.77%. For 1990, the effect of a similar experiment would have been even smaller, only 0.15%.

The estimates were also used to compute the effect of the approximate doubling of volatility that occurred in 1992 inside the ERM. Frankel and Wei (1993) found that such doubling would have decreased trade by 0.25%.

A recent paper, by Eichengreen and Irwin (1993), gives an historical perspective of the impact of volatility on trade. This paper examines the role of regional, commercial and financial arrangements in the dramatic decline in trade volume during the early thirties (about 30% between 1929 and 1939). The empirical analysis relies on the gravity model. Exchange rate volatility was introduced to capture one effect of financial arrangements. Three separate equations were estimated for bilateral trade flows between 34 countries in 1928, 1935 and 1938.

The results show that volatility had a negative impact on trade. This negative effect was most pronounced in 1935. When estimations were conducted, with a control for currency blocs, exchange rate volatility did not appear to have been a significant impediment to trade in 1938. This might have been due to the impact of the 1936 Tripartite Agreement between the US, the UK and France. The authors argue that, by reducing exchange rate uncertainty and risk, this agreement contributed to trade reconstruction. They also suggest that the negative impact of volatility in 1928 and 1935 was due to the absence of well-developed and economical hedging instruments and the lack of experience with floating rates.

b. Misalignment

Three papers concerned with the impact of misalignment on trade are presented here in detail. The first paper, by De Grauwe and de Bellefroid (1989), focuses on the experience of the Bretton Woods period as compared with the post-Bretton Woods period. The second paper (De Grauwe, 1987) draws on the ERM experience. The third paper, by Perée and Steinherr (1989), compares the European and US experiences.

The impact of medium-term exchange rate variability on the slowdown of the average growth rate of trade between the periods 1960-63 and 1973-84 is investigated by De Grauwe and de Bellefroid (1989) based on cross-sectional techniques. The average growth rate of bilateral trade flows over each period is supposed to be influenced by the income of the importing country, the oil shock, variability, and a set of dummies representing trade arrangements.

The sample includes ten industrialised countries : Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the UK and the US. The model leads to an analysis of the difference of export long-run growth rates, not only with respect to exchange rate regimes but also with respect to countries' environments.

Medium-term exchange rate variability is incorporated into the model, either in nominal or in real terms. Moreover, in each case, two statistical measures of variability are used. There are four trade arrangement dummies in the sample. The first one represents trade flows between the original EEC members during the first period. The second one involves the same group for the second period. The third dummy captures the effect of the UK's admission to the EEC. It concerns trade flows between the UK and the original EEC members during the second period. Finally, a fourth dummy is included in order to take account of the exceptional performance of Japanese exports. It concerns flows from Japan in each period. The trade arrangement dummies are defined in the following way. When a sub-group of countries form a customs union during sub-period t, the dummy is given a value 1. Otherwise, it is given a value 0.

Proxies of medium-term exchange rate variability all have the expected negative sign, and are usually significant. Both coefficient values and significance levels tend to be higher when real, rather than nominal, exchange rate variability is considered. Hence, medium-term variability of exchange rate has a significant negative effect on the growth rate of trade. This conclusion seems closely dependent on the use of medium-term variability, instead of short-term variability. Indeed, when the authors performed the same tests using measures of short-term variability, no significant effect on trade flows emerged.

Analysis of the results shows that trade integration has a significant influence on bilateral trade flows. During the first sub-period (fixed rates), trade integration between EEC countries increased the yearly growth rate of the members' trade by approximately 6%. During the second sub-period (floating rates), a positive and significant effect of integration on UK-EEC trade, amounting to some 5%, emerges.

On the basis of their estimated parameters, De Grauwe and de Bellefroid (1989) quantified the size of the contribution by each independent variable to trade evolution among the ten

industrialised countries. They found that about half the total decline in the growth rate of international trade, among these countries, is due to the deceleration of output growth rate. The slowdown of Japanese penetration and the deceleration of integration between the original EEC countries, after 1973, explain about 30% of the decline. The increase of variability in exchange rate during the post-Bretton Woods era is responsible for the remaining 20%. Hence, the variability effect, although less important than income and integration effects, contributes significantly to the decline of trade growth rates.

A disaggregated analysis, distinguishing between intra-EEC and extra-EEC trade, was also conducted. Deceleration of trade integration appears as the most important explanation for growth rate decline in intra-EEC trade. Exchange rate variability is only responsible for about 5% of such decline. Regarding extra-EEC trade, the story is completely different : exchange rate variability accounts for about one third of the decline in trade.

In another paper, De Grauwe (1987) focuses on trade performances of the ERM. A most striking aspect of the ERM is that intra-ERM trade has grown much more slowly since 1979. Moreover, during the same period, intra-ERM trade has grown as much as 50% more slowly than the trade of ERM countries with non-ERM countries. These evolutions have occurred despite a substantial decrease in variability of ERM exchange rates, as compared to other OECD exchange rates. This is puzzling if one accepts that lower exchange rate variability should foster trade.

De Grauwe (1987) estimated a model comparable to the one presented in De Grauwe and de Bellefroid (1989). Definitions for dependent and explanatory variables, and the compositions of the sample, are also the same. The estimation period is separated into two sub-periods : one before the EMS (1973-78), and the other during the EMS (1979-84).

The analysis gives the following results. With respect to economic integration and income effects, the conclusions are broadly the same as in De Grauwe and de Bellefroid (1989). The coefficient for exchange rate variability is negative and significantly different from zero, suggesting that trade flows grow more slowly in an environment with high real exchange rate variability, than in an environment with low variability.

The results of the estimation were used to quantify the contribution of the different variables to the decline in the growth rate of intra-ERM trade after 1979. It was found that most of the decline is due to the trade integration slowdown between ERM countries. Another significant, although smaller, part of the decline follows from the deceleration of economic growth within the ERM. Reduction of variability inside the ERM, since 1979, has added a modest surplus (0.1 percentage point) to the growth rate of intra-ERM trade. The positive contribution of exchange rate stability was, of course, offset by the two other factors.

There is an alternative way to examine the contribution of exchange rate variability to the growth rate of intra-ERM trade. This would be to investigate what growth rate could be observed if ERM exchange rates were as variable as non-ERM exchange rates. De Grauwe (1987) shows that if ERM countries had experienced the same exchange rate variability as other industrialised countries, the growth of intra-ERM trade would have declined by an additional 1.2%.

To sum up, it appears that the greater exchange rate stability provided by the ERM has had a positive effect on intra-ERM trade. However, the deceleration of economic growth and the slowdown in the trade integration process between ERM countries has done more than compensate for the exchange rate stability effect.

While De Grauwe (1987) and De Grauwe and de Bellefroid (1989) use cross-sectional techniques, Perée and Steinherr (1989) rely on time-series techniques to assess the impact of medium-term variability on trade. They computed two measures of variability : one captures only current misalignment, and the other combines current and expected misalignments. In addition to the effect of each variability measure on trade volume, they also estimated the impact of world demand, real exchange rate, and terms of trade. The estimation concerns aggregate trade flows for the US, the UK, Belgium, Germany and Japan. Bilateral trade flows for the US were also considered. Data are annual and cover the period 1960-85.

The estimation results show that demand and price elasticities are generally significant, with the expected sign. The misalignment variables are also significant, with a negative sign, in most cases. Depending on how variability is calculated, results change somewhat, although not in a dramatic way. In the case of the US, variability is never significant. Perée and

Steinherr (1989) suggest that this may be due to the fact that a large share of the US export is invoiced in dollars. Uncertainty seems, therefore, to be borne by buyers of US goods.

The three papers reviewed above support the idea that medium-term variability of exchange rate has a negative effect on trade volume.

2. Variability and trade adjustment

a. Volatility

In a recent paper, Sapir and Sekkat (1990) studied empirically the impact of nominal exchange rate volatility on the response of trade prices to exchange rate changes, drawing on the experience of the EMS. They focused on price equations, and controlled for the effect of exporter cost, and exchange rate. The aim of volatility variables was to capture the ERM effect.

Exchange rate volatility was supposed to affect trade prices either directly or indirectly. The direct effect was the same as in the traditional approach. The indirect effect stemmed from recent developments in the trade literature. It followed from the fact that, in the presence of greater exchange rate instability, exporters were reluctant to pass on given exchange rate changes into export prices (they reduce pass-through), because they expected the change to be reversed in the near future.

To control for potential change in pass-through due to market structure, the price equation was estimated separately for seven industries with different characteristics. These industries included : chemical products, metal products, agricultural and industrial machinery, office machines, electrical goods, motor vehicles, and textiles and clothing. Each industry's equation was estimated over a sample of five importers (three inside the ERM : France, Germany and Italy ; and two outside the ERM : the UK and the US), and eight exporters (the five importers, plus Belgium, Japan and the Netherlands). The sample period was 1966 to 1987, depending on data availability.

The estimated coefficient of the current exchange rate variable had the predicted negative sign, and was significantly different from zero in nearly all cases. The regression results showed that volatility had generally no impact on exchange rate pass-through (the indirect effect). Out of 35 reported cases, the estimate of volatility impact on pass-through was significantly positive in only four instances. There was no obvious pattern among these cases, either in terms of sectors or in terms of market. The level of pass-through, including the indirect effect of volatility, was computed for suppliers distinguishing between ERM and non-ERM members. This level was found always close to unity, except in the German and US markets, where it was close to zero. Concerning ERM /non -ERM comparison, the level of pass-through was greater for intra-ERM trade in 11 instances out of 21 cases relating to ERM markets. However, this difference in the level of pass-through was significant in only four cases.

Regression results also indicated that volatility had generally no direct impact on import prices. The volatility variable coefficient was significantly different from zero in only five cases out of 35, three of which occurred in the German market. In all these situations, volatility had a positive impact on prices, implying that the exchange risk was borne by the exporter.

The estimated coefficient of the cost variable had the predicted positive sign and was significantly different from zero in nearly all cases. The degree of cost pass-through for a given sector tended to be the same across all five markets in the sample. Two categories of sectors could be distinguished according to cost coefficient size. The first category comprised four sectors, which displayed a high degree of pass-through (i.e. at least 70 per cent) : chemical products, metal products, motor vehicles, and textiles and clothing. In these sectors, exporters seemed to enjoy strong market power, which enabled them to pass their cost changes through to foreign buyers. In the last three sectors, this situation might reflect the collusive behaviour of exporters, helped by the imposition of voluntary export restraint (VER) arrangements.

The second category included three sectors with a low cost pass-through (i.e. at most 40 per cent) : agricultural and industrial machinery, office machines and electrical goods. Here, exporters appeared not to have very much market power. This was particularly true in the US

markets for office machines and electrical goods, for which the cost coefficient was close to zero, reflecting a strong competitive environment.

b. Misalignment

The impact of misalignment on the process of trade adjustment was recently investigated by Sapir and Sekkat (1995) in a dynamic framework. Their purpose was to examine whether the ERM, by reducing exchange rate misalignment, had modified the expectations of economic agents in favour of greater exchange rate stability and, thereby, improved the process of trade adjustment. The central role is assigned to the reduction of misalignment. While it is widely acknowledged that the ERM has produced such a reduction (Ungerer et al. (1990)), Sapir and Sekkat do not exclude a priori the possibility that this might also have occurred under a regime of flexible rates. They leave it to the data to determine if fixed exchange rate regimes, like the ERM, are required to achieve a smooth process of trade adjustment.

They construct a two-period model of a duopoly competing in a market with differentiated products and consumer switching costs. They explicitly introduce economic agents' expectations of exchange rate stability. In the first period, economic agents are uncertain about the second-period exchange rate level. As in Froot and Klemperer's model, firms' second-period demands depend on first-period market shares due to the presence of switching costs. The main difference between the two models resides in the explicit introduction by Sapir and Sekkat of economic agents' expectations concerning exchange rate stability.

The theoretical analysis shows that the relationship between trade prices and current exchange rate depends upon both the type of product under consideration and exporter's perception about exchange rate stability. The empirical analysis by Sapir and Sekkat investigates whether the ERM, by reducing exchange rate misalignment, has enhanced the perception of stability by exporters as reflected in their pricing behaviour.

Sapir and Sekkat use two samples corresponding to two exchange rate regimes, and investigate whether international pricing decisions differ between the two regimes. In addition, within each exchange rate sample, a distinction is made between two types of

product. The two exchange rate regimes are the adjustable peg EMS and the floating system, which prevailed outside the EMS during the 1980s. The two types of product correspond to situations where dynamics matters or not, i .e. where switching costs are present or not.

Given the theoretical analysis, estimates of the coefficients of the expected exchange rate variable are expected to be negative and to vary across the four cases. With floating exchange rates and switching costs, they are expected to be different from zero. On the contrary, with pegged rates and switching costs, a zero value is expected. Finally, if there are no switching costs, one expects the estimates to be nil, regardless of the exchange rate regime.

The price equation is estimated for six sectors, three where dynamics is thought to play an important role (office machines, electrical goods, and motor vehicles), and three where dynamics is assumed to be unimportant (chemical products, metal products, textiles and clothing).

For each sector, the equation is estimated over two different samples. The ERM sample covers bilateral trade flows among ERM-participating importers and exporters. The importers are France, Germany and Italy. The exporters are the three importers plus Belgium and the Netherlands. The non-ERM sample covers trade flows between pairs of countries, where at least one of the partners is not an ERM member. Importers include, in addition to the above list of importers, the United Kingdom and the United States. Exporters include, in addition to the previous list of exporters, the United Kingdom, the United States and Japan.

Import prices are indexes of disaggregated import unit values. The costs of the importer and the exporter are proxied by the respective value-added deflators. Import prices and value-added deflators were obtained from a data bank constructed by the EC Commission. It includes prices and quantities for exports and imports on a bilateral basis among a number of industrial countries. It is disaggregated into manufacturing sectors defined at the two-digit level of the NACE classification. Contemporary bilateral exchange rates are obtained using the annual average dollar rates (IFS, line rf). Finally, the interest differential between the exporter and the importer is used as a proxy for expected depreciation. It is measured by the twelve-month Eurointerest (end-of-year observations) differential. The twelve-month Eurointerest figure was supplied by the Banque Nationale de Belgique.

The sample period starts in 1980, the year after the EMS was introduced, and ends in 1987. The estimates were performed using ordinary least squares (OLS) on pooled samples of time-series and cross-section data.

The estimated coefficients of the cost variables have the predicted positive sign and are significantly different from zero in nearly all cases. The coefficients of the current exchange rate variable have the predicted negative sign and are significantly different from zero in all cases but one (office machines for the ERM sample).

The main interest of the investigation is the coefficient of the expected exchange rate variable. According to the hypothesis of the authors, this coefficient is significantly different from zero only in situations where dynamics matters and exchange rates float. Among the 10 equations with significant overall F-statistics, the coefficient is nil in 8 cases and negative in 2 (electrical goods and motor vehicles for extra-ERM), as predicted by the theory. This result lends support to the view according to which the EMS matters. By reducing exchange rate misalignments in the ERM, the European Monetary System has succeeded in conveying to economic agents the message that exchange rates are relatively stable. This implies that the optimal price strategy can rely solely on current observations about exchange rates. By contrast, in countries outside the ERM, the results indicate that the degree of pass-through has been lower during the period 1980-87 than it might have been otherwise, due to perceptions about exchange rate instability.

One country where misalignment was particularly pronounced during the 1980s is the United States. Uncertainty about the stability of exchange rates resulting from misalignment was viewed by many economists as being responsible for the relatively low degree of pass-through on US trade prices. This led to questions being raised about the ability of the floating exchange rate regime to accomplish the process of trade adjustment.

The special place of the United States in the debate about the adjustment process under floating rates induced the authors to refine their analysis of non-ERM countries. The non-ERM sample was split into two sub-samples : one excluding the US as either exporter or importer, and the other covering US bilateral trade flows. The results showed a good overall

quality of fit. The estimated coefficients of costs and current exchange rate variables have the predicted signs and are generally significant. The estimated coefficients for the expected exchange rate variables are striking. They confirm that during the period 1980-87, the United States was clearly a special case. Except for office machines, the coefficient for the expected exchange rate is significant (at 10%) in all "dynamic" sectors for the US sub-sample. This coefficient is never significant when US bilateral flows are excluded, or in "static" sectors for the US sub-sample.

The conclusion by Sapir and Sekkat points out that, although floating rates prevailed in other countries as well during the 1980s, it appears that they had a dampening effect on the degree of pass-through only in the United States. They suggest that it is not so much the exchange rate regime as the degree of misalignment that matters in the process of trade adjustment. A system of pegged rates like the EMS may be a sufficient condition to guarantee against major misalignments (Ungerer et al. (1990)), but it is by no means necessary. A system of flexible rates, if properly managed, can perform equally well in this respect. This is clearly illustrated by the elimination of the dollar misalignment after the international agreements reached in the late 1980s.

3. A synthesis

A synthesis of the above review is presented in Table II.1. This synthesis suggests that no clear evidence of a significant adverse effect of volatility on trade has been established. The conclusion is actually representative of the whole evidence concerning the post-war period. Relying either on aggregate trade or on bilateral US data only, the literature was unable to clearly establish such an adverse effect. For instance, Akhtar and Hilton (1984), and Kenen and Rodrick (1986) supported the assumption that volatility had an adverse effect on trade. In contrast, Gotur (1985), Bailey et al. (1986), and IMF (1984) failed to identify such a negative influence. Hence, in 1984 the IMF concluded that "the larger majority of empirical studies on the impact of exchange rate variability on the volume of international trade are unable to establish a systematically significant link between measured exchange rate variability and the volume of international trade, whether on an aggregate or on a bilateral basis" (IMF ; 1984, p. 36).

Table II.1. Variability and EU Trade.

A synthesis of the empirical findings

Type of variability	Impact of variability	
	Impact on the level of trade variables	Impact on the sensitivity of trade variables to exchange rate changes
Volatility	■ Hooper and Kohlhagen (1978) : Q, P ■ Frankel et Wei (1993) : Q ■ Cushman (1983) : Q, P ■ Stockman (1994) : Q No consensus	■ Sapir and Sekkat (1990) : P No effect
Misalignment	■ De Grauwe and de Bellefroid (1990) : Q ■ De Grauwe (1987) : Q ■ Perée et Steinherr (1989) : Q Negative effect	■ Sapir and Sekkat (1995) : P Negative effect

Q = volume equations
P = price equation

As noticed by the IMF, however, the failure to establish a significant link did not prove that it did not exist. Two explanations for such a failure were put forward. First, an economic explanation argued that, in contrast to the interwar period, hedging instruments against exchange rate risk were now available at low cost ; and they reduced the impact of volatility on trade. Second, a statistical explanation called for measurement and econometric problems together with the influence of other economic factors.

Contrary to the link between volatility and trade, there is a consensus in the empirical literature on the negative impact of misalignment on trade. Since the ERM is widely credited for having contributed to reducing misalignment, one may conclude that it has had a positive impact on intra-EC trade. There are some doubts, however, whether a system of pegged rates like the EMS was absolutely necessary to achieve this objective. It may be that a properly managed system of flexible rates could have been equally effective.

III. The model

This section extends the model by Sapir and Sekkat (1995), to analyse simultaneously the effect of volatility and misalignment on trade variables. To our knowledge, this is the first formal model presented in the literature to simultaneously incorporate the effect of the two types of exchange rate variability. In doing so, the model and the subsequent empirical analysis combine the most important features of the four sets of studies presented in Table II.1.

The purpose is to keep the presentation at the minimum level of complexity compatible with the determination of the main relationships between exchange rate variability and trade variables. Consider a two-period model of a duopoly competing in a domestic market. At the beginning of each period, economic agents are uncertain about the exchange rate level. They are also risk averse. Due to the presence of switching costs (Froot and Klemperer (1989)), second-period demand for the firms' products depends on first-period market shares.

In the rest of this section the following subscripts are used : 1 and 2 refer to products, an asterisk refers to the equilibrium situations and a bar refers to first-period variables. No subscript is used for second-period variables.

a. Consumer behaviour [3]

Consider a market where a domestic producer of good 1 is competing with a foreign producer of good 2. The representative consumer in this market has a quadratic and strictly concave utility function :

$$U(x_1, x_2) = \alpha(x_1 + x_2) - \frac{1}{2}\beta(x_1 + x_2)^2 \qquad \text{(III.1)}$$

where x_i = quantity of good i, i = 1,2,

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[3] For the sake of simplicity, the time dimension is disregarded when presenting consumers' and producers' behaviour.

α, β, are positive parameters.

This utility function is a simplified version of the one presented by Singh and Vives (1984), who investigate its properties. The goods are assumed to be perfect substitutes.

The representative consumer is assumed to maximise his surplus : [4]

$$C\,S\,(x_1, x_2) = U(x_1, x_2) - C(x_1, x_2),$$ (III.2)

where $C\,(x_1, x_2)$ is the cost, for the consumer, of using quantities x_1 and x_2. This is defined by :

$$C(x_1, x_2) = (P_1 + S_1)x_1 + (P_2 + S_2)x_2,$$ (III.3)

where P_i = price of good i expressed in terms of the importing country's currency,

S_i = costs attached to the use of good i expressed in terms of the importing

country's currency.

Dynamics is introduced into the model by assuming that S_i is a decreasing function of previous purchases of good i. We consider a simple form for S_i :

$$S_i = \overline{S} - \eta \overline{x}_i, \quad i = 1,2$$ (III.4)

where $\overline{x}_i$ are previous purchases of good i. The second term in the RHS of (4) is the cost of switching between product 1 and 2. It is postulated that η, the marginal switching cost, is small relative to α, β and $\overline{S}$.

Without lost of generality, prices are assumed to be set in terms of the importing country's currency. This implies that the whole risk is borne by the producers and hence that consumer's risk aversion is not relevant here.

b. Producer behaviour

Domestic and foreign producers have constant marginal costs, respectively C_1 and C_2. Each producer chooses the desired level of its sales, taking the other producer's decision as given. Producers announce price levels (in the importing country's currency) and consumers buy goods according to their maximisation programme.

The producers' choice of the desired levels of their sales follows from the maximisation of the following utility functions :

$$DPS = \pi_1 - \rho_1 \left[V(\pi_1) \right]^{1/2} \qquad \text{for the domestic producer}$$

$$FPS = \pi_2 - \rho_2 \left[V(\pi_2) \right]^{1/2} \qquad \text{for the foreign producer}$$

where :

π_i = the profit of producer i in terms of his own currency

$V(\pi_i)$ = the variance of the profit

ρ_i = the relative measure of risk preference. Risk aversion implies $\rho_i > 0$.

The producers' utility function is similar to the one presented by Hooper and Kohlhagen (1978), who provide a detailed discussion.

c. Timing of events

To simplify the analysis, we focus on a two-period situation where individuals are rational and there is no discount factor. During the first period, the representative consumer is assumed to have never bought good 1 or good 2 before. At the beginning of each period, producers announce price levels. They are committed to these levels during that period. The consumer's purchases span the whole period. At the beginning of each period, the average level of exchange rate [5] during this period, e, is uncertain, and economic agents assume that it is the realisation of a random distribution with a mean equal to $\hat{e}$ and variance equal to σ^2.

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[4] This implies that U is defined in monetary terms and has the usual properties of the demand system.
[5] Given that the producers are committed to the announced price levels, while consumers' purchases span the whole, it is natural that the relevant variable to the producers is the average level of exchange rate.

There are different ways to model economic agents' expectations about the future behaviour of an exchange rate. To avoid heavy stochastic modelling, the following simple framework is adopted.

Information about the future behaviour of an exchange rate is generally provided by various economic institutes (central banks, universities, private firms, etc.) However, there is not always a consensus among specialists concerning the future evolution of the exchange rate. The focus in this study is on the future average level of exchange rate and variability. For simplicity, it is assumed that economic agents face only two categories of forecasts provided by economic institutes. Some institutes expect the future exchange rate level to be the same as the past exchange rate level, i.e. $\hat{e} = \bar{e}$, while others expect the two levels to be different, i.e. $\hat{e} \neq \bar{e}$. There is a consensus, however, between institutes that the variance of exchange rate is equal to σ, which is constant over time. The proportions of institutes expecting $\hat{e} = \bar{e}$ and $\hat{e} \neq \bar{e}$ are $0 < \theta < 1$ and $0 < (1 - \theta) < 1$ respectively. Hence, economic agents use the weighed average of the two expectations when taking decisions.

In the first period, economic agents maximise their intertemporal surplus. In the second period, the economic agents maximise their current surplus, taking into account the learning effect through the first-period purchases, $\bar{x}_i$. Firms' costs are $C_1 = \overline{C_1}$ and $C_2 = \overline{C_2}$ for the two periods [6]. At the beginning of the second period, economic agents observe the first-period realisation of exchange rate, $\bar{e}$.

The perfect Nash equilibrium of this game is determined below.

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[6] To avoid trivial solution $(\alpha - C_i - S), (\alpha - C_i - \bar{S})$ are positive.

d. Second-period equilibrium

In the second period, if firms have equal costs, the producer which had the largest market share in the first period enjoys an advantage over the other due to switching costs. The inverse demand system is derived from the maximisation of consumers' surplus (III.2) :

$$P_1 = \alpha - S_1 - \beta(x_1 + x_2),$$ (III.5.a)

$$P_2 = \alpha - S_2 - \beta(x_2 + x_1).$$ (III.5.b)

Utilities of the domestic and foreign firms are :

$$DPS = (P_1 - C_1)x_1 - \rho_1 \left[V((P_1 - C_1)x_1) \right]^{0.5}$$ (III.6.a)

$$FPS = (\hat{e} P_2 - C_2)x_2 - \rho_2 \left[V((e P_2 - C_2)x_2) \right]^{0.5}$$ (III.6.b)

where $\hat{e}$ is the expected average level of exchange rate during the second period (units of foreign currency per unit of domestic currency).

Each firm maximises its utility (III.6), taking the demand system (III.5) and the other firm's decision as given. Equilibrium sales are :

$$x_1^* = \frac{\alpha - \overline{S} + \dfrac{C_2}{\hat{e} - \rho_2\sigma} - 2C_1}{3\beta} + \eta\frac{2\overline{x}_1 - \overline{x}_2}{3\beta}$$ (III.7.a)

$$x_2^* = \frac{\alpha - \overline{S} - 2\dfrac{C_2}{\hat{e} - \rho_2\sigma} + C_1}{3\beta} + \eta\frac{2\overline{x}_2 - \overline{x}_1}{3\beta}.$$ (III.7.b)

Putting equilibrium quantities (III.7) into producers' utilities (III.6) and consumers' surplus (III.2) and using the relationship between prices and quantities (III.5), the equilibrium utilities for firms and consumers are :

$$DPS^* = \beta \left(x_1^*\right)^2,$$ (III.8.a)

$$FPS^* = \beta \left(x_2^*\right)^2 \left(\hat{e} - \rho_2 \sigma\right),$$ (III.8.b)

$$CS^* = \frac{1}{2}\beta \left(x_1^* + x_2^*\right)^2.$$ (III.8.c)

e. First-period equilibrium

In the first period, consumers are not tied down to any particular product or firm, so that only production costs set producers apart from one another. Consumers and producers base their decisions upon not only their first-period utilities, but also upon their expected second-period utilities. The intertemporal surplus of consumers is given by :

$$E(CS^*) + \alpha\left(\overline{x}_1 + \overline{x}_2\right) - \frac{1}{2}\beta\left(\overline{x}_1 + \overline{x}_2\right)^2 - \sum_{i=1}^{2} \left(\overline{P}_i + \overline{S}\right)\overline{x}_i$$ (III.9)

where $E(.)$ is the expectation based on the available information at the beginning of period 1.

Maximising the surplus with respect to $\overline{x}_1$ and $\overline{x}_2$ gives the inverse demand functions :

$$\overline{P}_1 = \overline{\alpha} - \overline{\beta}\left(\overline{x}_1 + \overline{x}_2\right)$$ (III.10.a)

$$\overline{P}_2 = \overline{\alpha} - \overline{\beta}\left(\overline{x}_2 + \overline{x}_1\right)$$ (III.10.b)

where :

$$\overline{\alpha} = \alpha - \overline{S} + \frac{\eta}{9\beta}\left(2\alpha - 2\overline{S} - C_1 - C_2 \, E\left(\frac{1}{\hat{e} - \rho_2\sigma}\right)\right)$$

$$\overline{\beta} = \beta - \frac{\eta^2}{9\beta}$$

These parameters are modified versions of α and β, when consumer switching costs are taken into account.

System (III.10) shows that an increase in the parameter $\overline{\alpha}$ results in an increase in $\overline{x}_1$ and $\overline{x}_2$. Since switching costs (i.e. $\eta > 0$) will increase the value of $\overline{\alpha}$, they increase the demand for goods 1 and 2 in period 1. At the same time switching costs will lower the impact on price, $\overline{\beta}$. In other words, switching costs increase the elasticity of demand. The relationship between η and first-period demand is illustrated in appendix D.

Knowing the inverse demand functions (III.10), each producer chooses the first-period sales that maximise its intertemporal utility :

$$\overline{DPS} = E\left[\beta\left(x_1^*\right)^2\right] + \left(\overline{P}_1 - C_1\right)\overline{x}_1 - \rho_1\left[V\left(\left(\overline{P}_1 - C_1\right)\overline{x}_1\right)\right]^{0.5} \tag{III.11.a}$$

$$\overline{FPS} = E\left[\beta\left(x_2^*\right)^2\left(\hat{e} - \rho_2\sigma\right)\right] + \left(\hat{e}\,\overline{P}_2 - C_2\right)\overline{x}_2 - \rho_2\left[V\left(\left(\overline{e}\,\overline{P}_2 - C_2\right)\overline{x}_2\right)\right]^{0.5} \tag{III.11.b}$$

where $\hat{e}$ is the first-period expected average level of exchange rate.

The resulting equilibrium quantities are :

$$\overline{x}_1^* = \frac{2\tilde{\beta}^e\left(\tilde{\alpha}_1^e - C_1\right) - \tilde{\gamma}\left(\tilde{\alpha}_2^e - \dfrac{C_2}{\hat{\overline{e}} - \rho\sigma}\right)}{4\tilde{\beta}\,\tilde{\beta}^e - \tilde{\gamma}\,\tilde{\gamma}^e} \tag{III.12.a}$$

$$\overline{x}_2^* = \frac{2\tilde{\beta}\left(\tilde{\alpha}_2^e - \dfrac{C_2}{\hat{\overline{e}} - \rho\sigma}\right) - \tilde{\gamma}^e\left(\tilde{\alpha}_1^e - C_1\right)}{4\tilde{\beta}\,\tilde{\beta}^e - \tilde{\gamma}\,\tilde{\gamma}^e} \tag{III.12.b}$$

where : $\tilde{\alpha}_1^e = \overline{\alpha}_1 + \dfrac{4\eta}{9\beta}\left(\alpha - \overline{S} - 2C_1 + C_2 E\left(\dfrac{1}{\hat{e} - \rho_2\sigma}\right)\right)$

$$\tilde{\alpha}_2^e = \overline{\alpha}_1 + \frac{4\eta}{9\beta} \frac{E(\hat{e}) - \rho\sigma}{\hat{\overline{e}} - \rho\sigma} \left(\alpha - \overline{S} - 2C_2 \frac{1}{E(\hat{e}) - \rho_2\sigma} + C_1 \right)$$

$$\tilde{\beta} = \overline{\beta} - \frac{4\eta^2}{9\beta}$$

$$\tilde{\beta}^e = \overline{\beta} - \frac{4\eta^2}{9\beta} \frac{E(\hat{e}) - \rho_2\sigma}{\hat{\overline{e}} - \rho_2\sigma}$$

$$\tilde{\gamma} = \overline{\beta} + \frac{4\eta^2}{9\beta}$$

$$\tilde{\gamma}^e = \overline{\beta} + \frac{4\eta^2}{9\beta} \frac{E(\hat{e}) - \rho_2\sigma}{\hat{\overline{e}} - \rho_2\sigma}$$

These parameters are modified versions of, respectively, α and β, which take into account both consumer switching costs and producers' behaviour. They embody the dynamic effect of exchange rate variations through the presence of η.

Substituting $\overline{x}_1^*$ and $\overline{x}_2^*$ into $\overline{P}_2$ gives the optimal pricing policy for the exporter, taking into account switching costs :

$$\overline{P}_2^* = \overline{\alpha} - \overline{\beta} \frac{(2\tilde{\beta} - \tilde{\gamma})}{4\tilde{\beta}^e\tilde{\beta} - \tilde{\gamma}\,\tilde{\gamma}^e} \left(\tilde{\alpha}_2^e - \frac{C_2}{\hat{\overline{e}} - \rho\sigma} \right) - \overline{\beta} \frac{(2\tilde{\beta}^e - \tilde{\gamma}^e)}{4\tilde{\beta}^e\tilde{\beta} - \tilde{\gamma}\tilde{\gamma}^e} (\tilde{\alpha}_1^e - C_1) \quad \text{(III.13)}$$

Notice that, given the assumption that η is small relative to α, β and $\overline{S}$, the terms $\overline{\beta}, \tilde{\beta}, \tilde{\beta}^e, \tilde{\gamma}, \tilde{\gamma}^e$, $\dfrac{2\tilde{\beta} - \tilde{\gamma}}{4\tilde{\beta}^e\tilde{\beta} - \tilde{\gamma}\tilde{\gamma}^e}$ and $\dfrac{2\tilde{\beta}^e - \tilde{\gamma}^e}{4\tilde{\beta}^e\tilde{\beta} - \tilde{\gamma}\tilde{\gamma}^e}$ are positive.

f. Discussion

Equations (III.12) and (III.13) can be used to compute the effect of a change in exchange rates, costs or variability on the foreign producer's price and sales. As far as costs are concerned it can easily be seen from (III.12) and (III.13) that if $\eta = 0$, **an increase in domestic cost increases $\overline{P}_2^*$ and $\overline{x}_2^*$. An increase in foreign cost increases $\overline{P}_2^*$ and decreases $\overline{x}_2^*$.** Using the continuity argument and the assumption that η is small relative to α, β and $\overline{S}$ **, these conclusions remain valid for $\eta \neq 0$.**

In what follows, we will concentrate entirely on the effect of a change in variables related to exchange rate behaviour. Totally differentiating (III.12b) and (III.13) gives :

$$d\overline{P}_2^* = \frac{\partial \overline{P}_2^*}{\partial C_1} dC_1 + \frac{\partial \overline{P}_2^*}{\partial C_2} dC_2 + \frac{\partial \overline{P}_2^*}{\partial \hat{e}_1} d\hat{\overline{e}} + \frac{\partial \overline{P}_2^*}{\partial E(\hat{e})} dE(\hat{e}) + \frac{\partial \overline{P}_2^*}{\partial \sigma} d\sigma \qquad \text{(III.14.a)}$$

$$d\overline{X}_2^* = \frac{\partial \overline{X}_2^*}{\partial C_1} dC_1 + \frac{\partial \overline{X}_2^*}{\partial C_2} dC_2 + \frac{\partial \overline{X}_2^*}{\partial \hat{e}_1} d\hat{\overline{e}} + \frac{\partial \overline{X}_2^*}{\partial E(\hat{e})} dE(\hat{e}) + \frac{\partial \overline{X}_2^*}{\partial \sigma} d\sigma \qquad \text{(III.14.b)}$$

The discussion starts with the issue of dynamics.

If there are no switching costs $(\eta = 0)$, the degree of pass-through (*the sensitivity of trade prices to first-period exchange rate change*) is independent of future values of costs and exchange rates :

$$\frac{\partial \overline{P}_2^*}{\partial \hat{e}_1} \bigg|_{\eta=0} = -\frac{1}{3} \frac{C_2}{(\overline{\hat{e}})^2}$$

which is always negative.

If switching costs are present $(\eta > 0)$, the effect of a change of current exchange rates on trade prices depends upon expectations regarding exchange rate stability, i.e. the above-mentioned parameter θ.

To illustrate the role of economic agents' perceptions about exchange rate stability, consider two extreme cases : $\theta = 1$, i.e. everybody expects the exchange rate to remain at the past level, and $\theta = 0$, i.e. everybody expects the exchange rate to be different from the past level.

Let us begin with $\theta = 0$. Equation (III.15) gives the change of foreign producer price following an expected change of current exchange rate level.

$$\frac{\partial \overline{P}_2^*}{\partial \hat{e}}\bigg|_{\theta=0} = -\overline{\beta}\,\frac{2\tilde{\beta} - \tilde{\gamma}}{4\tilde{\beta}\,\tilde{\beta}^e - \tilde{\gamma}\,\tilde{\gamma}^e}\,\frac{C_2}{\left(\hat{e} - \rho_2\sigma\right)^2} + \frac{\eta}{3\beta}\,\frac{E(\hat{e}) - \rho_2\sigma}{\left(\hat{e} - \rho_2\sigma\right)}\,\frac{4}{3\left(4\tilde{\beta}\,\tilde{\beta}^e - \tilde{\gamma}\,\tilde{\gamma}^e\right)}$$

$$\left\{\overline{\beta}\left(2\tilde{\beta} - \tilde{\gamma}\right)\left(\alpha - \overline{S} - \frac{2C_2}{E(\hat{e}) - \rho_2\sigma} + C_1\right) + \eta\left[\left(\overline{\alpha} - \overline{P}_2^*\right)\left(4\tilde{\beta} + \tilde{\gamma}\right) - \left(\tilde{\alpha}_1^e - C_1\right)3\overline{\beta}\right]\right\}\text{(III.15)}$$

which is negative and smaller in absolute value than $\dfrac{\partial \overline{P}_2^*}{\partial \hat{e}}\bigg|_{\eta=0}$ for small positive values of

η. If switching costs are very large, the sign of the pass-through can be reversed.

By contrast, when all the economic agents consider the change in exchange rate as permanent $(\theta = 1)$, the degree of pass-through is given by :

$$\frac{\partial \overline{P}_2^*}{\partial \hat{e}}\bigg|_{\theta=1} = -\overline{\beta}\,\frac{2\tilde{\beta} - \tilde{\gamma}}{4\tilde{\beta}^2 - \tilde{\gamma}^2}\,\frac{C_2}{\left(\hat{e} - \tilde{\gamma}^2\right)^2} - \frac{\eta}{3\beta}\,\frac{C_2}{\left(\hat{e} - \rho_2\sigma\right)^2}\left[2\overline{\beta}\,\frac{1}{2\tilde{\beta} + \tilde{\gamma}} - \frac{1}{3}\right] \qquad \text{(III.16)}$$

which is always negative. The degree of pass-through in this case is **larger in absolute terms** than in the former case if $\eta > 0$.

In practice, however, the parameter θ is likely to be between 0 and 1, i.e. some share of the exchange rate level change is expected to be permanent. Hence, the export price change $\left(\dfrac{\partial \overline{P}_2^*}{\partial \hat{\overline{e}}}\right)$ lies between lower and upper boundaries provided, respectively, by equations (III.15) and (III.16). It can be written as :

$$\frac{\partial \overline{P}_2^*}{\partial \hat{\overline{e}}} = \left.\frac{\partial \overline{P}_2^*}{\partial \hat{\overline{e}}}\right|_{\theta=0} + \frac{\partial \overline{P}_2^*}{\partial E(\hat{e})}\frac{\partial E(\hat{e})}{\partial \hat{\overline{e}}} \tag{III.17}$$

In other words, the response of export prices to current changes in exchange rates includes not only direct effects (given by equation (III.15)), but also indirect effects through the expectation that some share of $\hat{\overline{e}}$ will persist into the next period. Moreover, given that $\dfrac{\partial \overline{P}_2^*}{\partial \hat{\overline{e}}}$ and $\left.\dfrac{\partial \overline{P}_2^*}{\partial \hat{\overline{e}}}\right|_{\theta=0}$ are negative and that the former is larger in absolute value than the latter, equation (III.17) implies that $\dfrac{\partial \overline{P}_2^*}{\partial E(\hat{e})}$, **the impact of expected exchange rate on trade price, is negative**.

As far as trade volume is concerned, it can easily be shown, based on equations (III.10) and on the above discussion, that the volume will increase (decrease) more if exchange change is seen as permanent rather than temporary.

We turn now to the impact of volatility on trade variables. For the sake of simplicity, we leave aside dynamics, i.e. $\eta = 0$. The impact of volatility on foreign good price and volume is the following :

$$\left.\frac{\partial \overline{X}_2^*}{\partial \sigma}\right|_{\eta=0} = -2\rho_2 \frac{C_2}{3\beta\left[\hat{\overline{e}} - \rho_2\sigma\right]^2} \tag{III.18}$$

$$\left.\frac{\partial \overline{P}_2^*}{\partial \sigma}\right|_{\eta=0} = \rho_2 \frac{C_2}{3\left[\hat{\overline{e}} - \rho_2\sigma\right]^2} \tag{III.19}$$

Equation (III.18) shows that **an increase in volatility reduces trade volume**, while equation (III.19) shows that **an increase in volatility increases trade price**. Note that the positive sign of $\left.\dfrac{\partial \overline{P}_2^*}{\partial \sigma}\right|_{\eta=0}$ is conditional on the assumption that the whole risk is borne by the exporter.

In the opposite case, the sign of the derivative should be negative.

To sum up, the theoretical analysis shows that an increase in domestic or foreign costs should increase import prices. Import volume should decrease if foreign cost increases and it should increase if domestic cost increases. A depreciation of the national currency (e decreases), either actual or expected, should increase import prices and decrease import volume. An increase in volatility should increase import price and decrease import volume. By analogy, similar results are anticipated for export prices (dominated in domestic currency). For export volume we also have the same results except, of course, that a depreciation should increase export volume.

IV. The empirical analysis

The theoretical analysis in Section III pointed out the importance of the impact of exchange rate variability on trade variables when economic agents are risk averse and they are concerned with future market shares.

The aim of this section is to estimate volume and price equations for both import and export in the case of some European countries. The estimation should incorporate the major insights from Section III. It should also be based on data from the Commission in order either to permit replications of the procedure for other European countries, or to update the analysis for the countries considered in this study.

The analysis is conducted for four large countries (France, Italy, Germany and the UK) and one small country (Belgium). The choice of these countries is motivated by their contrasting behaviour with respect to exchange rate fluctuations.

The Commission provided the following data for each country [7] : total import (m) and export (x) of goods at 1990 prices, prices of import (pm) and export (px) in national currencies, actual nominal effective exchange rate (e), expected nominal effective exchange rate (ae), volatility of the nominal effective exchange rate (lve), relative unit wage costs (w), national GDP (y) and GDP of EC-15 (yw) plus the US and Japan.

Actual and expected nominal effective exchange rates are computed as weighted averages of bilateral rates of EC-15 plus the US and Japan. Expected exchange rate changes are derived from Eurointerest differentials. Volatility is computed as the standard deviation of monthly exchange rate changes for a given year. Relative unit wage costs are derived from a ratio between national and foreign costs. Both GDP variables are in 1990 prices and national currencies.

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[7] A detailed description of the data is presented in appendix C.

In this section we adopt an indirect solution to the problem of measuring misalignment (see the discussion in Section I). We consider the consequence of misalignment. It concerns economic agents' expectations about future exchange rate behaviour. In a period of substantial misalignment, economic agents expect the exchange rate to revert to its equilibrium level. Hence, using data on the expected exchange rate leads us to take account of economic agents' perception about the degree of misalignment.

Before embarking upon the estimation of trade variables equations, one should study the time-series properties of the data (see Appendix A). Of prime interest here is the degree of integration of individual series and the existence of cointegration relationships between the series.

The results of the integration/cointegration analysis, as well as the discussion of these results, are presented in Appendix B. To summarise the discussion there, the I(1) hypothesis is accepted for all the variables except volatility, which is considered as stationary, i.e. I(0). The results of the cointegration tests suggest that there exist long-term relationships between trade variables on the one hand and foreign and domestic demands, exchange rate, relative costs and expected exchange rate on the other.

No long-run relationship may exist between volatility, which is I(0), and trade variables, which are I(1). It follows, therefore, that previous studies relating levels of trade variables to volatility are questionable. Notice, however, that a short-run link between volatility and trade variables may exist. In this case, a shock to volatility would have only a temporary effect on trade variables. To test for the existence of such a short-run link, a regression of the *first difference* of trade variables (which become I(0)) on error correction terms, on the first differences of the I(1) explanatory variables (also becoming I(0)), and on the level of volatility, I(0), is performed.

Combining the results of Section III and of the cointegration analysis, the following system of equation is estimated :

$$dpx = \beta_0 + \beta_1 de + \beta_2 dyw + \beta_3 dw + \beta_4 lve + \beta_5 dae + \beta_6 ct_{px-1} \qquad \text{(IV.1.a)}$$

$$dx = \alpha_0 + \alpha_1 de + \alpha_2 dyw + \alpha_3 dw + \alpha_4 lve + \alpha_5 dae + \alpha_6 ct_{x-1} \qquad \text{(IV.1.b)}$$

$$dpm = \gamma_0 + \gamma_1 de + \gamma_2 dy + \gamma_3 dw + \gamma_4 lve + \gamma_5 dae + \gamma_6 ct_{pm-1} \qquad \text{(IV.1.c)}$$

$$dm = \varphi_0 + \varphi_1 de + \varphi_2 dy + \varphi_3 dw + \varphi_4 lve + \varphi_5 de + \varphi_6 ct_{m-1} \qquad \text{(IV.1.d)}$$

$$de = \delta_0 + \delta_1 dpx + \delta_2 dx + \delta_3 dpm + \delta_4 dm + \delta_5 ct_{e-1} \qquad \text{(IV.1.e)}$$

where :

px = log of export price in national currency.

x = log of export of goods at 1990 prices.

pm = log of import price in national currency.

m = log of import of goods at 1990 prices.

e = log of nominal effective exchange rate.

y = log of GDP (home country) at 1990 prices - national currency.

yw = log of main partners' GDP at 1990 prices - national currency.

lve = log of volatility (standard deviation of monthly exchange rate changes for a given year).

ae = log of expected nominal effective exchange rate.

w = log of relative unit wage costs.

ct_{px} (ct_x)= error correction term computed as the residual of the regression of px (or x) on e, yw, w and ae.

ct_{pm} (ct_m)= error correction term computed as the residual of the regression of pm (or m) on e, y, w and ae.

ct_e = error correction term computed as the residual of the regression of e on pm, px, x and m.

d = stands for first difference.

The fifth equation (IV.1.e) is added to the system in order to take account of the fact that, with aggregate data, there is a simultaneity issue between trade variables and exchange rate. The system is estimated using the three stages least square (3SLS) method over the period 1975-

1994 [8]. In what follows, the focus will be on the equations of the trade variables. The following signs of the coefficients are anticipated. In equation (IV.1.a), β_1 and β_5 should be negative because an appreciation, either actual or expected, of the domestic currency $(de > 0, dae > 0)$ should induce exporters to lower the price of export (in domestic currency) in order to preserve current sales or future market shares. An upward shift of the demand curve $(dyw > 0)$ should increase export price, i.e. $\beta_2 > 0$. The coefficient β_3 may be either positive or negative because dw is a ratio between domestic and foreign costs. The increase of either the domestic or the foreign costs leads to an increase in export prices. On the one hand, the domestic producer facing an increase in its costs will increase export price in order to preserve (at least partly) profit margin. Such behaviour is possible without a large loss of market share because of imperfect competition. On the other hand, and for the same reason, the foreign competitor will increase the price of its good when its costs increase. Thus the price of domestic exports could also be increased without loss of competitiveness. However, given that the foreign cost is the denominator of dw, when it increases dw decreases. The relation between dw and dpx is negative in this case. Hence, the sign of β_3 depends on which of the two effects (domestic or foreign costs) dominates. The impact of volatility on export price may be positive or negative, depending on whether the risk is borne by the importer or by the exporter ; $\beta_4 \gtrless 0$.

In equation (IV.1.b), α_1 and α_5 are negative because actual or expected appreciations depress export. Export volume depends positively on foreign demand ; $\alpha_2 > 0$ and negatively on volatility ; $\alpha_4 < 0$. Given that export depends positively on foreign cost and negatively on domestic cost, the sign of the coefficient of dw (ratio between domestic and foreign costs) is unambiguously negative ; $\alpha_3 < 0$.

The justification of the signs in equations (IV.1.c) and (IV.1.d) uses a reasoning similar to the above. We shall be brief. Appreciation of the national currency lowers import price (in domestic currency) and increases import ; $\gamma_1, \gamma_5 < 0$ and $\varphi_1, \varphi_5 > 0$. An increase of domestic demand increases import price and volume ; $\gamma_2, \varphi_2 > 0$. The impact of dw on dpm is either

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[8] Other methods of estimation were used and give similar results. Preliminary estimations suggest that the troubled period 70-74 (oil crisis, non-convertibility of the dollar, etc.) should be disregarded.

positive or negative ; $\gamma_3 \gtrless 0$, while its impact on dm is positive ; $\varphi_3 > 0$. Finally, volatility

reduces import ; $\varphi_4 < 0$, and may either increase or decrease import prices ; $\gamma_4 \gtrless 0$.

Table IV.3. Estimation results - Equations of trade variables
France

Dependent variable	Explanatory variables	Coefficients	t-statistics	R2
dpx				0.68
	ct_{px}	-0.98	-2.75*	
	de	-1.64	-1.97**	
	dyw	-0.81	-1.17	
	dw	1.34	2.69*	
	lve	-0.02	-0.89	
	dae	0.26	0.42	
dx				0.71
	ct_x	-0.46	-2.37*	
	de	-0.41	-1.06	
	dyw	1.26	3.73*	
	dw	-0.17	-0.73	
	lve	-0.01	-0.67	
	dae	0.09	0.32	
dpm				0.61
	ct_{pm}	-0.27	-1.02	
	de	-0.63	-0.58	
	dy	0.52	0.72	
	dw	1.74	2.34*	
	lve	-0.04	-1.10	
	dae	-0.59	-0.71	
dm				0.95
	ct_m	-0.87	-9.30*	
	de	0.45	2.14*	
	dy	2.64	20.64*	
	dw	0.51	3.96*	
	lve	-0.02	-2.34*	
	dae	0.16	1.05	

* = significant at 5%.
** = significant at 10%.

Table IV.4. Estimation results - Equations of trade variables
Italy

Dependent variable	Explanatory variables	Coefficients	t-statistics	R2
dpx				0.80
	ct_{px}	-0.07	-0.28	
	de	-0.78	-1.67**	
	dyw	0.86	0.91	
	dw	1.48	3.70*	
	lve	0.01	0.45	
	dae	0.14	0.40	
dx				0.65
	ct_x	-0.71	-3.96*	
	de	-0.48	-1.61	
	dyw	2.05	4.44*	
	dw	-0.36	-1.74**	
	lve	0.00	-0.10	
	dae	0.00	0.01	
dpm				0.86
	ct_{pm}	-0.21	-0.95	
	de	-1.61	-2.81*	
	dy	0.19	0.30	
	dw	1.95	3.38*	
	lve	-0.01	-0.26	
	dae	0.64	1.60	
dm				0.94
	ct_m	-1.17	-3.92*	
	de	-0.24	-1.27	
	dy	2.15	12.08*	
	dw	-0.11	-0.74	
	lve	0.01	1.14	
	dae	0.37	2.52*	

* = significant at 5%.
** = significant at 10%.

Table IV.5. Estimation results - Equations of trade variables
Germany

Dependent variable	Explanatory variables	Coefficients	t-statistics	R2
dpx				0.25
	ct_{px}	-0.32	-1.46	
	de	-1.02	-0.97	
	dyw	-0.25	-0.60	
	dw	-0.44	-1.73**	
	lve	-0.01	-0.41	
	dae	1.02	1.26	
dx				0.42
	ct_x	-0.02	-0.14	
	de	1.65	1.57	
	dyw	0.90	2.01*	
	dw	-0.11	-0.43	
	lve	-0.04	-1.48	
	dae	-1.97	-2.30*	
dpm				0.71
	ct_{pm}	-0.42	-1.43	
	de	-1.92	-0.73	
	dy	-0.42	-0.58	
	dw	-1.35	-2.52*	
	lve	-0.01	-0.15	
	dae	1.34	0.70	
dm				0.95
	ct_m	-0.88	-4.36*	
	de	0.30	0.66	
	dy	1.99	14.99*	
	dw	0.10	1.12	
	lve	-0.01	-0.49	
	dae	-0.28	-0.74	

* = significant at 5%.
** = significant at 10%.

Table IV.6. Estimation results - Equations of trade variables
United Kingdom

Dependent variable	Explanatory variables	Coefficients	t-statistics	R2
dpx				0.72
	ct_{px}	-0.34	-0.99	
	de	-0.89	-0.91	
	dyw	-0.53	-0.78	
	dw	1.48	1.60	
	lve	-0.01	-0.33	
	dae	0.09	0.29	
dx				0.88
	ct_x	-0.48	-2.17*	
	de	-0.16	-1.35	
	dyw	1.09	6.72*	
	dw	0.14	1.15	
	lve	-0.01	-2.78*	
	dae	-0.22	-4.63*	
dpm				0.63
	ct_{pm}	-0.29	-1.76**	
	de	-0.60	-1.16	
	dy	-0.03	-0.12	
	dw	0.95	1.99**	
	lve	-0.01	-0.53	
	dae	-0.09	-0.46	
dm				0.92
	ct_m	-1.19	-4.65*	
	de	-0.24	-1.00	
	dy	1.60	10.38*	
	dw	-0.09	-0.39	
	lve	0.00	0.27	
	dae	0.11	1.31	

* = significant at 5%.
** = significant at 10%.

Table IV.7. Estimation results - Equations of trade variables
Belgium

Dependent variable	Explanatory variables	Coefficients	t-statistics	R2
dpx				0.86
	ct_{px}	-0.93	-3.26*	
	de	0.48	0.90	
	dyw	-0.29	-1.01	
	dw	-1.04	-4.62*	
	lve	0.00	-0.15	
	dae	-1.15	-2.73*	
dx				0.85
	ct_x	-0.84	-6.64*	
	de	0.08	0.37	
	dyw	1.29	5.91*	
	dw	0.07	0.69	
	lve	0.00	-0.25	
	dae	-0.23	-1.23	
dpm				0.89
	ct_{pm}	-0.52	-0.94	
	de	0.32	0.37	
	dy	-0.35	-1.30	
	dw	-1.35	-5.10*	
	lve	-0.02	-0.51	
	dae	-1.19	-1.64	
dm				0.94
	ct_m	-1.32	-5.94*	
	de	-0.01	-0.06	
	dy	1.91	13.49*	
	dw	0.02	0.19	
	lve	0.00	-0.54	
	dae	0.26	1.80**	

* = significant at 5%.
** = significant at 10%.

Table IV.3 presents the results for France. The overall quality of fit is very high. The R_2 value lies between 0.61 and 0.95. The equation of import volume exhibits the highest R_2 (0.95). The coefficients of the explanatory variables have the anticipated sign and are of reasonable magnitude (when they are significant) in all the equations. The coefficients of the error correction term are highly significant (except for dpm). This confirms the importance of the long-run ties in determining the short-run dynamic of trade variables. The important implication of this result is that the usual practice of estimating equations in first difference only (i.e. without taking account of cointegration results) suffers from serious misspecification.

The intuition behind the importance of the incorporation of the error correction term into the regression is the following. Let us consider the relation between export volume and volatility.

Given that export is I(1) and volatility is I(0), only a short-run relationship may exist between the two variables. This means that a shock to volatility cannot have a permanent effect on export because of the attraction force of the long-run path of export. The volume of export first responds to the shock and then reverts to its long-run path. Hence, ignoring the existence of this long-run path when performing the regression lead to a misperception of the behaviour of the variables.

As far as individual explanatory variables are concerned, exchange rate and relative wages are significant in the export price equation, while only the latter is significant in the import price equation. In the export volume equation, the foreign demand coefficient is significant, and not the coefficients of the remaining variables. Finally, the import volume equation exhibits not only the highest R_2 , but also significant coefficients for almost all the variables. Short-term variability (volatility) has a negative impact on the growth rate of import volume.

The results for Italy are presented in Table IV.4. The overall quality of fit is very high. The R_2 lies between 0.65 and 0.94. Again the equation of import volume has the highest quality of fit (0.94). When they are significant, the coefficients have the anticipated sign and a reasonable magnitude. The error correction term is significant in volume equations and not in price equations. Looking at individual variables, relative wages is the unique significant variable in the export price equation. It is also significant, together with exchange rate, in the import price equation. In the export volume equation there are two significant variables : foreign demand and relative wages. Finally, as in the case of France, the import volume equation has the highest R_2 and the highest number of significant coefficients : domestic demand, relative wages and expected exchange rate. In contrast, for Italy this is the proxy of medium-term variability (misalignment) which has a significant coefficient.

The German results (Table IV.5) exhibit a low quality of fit (0.25) for export price, a medium quality of fit (0.42) for export volume, and very high quality of fit for import price and volume (0.71 and 0.95 respectively). The error correction term has a significant coefficient in the import volume equation. Looking at individual variables, it appears that relative wages is the only significant variable in the price equations and that demand is the only significant variable in the import volume equation. In the export volume equation, significant coefficients are

those of demand and of expected exchange rate (the proxy of misalignment). When they are significant the coefficients have the anticipated sign and a reasonable magnitude.

Estimation results for the UK (Table IV.6) show a high quality of fit (between 0.63 and 0.92), especially for the import volume equation. No coefficient is significant in the export price equation. The coefficients of the error correction term are significant in the remaining three equations. Here again, and except for variability and error correction, demand is the only significant variable in volume equations, while relative wages is the only significant variable in price equations. Both short-term and medium-term proxies of variability have significant coefficients in the export volume equation. The signs and the magnitude of the significant coefficients are in accordance with economic theory.

The last set of results concerns a small open economy : that of Belgium. The results for this country (Table IV.7) exhibit a pattern very similar to those of the other countries : a high quality of fit (from 0.85 to 0.94), especially for the import volume equation (0.94), an important role of the error correction term (dpx, dx and dm), and a clear difference between the roles of demand (the only determinant of volumes) and of relative wages (the only determinant of prices). Short-term variability has no impact in the Belgian case, while medium-term variability significantly affects export price and import volume.

Combining the results for the five countries under study, several interesting features emerge. First, taking account of the long-term properties of the system through cointegration analysis is crucial to the quality of the results. The above analysis has shown that the error correction term, which ties the short-term dynamics of trade variables to their long-term path (cointegration relationship), is in general an important explanatory variable in the equations. Therefore, ignoring such a tie, as it is the practice in many studies, induces misspecification and misunderstanding of the behaviour of trade variables. Second, it appears that a major determinant of price changes (import and export) is relative wages changes and a major determinant of volume changes is domestic or foreign demand changes. It appears, therefore, that in the short term, the growth of international trade is mainly dependent on demand, while the evolution of the terms of trade depends mainly on relative costs. A possible explanation for this finding may rely on low short-term elasticities of price with respect to income and of volume with respect to price (see Hooper and Kohlhagen (1978) for a discussion). Third,

exchange rate variability seems to affect trade volume almost exclusively. Whether the impact of variability concerns export or import, and whether this impact is driven by volatility or by misalignment, depends on the country. The impact concerns the volume of import in France, Italy and Belgium. It concerns the volume of export in Germany and the UK. More interesting is the type of variability, which appears to have a significant impact. Misalignment significantly affects trade in four cases out of five : Italy, Germany, the UK and Belgium. Volatility has a significant impact on trade in only two cases out of five : France and the UK.

Compared to the existing literature the present study has two new features. First, a cointegration approach is adopted. Second, the impacts of volatility and misalignment are examined simultaneously.

Adopting cointegration analysis not only ensures a correct specification and inference, but also leads to useful policy recommendations. It is possible to distinguish between structural and cyclical determinants of trade variables. Structural determinants are those which are involved in the (long-term) cointegration relationship. The results have shown that demand, costs, exchange rate and misalignment are structural determinants of trade variables, i.e. they determine the long-term path.

On the contrary, exchange rate volatility is at most a short-term determinant. An increase in volatility will have only a temporary effect on trade variables. These variables first respond to the change in volatility and then revert to the long-term path. In other words volatility cannot be responsible for a long-term disequilibrium in trade balance. The main policy implication is that the response to a structural disequilibrium in trade must rely on the long-term determinants (demand, costs, misalignment, etc.) and not on volatility.

The simultaneous analysis of misalignment and volatility showed that the former has a long-term impact on trade variables, while the latter has only a short-term impact. Moreover, the impact of volatility was found in only a few cases, whereas misalignment has an impact in almost all the countries. This is in accordance with the findings of the literature.

More striking is the fact that variability seems to affect only trade volumes, and that it does not do so uniformly for export and import and across countries. The different impact of

variability on prices and volume was also reported in the case of European countries by Cushman (1983), Gotur (1985), and Akhtar and Hilton (1984). Cushman (1982) suggested that this contrast might be explained by reference to the low elasticity of prices in the short term. This low elasticity might be due, for instance, to the presence of switching costs. A producer might prefer holding prices unchanged in order to preserve its market share and to benefit from consumers' loyalty in the future. The non-uniform impact of misalignment across volume equations (export versus import) may be explained on the basis of the empirical analysis of the dynamic imperfect competition models of trade. The results of Baldwin and Krugman (1989) and Froot and Klemperer (1989) established that misalignment plays a role only for those sectors with either sunk costs on the supply side or switching costs on the demand side. In addition, Sapir and Sekkat (1995) demonstrate that the role of misalignment also depends on the type of exchange rate regime linking trade partners. It follows that misalignment will appear as a significant explanatory variable only for some sectors and for flows between some partners. Hence, its significance across volume equations depends on the composition of trade in terms of goods and partners. As a consequence, the results on variability do not mean, for instance, that the French importers or exporters are not sensitive to misalignment. Instead, the results imply only that at the aggregate level (over sectors and partners), misalignment is not a major determinant of the short-term behaviour of the French trade.

Tables IV.8. The contribution of explanatory variables to the growth rate of trade variables

	France	Italy	Germany	UK	Belgium
dpx	4.87	8.17	1.99	5.72	2.90
	4.87	*8.17*	*1.99*	*5.72*	*3.46*
de	1.82	-	-	-	-
dyw	-	-	-	-	-
dw	0.85	4.58	0.46	-	2.48
lve	-	-	-	-	-
dae	-	-	-	-	-0.56
dx	4.37	5.60	5.22	4.53	4.58
	4.37	*5.60*	*10.89*	*6.98*	*4.58*
de	-	-	-	-	-
dyw	3.42	5.78	2.54	3.07	3.64
dw	-	-	-	-	-
lve	-	-	-	-1.63	-
dae	-	-	-5.67	-0.42	-
dpm	4.85	7.59	1.52	5.20	2.92
	4.85	*7.59*	*1.52*	*5.20*	*2.92*
de	-	7.89	-	-	-
dy	-	-	-	-	-
dw	1.10	6.04	1.42	2.43	3.22
lve	-	-	-	-	-
dae	-	-	-	-	-
dm	4.13	4.95	4.81	4.43	4.32
	7.39	*6.68*	*4.81*	*4.43*	*4.19*
de	-0.50	-	-	-	-
dy	6.58	5.94	5.51	3.86	5.36
dw	0.32	-	-	-	-
lve	-3.26	-	-	-	-
dae	-	-1.73	-	-	0.13
d(px*x)	9.24	13.77	7.21	10.25	7.48
	9.24	*13.77*	*12.88*	*12.30*	*8.04*
de	1.82	-	-	-	-
dyw	3.42	5.78	2.54	3.07	3.64
dw	0.85	4.58	0.46	-	2.48
lve	-	-	-	-1.63	-
dae	-	-	-5.67	-0.42	-0.56
d(pm*m)	8.99	12.54	6.32	9.63	7.24
	12.25	*14.27*	*6.32*	*9.63*	*7.11*
de	-0.50	7.89	-	-	-
dy	6.58	5.94	5.51	3.86	5.36
dw	1.43	6.04	1.42	2.43	3.22
lve	-3.26	-	-	-	-
dae	-	-1.73	-	-	0.13

The regression results in Tables IV.3 to IV.7 are used to quantify the contribution of the independent variables to the growth rate of trade variables over the sample period.   To

compute the contribution of a given variable, its regression coefficient is multiplied by its average level over the sample period. Such a calculation may be conducted with confidence only for those variables with a significant coefficient. The results are, therefore, reported for these cases only.

In Table IV.8 there are six sets of results, i.e. one for each trade variable, one for the value of export and one for the value of import. Within each set, the first line gives the growth rate of the relevant trade variable. The second line gives (in italics) the estimated growth rate of the trade variable in the absence of variability. The remaining five lines report the contribution of the growth rate of the corresponding explanatory variable to the growth rate of the dependent variable. For instance, the results for France imply that the average growth rate of px was 4.87%. The contribution of the French exchange rate depreciation to the 4.87% is 1.82 percentage points. Even when there is only one significant explanatory variable, the two percentage values need not be equal. The difference is due to the part of the dependent variable which is not explained by the regression. This part may be a negative percentage because the sum of the contributions may exceed the growth rate of the dependent variable. This means that this growth rate would have been higher if unexplained phenomena had not occurred.

In general, the contribution of either relative costs in price equations or demand in volume equations accounts for a large share of the growth rate of the relevant trade variable. Relative costs and demand are also the most important contributors. The increases in relative costs and in demand lead to an important increase in trade prices and volumes respectively.

Variability had a negative impact on the growth rate of either export or import volumes (except in the case of Belgium). Its contribution is in general lower than the contribution of other significant variables. Nonetheless, over the sample period, trade volume would have grown faster if exchange rate variability had been removed.

In some cases the contribution of variability is very large. Removing exchange rate volatility in France would have increased the growth rate of import from 4.13% to 7.39%. In the UK, the same scenario would give 6.16% instead of 4.53% as a growth rate of export. Economic agents' expectations that the German mark would further appreciate had hurt German export,

which would have increased at a rate of 10.89% instead of 5.22% In Italy, it is the expectation that the lira will further depreciate which reduces the import growth rate from 6.68% to 4.95%. This is just the opposite situation to that in Germany. It is not surprising. In Belgium the contribution of variability is small.

Looking at the impact of variability on the values of import and of export, the contrast between France and Italy on the one hand, and Germany and the UK on the other, is confirmed. Belgium seems almost unaffected by variability. Variability greatly reduces the value of import in France and Italy, while it does the same for German and British export values. There is no doubt that variability was harmful for Germany and the UK. It is not clear, however, that France and Italy should be happy with the impact of variability on the value of their import. This is due to a reduction in the volume of import. It may, therefore, be reflected in a reduction in domestic production if imported inputs are concerned.

Table IV.9. The impact of 1992-93 variability on the growth rate of trade variables

	France	Italy	Germany	UK	Belgium
dpx	-2.43	5.50	0.66	5.03	-2.00
	-2.43	*5.50*	*0.66*	*5.03*	*0.10*
lve	-	-	-	-	-
dae	-	-	-	-	-2.10
dx	1.81	6.65	2.19	2.99	2.99
	1.81	*6.65*	*7.54*	*5.07*	*2.99*
lve	-	-	-	-1.03	-
dae	-	-	-5.35	-1.05	-
dpm	-3.64	4.95	-2.08	3.41	-3.53
	-3.65	*4.95*	*-2.08*	*3.41*	*-3.53*
lve	-	-	-	-	-
dae	-	-	-	-	-
dm	-1.65	-2.79	-2.94	5.04	2.80
	1.59	*0.87*	*-2.94*	*5.04*	*2.33*
lve	-2.06	-	-	-	-
dae	-	-3.66	-	-	0.47

The 1992/93 ERM crises created fears about European Union trade. The worries concerned the impact of the increased exchange rate variability on European trade. The results in Table IV.9 give some indications of the extent to which these fears may be founded. There are four sets of results. Within each set, the first line gives the observed average growth rate of the corresponding trade variable for 1992-93. The second line (in italics) gives the estimated growth rate if the average level of variability in 1992-1993 was equal to the average level in 1987-1991. The third and fourth lines break down the difference between the two types of variability. The exact computation is similar to Table IV.8, as well as the interpretation of the figures. For instance, the results for France imply that the 1992-93 growth rate of import would have been equal to 0.41% (-1.65 + 2.06) instead of -1.65% if volatility was equal to the average level of 1987-91 instead of the average of 1992-93.

In general, the results in Table IV.9 confirm the findings from Table IV.8 : the impact of increased variability is negative and large in magnitude. Expectation of further lira depreciation has decreased the import growth rate in Italy by 3.66 percentage points, while expectation of a further D-mark appreciation decreased the German growth rate of export by 5.53 percentage points. In the UK, increased volatility and expectation of sterling appreciation had reduced the growth rate of export by 2.08 percentage points.

V. Conclusion

The impact of exchange rate variability on international trade is a major concern of policy makers. In Europe, given the recent ERM crisis (1992) and the EMU debate, this theme has attracted renewed interest.

The present study analyses the impact of exchange rate variability on EU trade. The study is conducted at the aggregate level. It distinguishes between two types of variability : volatility and misalignment. The objective is to construct a small econometric model allowing the evaluation of the impact of variability on trade.

The testable relationships between variability and trade variables are derived from a two-period duopoly model. The model analyses a domestic market where foreign and domestic producers are competing. Economic agents are risk averse, and are concerned with future market shares. At the beginning of each period they are uncertain about the exchange rate level. The model allows a simultaneous analysis of the impact of the two types of variability (volatility and misalignment) on trade variables.

The theoretical relationships are tested using data for five countries : France, Italy, Germany, the UK and Belgium. Cointegration techniques are used in order to take account of the time-series properties of the data and, hence, to avoid misspecification problems. A system of five equations is estimated simultaneously. Four equations concern trade variables : import price and volume and export price and volume. The fifth equation is added to the system to avoid potential simultaneity bias. Indeed, with aggregate data, a bi-directional relationship exists between exchange rate and trade variables. Given the results of the cointegration analysis, an error correction term is also incorporated into each equation.

The results show that there exists a long-term relationship between trade variables and relative costs, demand, exchange rates and expected exchange rates. No such relation was found with respect to volatility. Refined econometric analysis suggests that prices are mainly sensitive to relative costs, while volumes are mainly explained by demand. Exchange rate variability was found to have a significant effect on volumes only. The type of variability (volatility or misalignment) which has a significant impact depends on the country under consideration. Misalignment was found to affect trade volume significantly in four cases out of five, while volatility had a significant impact in only two cases.

The results of the estimation were used to assess the contribution of the explanatory variables to the growth rate of trade variables. The impact of the recent ERM crisis (1992) was also examined. It was found that while the most important contributors remain relative wages and demand, variability is responsible, to a large extent, for a decrease in the growth rate of trade variables. The analysis of the ERM crisis confirms the harmful impact of variability on trade volumes. Volatility appears, however, to be a second-order factor in comparison to relative wages, demand and misalignment.

The findings of the present study clearly lend support to economic policies designed to reduce exchange rate misalignment and costs divergence with respect to trading partners. The results have shown that demand, costs, exchange rate and misalignment are structural determinants of trade variables, i.e. they determine the long-term path. On the contrary, exchange rate volatility is at most a short-term determinant. An increase in volatility will have only a temporary effect on trade variables. These variables first respond to the change in volatility and then revert to the long-term path. In other words volatility cannot be responsible for a long-term disequilibrium in trade balance. The main policy implication is that the response to a structural disequilibrium in trade must rely on the long-term determinants (demand, costs, misalignment, etc.) and not on volatility.