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Exchange Rate Misalignment and Agricultural Trade[1]

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Abstract:

Using a sample consisting of bilateral trade flows across 10 developed countries between 1974 and 1995, this paper explores the effect of exchange rate misalignment on the growth of agricultural trade as compared to other sectors. Controlling for other factors likely to determine the growth in bilateral agricultural trade, the results show that long-run real exchange rate variability has had a significant negative effect on the growth of agricultural trade over this period. Moreover, the negative impact of misalignment on the growth of agricultural trade has been more significant compared to other sectors.

Keywords: Exchange rates, misalignment, agricultural trade

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Exchange Rate Misalignment and Agricultural Trade

1. Introduction

There has been considerable dispute among international economists as to whether the high level of exchange rate volatility characterizing the world economy since the breakdown of the fixed exchange rate system has had a negative effect on international trade. Empirical observation shows that daily or monthly nominal exchange rate movements have become much more volatile since 1973. The most common assertion in the literature has been that risk associated with exchange rate volatility will reduce the level of exports, e.g., Hooper and Kolhagan. This is countered by the argument that the use of forward markets could ameliorate risk in the short- to medium-run. There have been many empirical studies that have attempted to shed light on this issue, though the econometric evidence is ambiguous. For example, in early research, Cushman found a negative effect, while Klein found a positive effect, where both of these studies focussed on the United States only. Other notable studies include Thursby and Thursby, Frankel and Wei, Eichengreen and Irwin, among others, all of which focus on world trade and find a negative impact of exchange rate volatility on trade.

More recently, there has been renewed interest in this issue with a number of empirical studies based on the gravity model of trade, and making use of panel data.[1] For example, Rose, using bilateral trade data for a panel of 186 countries over the period 1970-1990, found a small, but statistically significant, negative effect of exchange rate volatility on trade. De Grauwe and Skudelny, focusing on European Union (EU) trade flows, found a statistically significant negative impact of exchange rate volatility on trade, as did Dell'Ariccia, where again the focus was on Europe. Despite this renewed interest, the focus of these studies is on aggregate data making no allowance for the fact that the impact of exchange rates may vary between sectors.

The focus of this paper is to consider the impact of exchange rate variability on agricultural trade in comparison to other sectors in the context of recent econometric work based on bilateral trade flows between a number of countries and making use of the panel nature of the data.

In focusing on the impact of exchange rate variability on trade, however, it is important to distinguish between short- and medium/long-term changes in exchange rates. A common argument against the focus on short-run variability is that exchange rate risk can be readily and cheaply hedged with appropriate risk management instruments.[2] In this regard, De Grauwe and de Bellefroid, and De Grauwe, argue that it is not short-run variability that is relevant in considering its impact on trade; rather, it is long-run variability (or misalignment) in exchange rates that is likely to affect trade. Specifically, while the short-run volatility of exchange rates is well-known, an additional feature of the floating rate system has been that real exchange rate movements have been characterized by ‘long swings’ and have deviated from their equilibrium levels for long periods of time, what De Grauwe and de Bellefoid refer to as ‘sustained misalignment’. Similarly, Peree and Steinherr, suggest that while short-term exchange rate risk can be hedged in financial markets, uncertainty beyond a one-year time horizon cannot be hedged at low cost. Using a sample of industrial countries, they find that exchange rate uncertainty defined over the medium-term adversely affects trade flows for all countries in their sample except for the United States. Obstfeld makes a similar observation that while short-run volatility may be successfully hedged, exchange rate misalignment is more likely to be a problem. Moreover, rather than focusing on levels of trade, which is the dependent variable in most empirical studies, De Grauwe and de Bellefroid, and De Grauwe, both argue that the relevant variable is the *growth* of international trade. With the emphasis on growth of international trade over periods of 5 to 10 years, they find variability of real exchange rates has negatively affected the growth of trade between developed countries.

Research on the impact of exchange rate variability on agricultural trade has been relatively thin. Reflecting the earlier research in the general literature, empirical research relating to (short-run) exchange rate volatility and agricultural trade flows has given ambiguous conclusions. For example, Pick found that exchange rate risk had no effect on US trade flows to other developed countries, though it did have a negative effect on US exports to developing countries. In contrast, Klein found that short-run real exchange rate volatility negatively affected US agricultural exports compared to other sectors, and Anderson and Garcia found significantly negative effects of exchange rate variability on US exports of soybeans to three developed countries. More recently, Langley *et al*. found that exchange rate volatility had a positive impact on Thailand's exports of poultry, but not on aggregate agricultural exports.

In general, three criticisms can be made of the literature relating to exchange rate variability and agricultural trade. First, and most obviously, empirical studies that have addressed this issue have been rather sparse. Second, the emphasis has typically been on US agricultural trade flows with few studies considering the effect of exchange rate variability on bilateral trade flows of other countries. Third, the focus of attention has been on short-run exchange rate volatility, the effects of medium to long-run exchange rate variability associated with exchange rate misalignment having been ignored though, reflecting the observations from the wider literature, this is arguably more likely to have a more significant impact on trade.

This paper addresses the issue of the effect of exchange rate *misalignment*, i.e., the departure of the exchange rate from its fundamental value, on the *growth* of agricultural trade and compares the impact on agricultural trade relative to other sectors. More specifically, two aspects of misalignment are considered. The first, which relates to the variability of exchange rates, reflects the impact of uncertainty that cannot be hedged or at least not as easily as risk associated with short-run changes in exchange rates. The second relates to the magnitude of misalignment in any given period which may cause hysteresis effects whereby large changes in exchange rates may affect trade via entry or exit of firms. The data used in this study comprises of bilateral trade flows for 10 developed countries between 1974-1995 separating out from the aggregate trade flows data on trade in agricultural products, machinery, chemicals and other manufacturing. The principal attraction of cross-sectional bilateral trade flow data is that it allows us to consider a range of factors that are likely to determine the growth of trade between countries including income growth, relative prices and the effects of trading blocs such as the EU similar to recent studies that have used the gravity model framework. Clearly the interest lies in whether exchange rate misalignment has affected the growth in agricultural trade once we have controlled for these other factors. The paper is organized as follows. In section 2, the relevant aspects of exchange rate misalignment are outlined and their connection with the growth of trade is discussed. In section 3, an overview of the data set and a review of key statistics relating to the growth of agricultural trade and exchange rate variability since the 1960s are presented. In section 4, variable construction and data are discussed, while in section 5 the econometric specification and results are reported. The principal results are summarized in section 6.

2. Exchange Rate Misalignment

There are a large number of papers in international macroeconomics that have observed the deviation of exchange rates from their equilibrium levels which relates to the concept of misalignment whereby under- or over-valuation departs from fundamental levels for several years. Recent examples include Mark (1995), Frankel, and MacDonald, among many others. However, in focusing on misalignment, one can distinguish between two aspects: the deviation from the fundamental value over time, i.e., 'sustained misalignment', and the magnitude of under/over-valuation in any given period. We outline each in turn.

(i) 'Sustained Misalignment'

Exchange rate misalignment can be defined as the persistent departure of the nominal exchange rate from its long-run equilibrium level, where misalignment can be characterized as either over- or under-valuation of the currency relative to fundamentals. Measuring misalignment is difficult and inherently imprecise, as it requires estimation of what is termed the fundamental equilibrium exchange rate. Typically in the literature, it is assumed that purchasing power parity (PPP) is the long-run equilibrium condition of nominal exchange rates.[3] Essentially, PPP should hold because exchange rates equalize relative price levels in different countries. The standard expression for *absolute* PPP is:

(1) $$s_t = p_t - p_t^*,$$

where s_t is the home currency price of a foreign currency, p_t is the domestic-currency price of a particular good(s), p_t^* is the foreign currency price of the good(s), and lower case letters denote logarithmic values. The implication of (1) is that trade in goods will result in identical prices across countries. Allowing for factors such as transport costs, PPP in its *relative* form implies that a stable price differential should exist for the same good(s) selling in different countries, the implication being that real exchange rates between countries should be equal to a constant in the long-run, and, consequently, there is no misalignment of exchange rates from relative PPP, i.e., the real exchange rate should be mean-reverting (MacDonald).

In more recent research, the focus has been on the use of co-integration methods applied to the following equation:

(2) $$s_t = \beta + \alpha_0 p_t + \alpha_1 p^*{}_t + \varphi_t .$$

If s_t, p_t, p_t^* are integrated of order one, I(1), then a weak form of PPP exists if the residual term from estimation of (2) is stationary, I(0), and a stronger form of PPP exists if homogeneity is satisfied, i.e., $\alpha_0 = 1$, and $\alpha_1 = -1$. Using this type of approach, several early studies found no evidence of significant mean reversion of exchange rates toward PPP (Mark, 1990; Fisher and Park). Several authors have argued, however, that the data period for the recent float is too short to have any confidence in the power of statistical tests for stationarity of real exchange rates (Lothian and Taylor, 1997). As a consequence, recent research has either been based on long-term, pre-float data (Lothian and Taylor, 1996), or multi-country panel data (Flood and Taylor; Frankel and Rose). This more recent evidence rejects the random walk hypothesis of real exchange rates. Essentially, real exchange rates revert to equilibrium values over the long run, and, correspondingly, nominal exchange rates and relative prices converge, reviving the notion that PPP is a long-run equilibrium condition of nominal exchange rates (MacDonald), although consensus estimates suggest that the speed of convergence to PPP is very slow, the deviations appearing to dampen out at a rate of roughly 15 percent per year (Rogoff). [4] This implies that deviation from the mean for real exchange rates may be regarded as a suitable measure of exchange rate misalignment between countries since stationarity of a variable implies the existence of a finite long-run variance of the series. Further, if it is assumed that underlying innovations of real exchange rates are Gaussian, the sample variance of the real exchange rate can be treated as a sample counterpart of the underlying long-run variance of the true population by ergodicity of a stationary process (Hamilton).

Specifically, if long-run PPP holds, as shown in (2), the nominal exchange rate, $s_t = \beta + \alpha_0 p_t + \alpha_1 p^*{}_t + \varphi_t$, α_0 = 1 and α_1 = -1, and the underlying innovation φ_t should be a stationary process, which has mean zero and finite long-run variance, σ_φ^2. The time-series movement of the estimated residuals, $\hat{\varphi}_t$, can be thought of as the time-series movement of misalignment. Furthermore, under the assumption of long-run PPP, we can also express the equation as, $s_t - p_t + p_t^* = \beta + \varphi_t$. The left hand side is simply the log of the real exchange rate, r_t, so that it can be also expressed as, $r_t = \beta + \varphi_t$. It is important to note that $E(r_t) = \beta$, and $VAR(r_t) = VAR(\varphi_t) = \sigma_\varphi^2$. Therefore, as the estimated variance (standard deviation) of r_t is equal to the estimated variance of φ_t, it is used as a proxy for exchange rate misalignment over the sample period.[5]

As outlined above, it is argued that it is the uncertainty associated with the variability of exchange rates over the medium to long-run that is more likely to adversely affect trade as such variability cannot be hedged or done so cheaply. Studies that have considered the impact of misalignment on trade consistently have found negative effects on the level of trade (Peree and Steinher) and on the growth of trade (De Grauwe and Bellfroid; De Grauwe).[6]

(ii) <u>Magnitude</u>

The second aspect of exchange rate misalignment relates to its magnitude. If there is a sufficiently large exchange rate shock, it is possible that firms will either leave or enter an industry, and without a countervailing large exchange rate shock, the new market structure will persist, i.e., there is *hysteresis* (Baldwin; Baldwin and Krugman). The role of sunk costs is essential to the hysteresis story as they determine whether firms will enter or exit an industry. For example, if the level of sunk costs were high, there may be a ‘band of inaction’ whereby firms that would otherwise have left the industry following an adverse change in the exchange rate do not do so. With sufficiently large changes in the exchange rate, firms may exit the industry but, given the sunk costs of entry, do not return when the exchange rate recovers. Essentially, exchange rate misalignment can only cause structural change in international commodity flows if the magnitude is large. Figure 1 summarizes the impact of large changes in the exchange rate on exports.

Each of the upward sloping curves relates to the supply of exports which is determined by the exchange rate on the y-axis, where a rise in the exchange rate, e.g., one US$ in terms of Deutchmarks, relates to a depreciation of the currency and hence an increase in exports. If the exchange rate falls by a small amount, e_0 to e_1, exports decrease as expected but there is no exit from the industry. However, if there is a large change in the exchange rate, exit from the industry occurs that shifts the export supply schedule to S^1. This leads to a permanently lower level of exports even if the exchange rate rises. Clearly, starting at e_0, for a sufficiently large rise in the exchange rate, entry occurs and the export supply curve shifts to S^2. The effect of shifts in the export supply schedules due to large changes in the exchange rate are the hysteresis effects, the relevance of the shifts in these export supply schedules being dependent on the significance of sunk costs specific to particular sectors. Consequently, sufficiently large changes can affect the growth of trade via hysteresis. We capture the magnitude of exchange rate changes by using a measure of skewness. The advantage of this measure is that it allows us to determine what is 'large' from the distribution of exchange rate changes over the period. The expected effect of misalignment on trade if hysteresis exists is negative.

In summary, we focus on two aspects of exchange rate misalignment on trade. The first relates to its deviation from PPP and relates directly to its variability over time. In common with the literature on uncertainty and variable exchange rates, this is expected to have a negative effect on trade. The second relates to the magnitude of misalignment. Here the expected effect of misalignment on trade if hysteresis exists is negative. The effects of exchange rate misalignment may also be anticipated to vary between sectors. For example, Maskus argued that agriculture was more likely susceptible to exchange rate variability than other sectors due to, for example, the dependence on world markets, the absence of long-term contracts and so on. By extension, in relation to the hysteresis argument, the relative importance of sunk costs, e.g., initial investment costs in distribution, product substitutability *etc*., will also likely vary between sectors. As a result, it may be the case that the effect of exchange rate misalignment on agricultural trade might be different from the effects on other manufacturing industries. In other words, even if exchange rate misalignment under the floating system has no explicit real impact on aggregate international commodity trade, it might have an explicit real impact on agricultural trade. This is the focus of the remainder of the paper.

3. Exchange Rates and the Growth of Agricultural Trade: 1963-1995

As is well known to the most casual observer of economic trends in the post-war period, the world economy was characterized by high rates of growth in world trade in all sectors during the 1960s. This was followed by considerably lower, and more variable, rates of growth in world trade over the 1970s, 1980s, and early 1990s. The high levels of growth in world trade were due to, or at least coincided with, high rates of growth of GDP in most developed countries, the reduction in tariffs resulting from successive GATT rounds and exchange rate stability under the auspices of the Bretton Woods system. The 1970s through to the early 1990s told a very different story: the growth in world trade slowed considerably; GDP growth rates fell; protectionism increased; and exchange rates became more volatile following the collapse of the fixed exchange rate regime. Reflecting the patterns of manufacturing trade over the period 1960-1995, growth in trade of agricultural products was extremely high over the 1960s, but slowed dramatically in the post-1973 period.

Relevant data highlighting these patterns are presented in Table 1. The summary figures reported in this table relate to bilateral trade flows for various sectors based on one-digit SITC definitions contained in the OECD series *Trade in Commodities*. The sample consists of 10 developed countries over the 1963-1995 period, the countries comprising the sample being the G10 countries Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the UK and the US. Taken together these countries accounted for 57 percent of total world imports of agricultural goods, and around 46 percent of total world exports at the mid-point of the sample period, 1985. The figures in the table highlight the differences during and following the Bretton Woods system for these 10 countries. Over the period 1963-1972, total bilateral trade flows between the sample countries grew by an average annual growth rate of 8.02 percent, while for agriculture, bilateral trade flows grew at an average annual growth rate of 6.49 percent. In the 1974-1995 period, total bilateral trade flows between the sample countries grew at an average annual growth rate of 2.83 percent, while for agriculture, the average annual rate of growth fell to 0.15 percent. This represents a significant decline in the growth of agricultural trade since the end of the fixed exchange rate regime. Note, however, that other sectors also exhibited a decline in their average annual growth rates of bilateral trade following the collapse of the Bretton Woods system. In part, the slowdown in agricultural trade in the post-1973 period may reflect the slowdown in GDP growth in these 10 countries. In the period 1963-1972, the average annual growth rate of real GDP was 4.91 percent, while over the period 1974-1995 this had fallen to 2.27 percent. Since import elasticities tend to be high, one would expect growth rates in GDP to have a significant effect on growth of agricultural trade flows.

4. Variable Construction and Data

The focus in this paper is on the relationship between, a measure of long-term real exchange rate variability ($\hat{\sigma}_{ij}^{r}$), the existence of skewness ($skew_{ij}^{r}$) and export growth rates ($\Delta \ln q^{k}{}_{ijt}$). q_{ijt}^{k} is the real export value of country *i* to country *j* in year *t* for sector *k*, where *k* refers to specific export sectors, 1=total exports, 2=machinery, 3=chemicals, 4=other manufacturing, and 5=agriculture. q_{ijt}^{k} is constructed as follows: using the OECD bilateral trade data set *Trade in Commodities* classified by one-digit SITC code, the nominal value of exports from *i* to *j* for each sector *k* in US dollars is collected. This is converted into the exporting country's currency using nominal exchange rates from the IMF series *International Financial Statistics*, and deflated by the consumer price index of the exporting country (1982-84=100) from the Bureau of Labor Statistics. From this, the annual percentage rate of growth of exports, $\Delta \ln q^{k}{}_{ijt}$, is calculated, where Δ is the first difference operator, and ln refers to the natural logarithm.

The data used for calculating the measures of misalignment are based on real exchange rate series, r_{ijt}, derived by taking the dollar based real exchange rate for the importing country *j* and dividing by the dollar based real exchange rate for the exporting country *i* giving the cross-rate. This is based on nominal exchange rate data from the IMF series, deflated by a foreign/home country consumer price index (1990=100), as reported by the Economic Research Service of USDA. The series is then normalized to 1973=100, and transformed into natural logarithms. Given the sample of 10 countries, there is a cross-section of 90 bilateral trade flows (10x9), with annual data covering 22 years (1974-1995) for each trade flow, generating a complete panel of 1980 observations (90x22) for each sector *k*.

In terms of the measures of exchange rate misalignment, the standard deviation of the real exchange rate captures the sustained misalignment of exchange rates over the period as outlined in section 2(i). The expected effect of this on the growth of trade, in line with other studies, is negative. In terms of capturing the magnitude of misalignment we use a measure of skewness given by:

$$skew_{ij}^{r} = \frac{T}{(T-1)(T-2)} \sum_{t=1}^{T} \left(\frac{r_{ijt} - \bar{r}}{s} \right),$$

where T is the number of observations and s is the sample standard deviation of each normalized real exchange rate series. The expected sign on the skewness variable if hysteresis is important is negative. Right skewness indicates a 'sufficiently large' overvaluation of the exporters currency over the period that, contingent on sunk costs, would lead to exit thus reducing the growth of trade. Left skewness, a negative value for the measure, would indicate a 'sufficiently large' under-valuation that would lead to entry and hence increase the growth of trade. Taken together, the expected sign will be negative if hysteresis has affected trade.

It is also important to note at this point that the sample consists of countries that have had different international monetary systems during the post-Bretton Woods era. Most of the European countries have used a managed exchange rate system since 1979 under the EMS, albeit with different target zones for specific country pairings. In contrast, other countries, including the US, have generally operated under a free-floating system, although the degree of international coordination to stabilize exchange rate variation has differed by country.

Therefore, it is also possible to examine empirically whether different monetary systems have had an important role in explaining long-run trade growth rates among the sample countries.

5. Econometric Specification

(i) <u>Cross-Sectional Analysis</u>

Recall that the focus is on the growth of trade. The basic econometric specification is similar to recent work in this area which is based on the gravity model, though since our focus is on the rate of growth of trade over the period we suppress those variables that are unlikely to have changed over the period, i.e., we do not consider the role of common language, distance or common borders that feature in gravity models that focus on the level of trade. As a first cut, we start by considering the average rate of growth of trade over the whole period, 1963-1995. In so doing, the specification is essentially cross-section in nature as it relates to the average rate of growth of income, average relative prices, membership of the EU, and variables capturing alternative aspects of misalignment. As such, this cross-section specification replicates the procedure followed by de Grauwe and Bellefroid, and de Grauwe that are highly cited papers in this area.

The specification of the regression model is given by:

$$(3) \qquad \overline{\Delta \ln q_{ijt}^{k}} = \alpha_0^k + \alpha_1^k \overline{r_{ijt}} + \alpha_2^k \hat{\sigma}_{ij}^r + \alpha_3^k skew_{ij}^r + \alpha_4^k \overline{\Delta \ln y_{it} y_{jt}} + \alpha_5^k EU + \varepsilon_{ij}^k .$$

The dependent variable relates to the average rate of growth of exports from sector *k* between country *i*, and *j* over the 1963-1995 period. In terms of the control variables, i.e., those that would likely affect the growth of trade between countries, $\bar{r}_{ijt}$ is the average level of relative prices, with 1973 as the base year. This is measured by the average real exchange rate over the sample period and is expected to be negative, i.e., if, on average, domestic prices were higher than foreign prices, export growth will be lower.[7] $\overline{\Delta \ln y_{it} y_{jt}}$ is the annual average growth rate in the product of the real income of the exporting country *i*, and the importing country *j* over the sample period. The variable is expected to pick up both demand and supply side effects on the growth of trade. This is collected from the IMF series *International Financial Statistics*, (line 99b), the series already being deflated (1990=100). A dummy variable, *EU*, is also included to account for trade between members of the EU, as we would expect membership of a customs union to have a positive impact on average annual growth rates of trade. As discussed above, $\hat{\sigma}_{ij}^{r}$, and $skew_{ij}^{r}$ capture different aspects of exchange rate misalignment.

The estimation results for the whole sample are shown in Table 2. In the case of average relative prices, we can reject the null hypothesis of no relationship at the 1 percent level in the case of machinery, other manufacturing, and agriculture, and at the 5 percent level for total exports and chemicals, and the sign of the estimated coefficients are negative as expected. Interestingly, the response of trade growth rates to average relative prices is highest for agriculture among the sectors considered here.[8]

With respect to the measures of misalignment, in the case of total trade, the estimated coefficient on real exchange rate variability is positive and statistically significant at the 10 percent level, while the signs on the coefficient of this variable for the other sectors remain the same, i.e., positive, and statistically significant at the 5 percent level in the case of the machinery and chemicals sectors, and negative, but statistically insignificant in the case of other manufacturing and agriculture sectors. Although these positive signs are not necessarily inconsistent with underlying theory, *c.f.* footnote 6, they do contradict the results from more recent empirical research in this area. In the case of skewness of the real exchange rate distribution, the estimated coefficients have the expected negative sign but are only statistically significant in the case of the chemicals, other manufacturing, and agriculture sectors. The results for agricultural trade are stronger compared with other sectors.

In terms of the additional control variables, the annual average growth rate in the real income variable is positive in the case of total trade, and the machinery and other manufacturing sectors, but it is only statistically significant for the case of the machinery sector. The estimated coefficients for the chemicals and agriculture sectors are negative but statistically insignificant. The dummy variable accounting for EU membership is positive and statistically significant in all cases.

It turns out, however, that there is a strong negative correlation between the measure of misalignment and the EU dummy, as most members of the EU are also members of the EMS. Therefore, inter-EMS trade was omitted from the sample due to the fact that monetary coordination might be observationally equivalent to the effects of a customs union.[9] In this case, though, a dummy variable is added to represent trade between the UK and other EU members because while the UK is a member of the EU, it has not been a member of the EMS for the complete sample period.[10] The following model is estimated with this sub-sample:

$$\overline{\Delta \ln q_{ijt}^{k}} = \alpha_0^k + \alpha_1^k \overline{r_{ijt}} + \alpha_2^k \hat{\sigma}_{ij}^r + \alpha_3^k skew_{ij}^r + \alpha_4^k \overline{\Delta \ln y_{it} y_{jt}} + \alpha_5^k EU_{UK} + \varepsilon_{ij}^k, \quad (4)$$

EU_{UK} being a dummy variable relating to UK's membership of the EU, and all the other variables are as previously defined.

The estimation results for the non-EMS sample are reported in Table 3. Overall, compared to the whole sample, statistical power of the model increases in terms of R^2 and t-ratios. For the case of average relative prices, the results are very similar: we can reject the null hypothesis of no relationship at the 1 percent level in the case of machinery, other manufacturing, and agriculture, and at the 5 percent level for total exports and chemicals, and the sign of the estimated coefficients are negative as expected. Again, the response of trade growth rates to average relative prices is highest for agriculture among the sectors considered here. The estimated coefficients imply that a one-unit appreciation (depreciation) in the average relative price index during the sample period is associated with a 2.9 percent decrease (increase) in total export growth rates, compared to a 12.4 percent decrease (increase) for the agriculture sector.

With respect to the standard deviation of real exchange rates, in the case of total trade, the estimated coefficient on real exchange rate variability is now negative and statistically significant at the 5 percent level, while the signs on the coefficient of this variable for the other sectors are all now negative but statistically insignificant in the case of the machinery and chemicals sectors. For agricultural trade and other manufacturing the effects are negative (as in Table 2) but now statistically significant at the 1 percent level. In the case of skewness of the real exchange rate distribution, the estimated coefficients are negative in all sectors, and statistically significant in the case of total trade, chemicals, other manufacturing, and agriculture sectors. In terms of the additional control variables, the coefficient on annual average growth rates in the real income variable is positive in all sectors, but it is only statistically significant at the 1 percent level in the case of total trade, and the machinery and other manufacturing sectors. This implies that for an increase of 1 percent in combined annual average growth rates of income, there is 1.05, 1.375, and 1.33 percent increase in annual average growth rates of trade for the total, machinery, and other manufacturing sectors respectively. The coefficient on the dummy for UK membership of the EU is positive and statistically significant at the 1 percent level in all sectors. These results suggest that not participating in international monetary coordination of the type represented by the EMS results in greater exchange rate misalignment, and, hence, more impact on the growth of international trade.

Overall, the results suggest that the impact of exchange rate misalignment has had a more negative effect on the growth of agricultural trade compared to the growth of trade in other sectors. These negative effects are more evident when trade between countries that were party to the EMS is taken out of the sample.

(ii) <u>Panel Analysis</u>

There are two potential disadvantages of using a cross-sectional approach. First, by averaging the variables *a priori*, all time-series movement of variables is simply eliminated. Second, loss of observations from averaging the data could possibly have introduced small-sample bias. Therefore, in order to maximize data usage and properly control for time-invariant variables, a panel-data analysis is also conducted.

The following regression model was estimated:

(5) $$\Delta \ln q^{k}{}_{ijt} = \alpha_{0ij}^{k} + \alpha_{1}^{k} r_{ijt} + \alpha_{2}^{k} \Delta \ln y_{it} y_{jt} + \alpha_{3}^{k} \hat{\sigma}_{ij}^{r} + \alpha_{4}^{k} skew_{ij}^{r} + \varepsilon_{ijt}^{k},$$

$\Delta \ln q^{k}{}_{ijt}$, r_{ijt}, and $\Delta \ln y_{it} y_{it}$ are now time-varying variables, while the second and third moments of real exchange rates remain as time-invariant variables. Consequently, the empirical model contains two explanatory variables that move in both time and cross-sectional dimensions (income growth and relative prices), and two variables, which move in only a cross-sectional dimension (the variability and skewness of exchange rates over the sample period). Moreover, in (5), it is assumed that there is cross-sectional variation in the constant terms. In an economic sense, this restriction implies that there are specific cross-country effects such as distance and trade barriers that are not captured separately in the model.

In order to aid discussion of the panel estimation method used, (5) is re-written in matrix form:

(6) $$Y_{it} = \alpha_{i} + X_{it}\beta + Z_{i}\gamma + \varepsilon_{it},$$

where Y_{it} is the dependent variable, $\Delta \ln q^{k}{}_{ijt}$, X_{it} is a vector of time-variant control variables, $\Delta \ln y_{jt}$ and $\ln r_{ijt}$, and Z_i is a vector of time-invariant control variables, $\hat{\sigma}^{r}_{ij}$ and $skew^{r}_{ij}$. This model assumes the slope coefficient, β, is the same for each cross-sectional unit, while the constant term, α varies across cross-sectional units.

Panel estimation of (6) with the specified restrictions on α_i and β has been common in empirical research, several estimation procedures having been suggested. However, with time-invariant variables, the estimation methods are restricted. Excluding the time-invariant variables, a general model specification is as follows:

(7) $$Y_{it} = \alpha_i + X_{it}\beta + \varepsilon_{it},$$

where Y_{it} is an $NT \times 1$ vector of the dependent variable, X_{it} is an $NT \times k$ matrix of independent variables, and ε_{it} is an $NT \times 1$ vector of the error term with mean zero and variance σ^2_{ε}. If α_i is assumed fixed, the usual least squares with a cross-section dummy variable or with transformed data can be applied, known as a 'LSDV' or 'within' estimator.

If α_i is assumed to be a random variable, distributed with a mean μ, and variance σ^2_{α}, it is a 'random effects' model, (7) being expressed as:

(8) $$Y_{it} = \mu + X_{it}\beta + \eta_{it}$$

where $\eta_{it} = \alpha_i + \varepsilon_{it}$. Now consider the case where a time-invariant variable, Z_i, is included to capture cross-section variation explicitly, and it is believed that Z_i is strongly correlated with the unobservable cross-section specific latent effect, α_i:

(9) $$\alpha_i = \mu + Z_i\gamma + \eta_i,$$

(8) is re-written as:

(10) $$Y_{it} = \mu + Z_i \gamma + X_{it}\beta + \xi_{it},$$

where $\xi_{it} = \eta_i + \varepsilon_{it}$. While (10) is similar to the usual 'random effect' specification, there is, however, an important difference between the usual 'random effect' model and our model specification. In the case of (8), there can be correlation between Z_i and the individual latent effect η_i (Hausman and Taylor). Given such correlation, only the 'within' estimator is unbiased and consistent. Moreover, additional instrumental variables are needed to estimate γ consistently. However, due to the orthogonality condition of (10): i.e., if (9) is true, then $E(\eta_i \mid Z_i) = 0$. As a result, Z_i can be treated as an exogenous variable, and γ can be estimated consistently using a two-step procedure suggested by Hausman and Taylor.

In the first stage regression, a 'within' estimator is used with the whole sample, which is an unbiased and consistent estimator given the assumptions on α_i. By transforming the data in order to implement a 'within' estimator, however, all the time-invariant variables, Z_i, and cross-country effects, α_i, are eliminated. Hence, in the first stage, least squares methods are applied to:

(11) $$\tilde{Y}_{it} = \tilde{X}_{it}\beta + \tilde{\eta}_{it}.$$

where $\tilde{Q}_{it} = Q_{it} - \overline{Q_i}$ and $\overline{Q_i} = (1/T)\sum_{t=1}^{T} Q_{it}$ for any variable Q.

In the second stage, a latent variable is constructed based on the unbiased and consistent estimates $\hat{\beta}_W$ from the first-stage regression and the following regression is estimated using a cross-sectional approach:

(12) $$\hat{\alpha}_i = \overline{Y_i} - \overline{X}_i\hat{\beta}_W = \mu_i + Z_i\gamma + \eta_i,$$

where the coefficients on the time-invariant variables can be estimated consistently if the number of cross-sectional units is large enough.

The estimation results are reported in Table 4, where the estimated coefficients for the first two variables are from the first-stage regression (11), and the remaining coefficients are from the second-stage regression (12). It is important to note that because the estimated coefficients for the constant come from the second-stage regression, they contain no economic meaning and, consequently, are not reported.

Focus first of all on the variables that capture the effect of exchange rate misalignment. Compared to the cross-sectional analysis including members of the EMS, no statistically significant relationship is found between long-run real exchange rate variability and export growth rates in the case of the machinery, chemicals, other manufacturing and agricultural sectors, however, this relationship remains negative with the exception of the machinery sector, which retains its positive sign. In the case of skewness of the real exchange rate distribution, the negative effect is statistically significant at the 5 percent level only in the case of the agriculture sector. These results confirm those of tables 2 and 3 that the negative effect of exchange rate misalignment on agricultural trade is stronger compared with trade in other sectors and that the effect on agriculture would not be apparent by considering aggregate data only.

In terms of the control variables, the estimated coefficients on the relative price measure have the expected negative sign, and they are all statistically significant at the 1 percent level and are higher than those of the cross-sectional regression. The size of the estimated coefficient is higher for agricultural trade than total trade and trade in chemicals and machinery. In the case of income growth rates, the estimated coefficients all have the expected positive sign, and are statistically significant at the 1 percent level, except for agriculture, which is significant at the 5 percent level. Finally, the dummy variable accounting for EU membership is positive in all cases, but only statistically significant for the agricultural sector.

As with the cross-sectional analysis, intra-EMS trade was omitted from the panel analysis due to the fact that monetary coordination might be observationally equivalent to the effects of a customs union. The estimation results for the non-EMS sample are reported in Table 5. As with the full sample, no statistically significant relationship is found between long-run real exchange rate variability and export growth rates in the case of total trade, the machinery and chemicals sectors. For other manufacturing and agricultural sectors, however, this relationship remains negative, and is statistically significant. In the case of skewness of the real exchange rate distribution, the negative effect is again statistically significant at the 5 percent level only in the case of the agriculture sector, confirming again the strong negative effect of exchange rate misalignment on agricultural trade.

The estimated coefficients on relative prices have the expected negative sign, and they are all statistically significant at the 1 percent level, but they are higher than those of the cross-sectional regression. In the case of income growth rates, the estimated coefficients all have the expected positive sign, and are statistically significant at the 1 percent level, except for agriculture, which is not statistically significant. Finally, the coefficient on the dummy for UK membership of the EU is positive in all cases, but only statistically significant for the chemical and agricultural sectors.

The two-step panel procedure suggests that uncertainty associated with exchange rate misalignment and hystersis generally has had a very limited impact on the growth of trade between these ten countries. This conflicts with the results of the various papers involving de Grauwe that long-run exchange rate misalignment has negatively reduced the growth of trade.

However, the results show that the effect of exchange rate misalignment is more pronounced on agricultural trade than would be evident from looking at aggregate trade data alone. Moreover, the impact of misalignment is greater on agricultural trade compared to trade in other key sectors, specifically machinery, chemicals and, depending on the nature of misalignment, other manufacturing.

6. Summary

This paper has focused on whether exchange rate misalignment has negatively affected the growth of agricultural trade, as compared to other sectors. Exchange rate misalignment is interpreted to be the persistent deviation of nominal exchange rates from their long-run equilibrium of purchasing power parity, which implies that real exchange rates should be mean reverting. We have explored the potential impact on trade associated with two aspects of misalignment: long-run variability and the magnitude of exchange rate misalignment, which may give rise to hysteresis effects. Moreover, unlike other studies in this area, we have used more dis-aggregated data since the effects of misalignment may vary by sector depending on sectoral characteristics such as the role of sunk costs and so on.

In order to explore this, we constructed a bilateral trade matrix involving trade flows between 10 developed countries. Using cross-sectional analysis, the data were collapsed to annual average growth rates of exports, which were regressed on the second and third moments of the distribution of real exchange rates, controlling for relative prices,the annual average rates of growth income and membership of the EU/EMS. Focussing on the average growth of trade, the model was estimated for 4 sectors over the period 1974-1995. The conclusion is clear: compared to other sectors, the growth of agricultural trade has been adversely affected by variability in real exchange rates, particularly when the sample countries excluded bilateral trade between EMS countries. Extension of the analysis to the complete panel data set confirms the negative effects of real exchange rate variability on agricultural trade growth for non-EMS countries. In addition, it was also found that that skewness in the distribution of exchange rates have also affected the growth of trade with, again, agricultural trade showing a negative and the most significant effect compared to trade in other sectors.

Overall, the results presented in this paper make a contribution to our understanding of the connection between exchange rate movements and international trade flows. Typically, the literature has focused on the impact of increased short-run exchange rate volatility since the breakdown of the Bretton-Woods system. As pointed out by De Grauwe and de Bellefroid, De Grauwe, and Peree and Steinherr, short-run volatility can be hedged, and, therefore, it is long run variability in exchange rates that matters. This implies that if long-run variability is a function of the deviation of nominal exchange rates from underlying fundamentals, then macroeconomic policy may have a key role in influencing trade flows. The evidence reported in this paper suggests that agricultural trade is more susceptible to exchange rate misalignment than the aggregate trade data would suggest and that the negative effects on the growth of trade has a stronger effect on trade in agricultural goods compared with trade in other sectors.

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Figure 1: Exchange Rates and Hysteresis

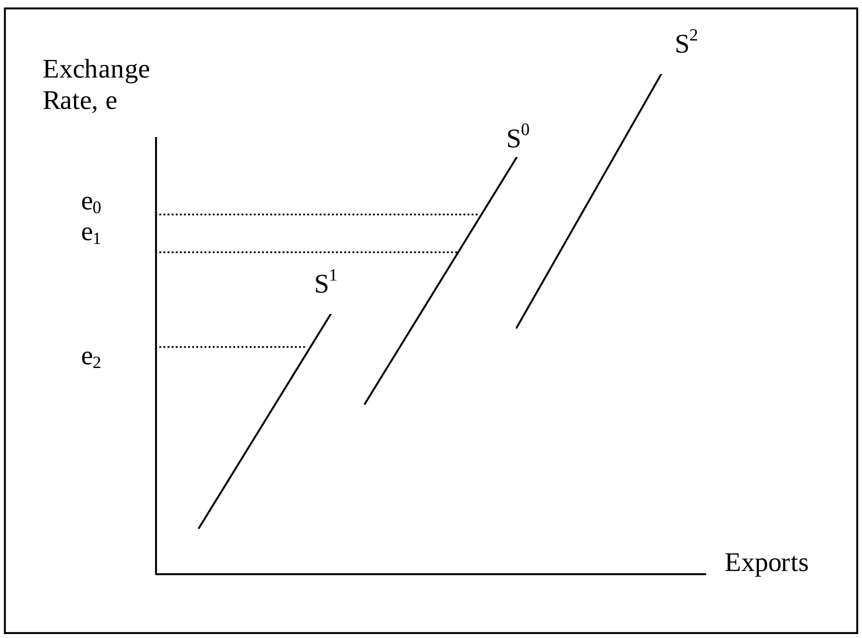

Table 1: Average Annual Rates of Growth of Exports for Sample Countries 1963-1995[1]

Export Growth Rates	1963-1972	1974-1985	1985-1995	1974-1995
Total Exports	8.02	3.73	1.98	2.83
Machinery	10.50	4.18	4.22	3.93
Chemicals	9.79	6.05	2.99	4.50
Other Manufacturing	7.66	1.05	1.34	1.19
Agriculture	6.49	0.52	-0.54	0.15

[1] Sample countries detailed in text

Table 2: Average Export Growth and Real Exchange Rate Variability (Sample size=90)

	Total	Machinery	Chemicals	Other Manufacturing	Agriculture
Constant	0.131^{a}	0.180^{a}	0.118^{b}	0.277^{a}	0.591^{a}
	(2.56)	(3.33)	(2.61)	(4.02)	(3.91)
Average Relative prices	-0.028^{b}	-0.043^{a}	-0.018^{b}	-0.058^{a}	-0.122^{a}
	(-2.58)	(-3.95)	(-2.01)	(-4.17)	(-5.20)
STD of real exchange rates	0.068^{c}	0.106^{b}	0.123^{b}	-0.028	-0.120
	(1.69)	(2.46)	(2.37)	(-0.45)	(-1.44)
SKEW of real exchange rates	-0.038	-0.014	-0.053^{b}	-0.085^{b}	-0.181^{a}
	(-1.45)	(-0.46)	(-2.49)	(-2.11)	(-2.62)
Average income growth rates	0.254	0.826^{a}	-0.159	0 .009	-0.556
	(0.93)	(2.87)	(-0.43)	(0.02)	(-0.91)
EU	0.014^{a}	0.014^{a}	0.012^{b}	0.016^{b}	0.038^{a}
	(3.20)	(3.07)	(2.16)	(2.50)	(3.91)
R^2	0.206	0.324	0.140	0.267	0.447

Notes: Ordinary Least Squares (OLS) estimator with heteroskedastic consistent covariance matrix (White) used to calculate standard deviation. *t*-ratios are in parenthesis; **a, b,** and **c** denote significant at 1, 5, and 10 percent level. The sample size for Chemicals is 86, 4 outliers having been deleted from the sample.

Table 3: Average Export Growth and Real Exchange Rate Variability: Non-EMS Case (Sample size=70).

	Total	Machinery	Chemicals	Other Manufacturing	Agriculture
Constant	0.126[a]	0.185[a]	0.108[b]	0.270[a]	0.588[a]
	(2.75)	(3.62)	(2.46)	(4.57)	(5.33)
Average Relative prices	-0.029[a]	-0.045[a]	-0.019[b]	-0.059[a]	-0.124[a]
	(-3.03)	(-4.47)	(-2.11)	(-4.79)	(-5.40)
STD of real exchange rates	-0.094[b]	-0.003	-0.042	-0.321[a]	-0.360[a]
	(-2.05)	(-0.05)	(-0.64)	(-4.61)	(-2.87)
SKEW of real exchange rates	-0.056[b]	-0.044	-0.063[b]	-0.105[a]	-0.248[a]
	(-2.19)	(-1.31)	(-2.57)	(-2.84)	(-2.92)
Average income growth rates	1.052[a]	1.375[a]	0.685	1.333[a]	0.592
	(3.72)	(4.19)	(1.66)	(2.60)	(0.78)
EU_{UK}	0.027[a]	0.026[a]	0.026[a]	0.031[a]	0.052[a]
	(7.48)	(5.83)	(4.59)	(6.27)	(4.40)
R^2	0.408	0.428	0.293	0.485	0.477

Notes: Ordinary Least Squares (OLS) estimator with heteroskedastic consistent covariance matrix (White) used to calculate standard deviation. *t*-ratios are in parenthesis; **a, b,** and **c** denote significant at 1, 5, and 10 percent level. The sample size for Chemicals is 66, 4 outliers having been deleted from the sample.

Table 4: Export Growth and Real Exchange Rate Variability (Hausman and Taylor estimator, sample size=1980).

	Total	Machinery	Chemicals	Other Manufacturing	Agriculture
Relative prices	-0.275[a]	-0.273[a]	-0.191[a]	-0.344[a]	-0.322 [a]
	(-14.9)	(-10.97)	(-5.79)	(-11.12)	(-10.59)
Income growth rates	1.429[a]	1.214[a]	1.245[a]	1.953[a]	0.279[b]
	(18.7)	(11.79)	(9.09)	(15.25)	(2.21)
STD of real exchange rates	-0.022	0.077	-0.029	-0.176	-0.184
	(-0.19)	(0.725)	(-0.31)	(-1.300)	(-1.50)
SKEW of real exchange rates	-0.075	-0.048	-0.086	-0.127	-0.210[b]
	(-0.82)	(-0.56)	(-1.12)	(-1.154)	(-2.11)
EU	0.011	0.013	0.010	0.011	0.035[b]
	(0.80)	(1.01)	(0.87)	(0.659)	(2.37)

Notes: *t*-ratios are in parenthesis; **a, b,** and **c** denote significant at 1, 5, and 10 percent level.

Table 5: Export Growth and Real Exchange Rate Variability: Non-EMS Case (Hausman and Taylor estimator, sample size=1540).

	Total	Machinery	Chemicals	Other Manufacturing	Agriculture
Relative prices	-0.290[a]	-0.294[a]	-0.209[a]	-0.3659[a]	-0.3358[a]
	(-14.00)	(-10.48)	(-5.588)	(-10.35)	(-9.712)
Income growth rates	1.471[a]	1.162[a]	1.177[a]	2.005[a]	0.2142
	(15.68)	(9.138)	(6.944)	(12.51)	(1.366)
STD of real exchange rates	-0.143	0.0216	-0.1545	-0.3986[b]	-0.3159[c]
	(-0.931)	(0.145)	(-1.197)	(-2.163)	(-1.931)
SKEW of real exchange rates	-0.132	-0.116	-0.1287	-0.1936	-0.309[b]
	(-1.070)	(-0.969)	(-1.245)	(-1.312)	(-2.259)
EU_{UK}	0.027	0.0253	0.0290[c]	0.0321	0.05173[b]
	(1.353)	(1.287)	(1.701)	(1.321)	(2.398)

Notes: *t*-ratios are in parenthesis; **a, b,** and **c** denote significant at 1, 5, and 10 percent level.

[1] Of the early studies in this area, only that by Thursby and Thursby is a panel study.

[2] Vianne and de Vries show that even with the possibility of hedging, exchange rate volatility will still affect trade because it gives rise to a risk premium in the forward exchange rate.

[3] Although PPP is typically used as the concept against which to gauge misalignment, it is not the only measure. Recently, there have been more formal attempts to measure the equilibrium exchange rate based on an explicit characterization of fundamentals. Examples of recent work in this area can be found in Williamson, and MacDonald and Stein.

[4] 'Persistence' of exchange rates from PPP is another feature of misalignment which we do not consider here as it neither relates to the uncertainty associated with exchange rate changes nor informs us of 'how far' away from PPP the exchange rate is, only that it takes a certain amount of time to return to the PPP level.

[5] It should be noted that using the variance as a measure of misalignment over the whole period suggests that the measure of uncertainty is an *ex post*, rather than *ex ante*, one. In justifying this it should be noted that with low frequency data most of the uncertainty is unanticipated. This paper uses annual data; Mark (1995) confirms that most of the changes in real exchange rates with data of this frequency are unanticipated, as do Engle and Hamilton.

[6] De Grauwe shows that the effect of exchange rate uncertainty on trade could be positive if the profit function is sufficiently convex.

[7] Ideally, the measure of relative prices should be sector specific. Due to lack of data, however, we use a common aggregate measure for relative prices, the real exchange rate.

[8] As the relative price variable is measured by the real exchange rate, the relative impact of this variable on agricultural trade is consistent with early studies in the agricultural economics literature that argued agriculture is more susceptible to changes in the exchange rate compared with other sectors. See, for example, Schuh.

[9] It might be argued that in the case of agriculture, non-EU countries exporting to the EU will be affected by variable import levies which would increase (decrease) in response to a non-EU country's exchange rate being under- (over-) valued. Two factors will mitigate this. First, the regression is based on cross-country effects, so it is the extent of depreciation (appreciation) of the non-EU country's currency relative to all other currencies that matters. Second, the 1-digit SITC definition of agriculture includes many processed food products that are not subject to variable import levies by the EU.

[10] In this sub-sample, there is little collinearity between exchange rate misalignment and the EU dummy for the UK.