NATIONAL BANK OF BELGIUM

Conference
150th anniversary

WORKING PAPERS - RESEARCH SERIES

THE ROLE OF THE EXCHANGE RATE IN ECONOMIC GROWTH: A EURO-ZONE PERSPECTIVE

Ronald MacDonald[(*)]

(*) Department of Economics, University of Strathclyde, 100 Cathedral St, Glasgow, G4 OLN.

Statement of purpose:

The purpose of these working papers is to promote the circulation of research results (Research Series) and analytical studies (Documents Series) made within the National Bank of Belgium or presented by outside economists in seminars, conferences and colloquia organised by the Bank. The aim is thereby to provide a platform for discussion. The opinions are strictly those of the authors and do not necessarily reflect the views of the National Bank of Belgium.

The Working Papers are available on the website of the Bank:
http://www.nbb.be

Individual copies are also available on request to:
NATIONAL BANK OF BELGIUM
Documentation Service
boulevard de Berlaimont 14
B - 1000 Brussels

Imprint: Responsibility according to the Belgian law: Jean Hilgers, Member of the Board of Directors, National Bank of Belgium.

ISSN: 1375-680X

Editorial

On May 11-12, 2000 the National Bank of Belgium hosted a Conference on *"How to promote economic growth in the euro area?"*. A number of papers presented at the conference is made available to a broader audience in the Working Papers series of the Bank. This volume contains the fifth of these papers. The other five papers were issued as Working Paper 5-8 and 10.

Abstract

In this paper we consider a range of topics which connect exchange rates to the economic growth process. In particular, we first of all outline the basic properties of exchange rates when they are flexible. One key feature of flexible exchange rates is that they are highly volatile and such volatility may affect growth through the channels of trade and investment. These channels are considered in some detail in this paper. We also consider the links between sectoral and aggregate growth and the exchange rate, using the Balassa-Samuelson and Houthakker-Magee-Krugman hypotheses. The main conclusion of the paper is that the current exchange rate arrangements for the euro-zone area, both internal and external, are likely to stimulate economic growth.

TABLE OF CONTENTS:

1. INTRODUCTION

The role of the exchange rate in the economic growth process is not immediately apparent from a cursory glance at the growth literature. Indeed, the idea that a financial price can have real effects would at first blush perhaps seem to be a rather odd idea. However, some clues to the likely effects of exchange rates on growth may be gleaned from the behaviour of exchange rates when they are flexible. First, in a flexible exchange rate regime there is a very close correlation between real and nominal exchange rates and it is widely accepted, although not uncontroversial, that in the presence of sticky prices it is the nominal exchange rate which drives the real exchange rate. Furthermore, once a real exchange rate change occurs that change tends to be highly persistent or, indeed, permanent. Another feature of exchange rates when they are flexible is that they tend to be extremely volatile and such volatility has been argued to be excessive, in the sense that there appears to be no corresponding volatility in the kinds of variables driving exchange rates, such as relative money supplies and prices. What is the relationship between such exchange rate behaviour and economic growth?

In my lecture today I am going to take the body of economic growth theory as given and simply think of economic growth as driven by changes in the factor proportions, along the lines of a standard growth accounting relationship. What effect does the exchange rate have on these proportions? For the purposes of this lecture, it shall prove useful to decompose growth into permanent, cyclical and transitory components as:

$$\Delta y_t = y_t^P + y_t^C + \varepsilon_t , \quad (1)$$

where y_t denotes the natural logarithm of national income, ? is the first difference operator, and therefore ? y_t represents the growth rate, y_t^p and y_t^c are the permanent and cyclical components of national income and ε_t is a transitory term. The permanent component may be thought of as related to long-run, or steady state, growth and the cyclical element is the business cycle-related component. How can the exchange rate influence y_t^p and y_t^c? In this paper we distinguish between two potential exchange rate effects: a level and a volatility effect. The level effect might occur when a country experiences, say, a sustained appreciation of its nominal and real exchange rates, due to a tight monetary policy. This could make part, or all, of the country's traded sector unprofitable. The initial response of this exchange rate change may well be for firms exposed to trade to reduce their labour inputs to the existing capital stock and this could have a cyclical effect on growth. If the exchange rate misalignment was sufficiently prolonged then parts of the tradable sector could simply disappear, as occurred in the UK in the late 1970s and early 1980s. One could also imagine such a levels effect influencing the decision to invest in new capital for the country experiencing the misalignment.

However, perhaps the main channel by which the exchange rate is thought to influence economic growth is through the effect of exchange rate volatility on the profitability of international trade and investment. Indeed, the unattractive implications of exchange rate volatility for trade and investment has been argued to be one of the major weaknesses of floating exchange rate regimes (see for example Group of Twenty Four (1985) and the Group of Ten (1985)) and this certainly has been one of the driving forces for greater fixity of exchange rates within Europe, and also is behind calls for greater fixity of the tripolar three exchange rates - the euro, dollar and yen. Although it is sometimes argued that the existence of capital markets, and in particular a well developed forward market, should internalise the unpleasant consequences of exchange rate volatility, hedging is costly, and sometimes prohibitively so. Furthermore, such markets are often incomplete, particularly at horizons of greater than one year. We return to the issue of hedging below.

How important are the exchange rate effects discussed above likely to be for the euro-zone area? This is one of the aspects of the growth - exchange rate relationship I want to address in my lecture today. If we are prepared to think in terms of a causality relationship, then this effect may be thought of as exchange rate movements causing growth (positive or negative). There are two dimensions to this. First, there is the internal dimension - to what extent have locking exchange rates within Europe squeezed out the unpleasant consequences of exchange rate behaviour for intra-European trade and investment? Some insight into this question may be gleaned from an examination of the linkages that existed prior to the formation of the euro. Second, how important is this effect likely to be for the euro-zone area vis-à-vis its external trading partners? Given that the euro-zone as an entity is a relatively closed area in terms of international trade, it may be thought that this external effect is likely to be relatively small.

There is, however, another causality link between growth and the exchange rate, which is essentially the reverse of the above. Although there are various rationalisations for this effect, one that I shall discuss in this paper is related to the time series properties of real exchange rates. For example, and as I shall demonstrate below there is considerable long-run, or secular, persistence in real exchange rates. What explains this persistence and is the degree of persistence similar within and across monetary unions? Although there are a number of potential candidates to explain the persistence of real exchange rates there are two which are particularly pertinent to the topic of this lecture. One is the socalled Balassa-Samuelson effect which posits that a country which has relatively high productivity in its traded goods sector, compared to its non-traded goods sector, will have an overvalued currency relative to its trading partner(s). Furthermore, if the productivity growth in the home country's tradable sector is more favourable relative to its trading partners over time, this will impart a secular appreciation into its real exchange rate. Clearly, if this effect is significant it could have important policy implications for the internal workings of a newly formed monetary union since it implies that with a fixed nominal exchange rate the repercussions must be reflected in relative prices or inflation differentials. Are such differentials likely to be sustainable? To what extent, then, is the Balassa-Samuelson, effect important for the kinds of countries participating in EMU? An alternative perspective on the persistent nature of real exchange rates may be found in what I will refer to as the Houthakker-Magee-Krugman (HMK) hypothesis. This hypothesis suggests that countries with different long term growth rates, relative to their trading partners, or countries which face different elasticities of import and export demand, may suffer secular changes in their real exchange rate. Again, the extent to which this relationship does, or does not hold, for euro-zone countries may have important policy implications.

A final spin on the growth-exchange rate link, which has been brought into sharp relief recently by the sharp depreciation of the euro, is the effect of relative business cycle growth on an exchange rate. A number of commentators have argued that the euro is weak because aggregate growth in the euro-zone area is relatively slow; once growth in the euro-zone catches up with US growth, the euro will start to appreciate. We briefly discuss this linkage in section 4.

I am going to give my discussion of the growth - exchange rate topic an explicitly European perspective by generating some new empirical results for key EU countries. For the euro-zone area we may think of essentially two exchange rates: the internal and the external. Prior to monetary union there was some flexibility in the nominal and real exchange between European countries and there was much more flexibility in the external nominal and real exchange rates vis-à-vis non-European countries, such as the US. The advent of monetary union, of course, means that internal nominal rates are now rigidly fixed within Europe, although internal real rates can vary, while the external value of both the real and nominal euro have been flexible. Given that the euro-zone area is relatively closed - trade and investment is predominantly amongst EU countries - it has been suggested that the external flexibility of the euro is unlikely to have particularly large implications for the euro-zone area. I attempt to get a feel for the likely effects of exchange rate movements on euro-zone growth by constructing panel data sets consisting of the currencies of countries which are currently full participants of EMU. These panel data sets try to capture the effects of both internal and external exchange rate movements.

In sum, our approach to thinking about the growth - exchange rate relationship for the euro-zone area essentially involves presenting a smorgasbord of topics which seem relevant to this issue. In the next section we set the scene by presenting some stylised facts about the behaviour of real and nominal exchange rates in a flexible rate regime. Section 3 details the estimation methods used for our empirical results. We then go on in Section 4 to look at what a selection of open economy macro-economic exchange rate models have to say about exchange rate - growth linkages. In section 5 a brief of overview of the effects of the exchange rate regime on economic growth from an historical perspective is presented. In section 6 the relationship between growth and the exchange rate is considered by examining the Balassa-Samuleson and Houthakker-MageeKrugman hypotheses; some new empirical results are also presented in this section. In section 7 we focus on the potential role of the exchange rate in creating economic growth through the channels of investment and international trade. A concluding section gathers together the various points made throughout the paper.

2. SOME STYLISED FACTS ABOUT REAL AND NOMINAL EXCHANGE RATE BEHAVIOUR

Some insight into the topic of this lecture may be gleaned by asking the question: how do exchange rates behave when they are flexible? There are a number of so-called sylised facts relating to this question. First, when exchange rates are flexible they tend to be highly volatile. This volatility is usually gauged in a number of ways: on an historical basis when comparing the recent flexible rate experience with fixed, but adjustable, exchange rate regimes, such as the Bretton Woods regime; exchange rates are volatile relative to some measure of the expected exchange rate, such as the forward exchange rate or the expectation implied by survey data. exchange rates are volatile relative to certain fundamentals such as relative prices and money supplies[1].' The latter is illustrated in Table I where we present the coefficients of variation for a number of exchange rates relative to certain key fundamentals (these are US dollar bilateral exchange rates for the period January 1980 through to December 1997). However, Table I also indicates that exchange rate volatility is of a smaller order of magnitude than the volatility we observe in interest rate yields (indeed this is also true for other asset yields). However, despite the latter a number of papers have demonstrated that the volatility of a weighted average of fundamentals is roughly the same under both fixed and flexible exchange rates (Flood and Rose (1999)). The key distinguishing factor between the two regimes, as we have indicated, is the volatility of the exchange rate. By fixing the exchange rate this volatility simply disappears and does not show up elsewhere in the macroeconomy. Some have concluded from this kind of evidence that it is impossible to explain the volatility of exchange rates in terms of standard macroeconomic fundamentals.

Table 1 - Coefficients of Variation for Exchange Rates and Fundamentals

Country	Exchange Rate	Relative Prices	Interest Differential
France	18.16	8.32	199.38
Germany	16.23	2.51	54.53
Japan	14.58	2.79	146.49
Switzerland	16.73	3.78	40.40
UK	22.36	5.17	56.91

[1] See MacDonald (1988,2000) for an extended discussion.

In order to get a feel for the relative volatility of currencies, as opposed to their volatility relative to fundamentals, we present in Table 2 coefficients of variation for a group of European currencies, including those who have irrevocably locked their exchange rates within Europe. The rates are defined with respect to three numeraire currencies - the DNI, the Yen and the US Dollar. These show that the volatility of the US and dollar rates are about the same order of magnitude, but that the ERM effect has attenuated the volatility of the DM-based currencies to around one-half of that observed in the other rates. Furthermore, the volatility of all three rates is sample-specific, with the period of the 80's, a period when the convergence process was perhaps at its greatest in Europe, exhibiting the smallest volatility.

A second stylised fact about exchange rates is that there is a very close correspondence between real and nominal exchange rates. Although the interpretation of what causes this volatility is controversial, we would argue that it is the nominal exchange rate which drives the real exchange rate. Clearly such real changes could impact on the profitability of the tradable sector and this could affect growth in the medium run and also, perhaps, in the longer run. The close correlation between real and nominal exchange rates is illustrated in Figure 1[2] and also in Table 2 where we note that the relative nominal volatility of currencies discussed above seems to get transferred into roughly equivalent real volatility.

A third stylised fact about the behaviour of real exchange rates is that they are highly persistent. Evidence of such persistence may be obtained from the recent literature on Purchasing Power Parity (PPP)[3].' For example, single currency univariate unit root tests suggest that real exchange rates are effectively non-stationary, or to the extent that they do exhibit any mean reversion it is incredibly slow. In Table 3 we present some univariate unit root statistics to illustrate this persistence for the currencies examined in this paper. Three sample periods are considered: a full sample, 1980, quarter 1, to 1998, quarter 4 and two sub-samples within the full sample (1980,1 to 1989,2 and 1989,3 to 1998,4). These results indicate an inability to reject the null for any sample period for the DM and US dollar based currencies, although we note that 5 rejections for the yen based currencies occur in the full sample. These kind of results can usually be overturned by increasing the span of the data. Here we accomplish this by stacking the three sets of real exchange rates into panels and constructing Levin and Lin (1994) panel unit root t-tests and adjusted t-tests (adjt), along with the implied degree of quarterly adjustment (δ).

2 The correlation between real and nominal exchange rates is approximately 0.9.
3 See, for example, MacDonald (1995,2000).

These results are reported in Table 4 and indicate that the null of a unit root can easily be rejected in a panel context.

Table 4 - Panel - Unit - Root Tests

	t	adjt	d
USD	-5.02	-2.28	-0.05
DM	-5.70	-2.01	-0.08
YEN	-8.34	-4.76	-0.13

The speed of mean reversion is fastest for Yen based currencies and slowest for US dollar bilaterals.

A useful way of gaining extra perspective on the sources of exchange rate volatility is to decompose the overall real exchange rate - the exchange rate defined using CPI prices - into the relative price of traded goods across countries and the relative price of goods within a country, relative to its trading partners. In natural logarithms, the real exchange rate defined for CPI prices may be defined as:

$$q_t \equiv s_t - p_t + p_t^{*}. \quad (2)$$

If we assume that the general prices entering our definition of the real exchange rate can be decomposed into traded and non-traded components as:

$$p_t = \alpha_t p_t^{NT} + (1-\alpha_t)p_t^{T}, \quad (3)$$

$$p_t^{*} = \alpha_t p_t^{NT*} + (1-\alpha_t)p_t^{T*}, \quad (4)$$

where p_t^{T} denotes the price of traded goods, p_t^{NT} denotes the price of non-traded goods and the α_t's denote the share of non-traded goods in the overall price level (and are assumed to be the same across countries). Additionally, assume that a similar relationship to (2) can be defined for traded goods as:

$$q_t^{T} = s_t - p_t^{T} + p_t^{T*} \quad (5)$$

By substituting (3), (4) and (5) in (2) the following expression may be obtained:

$$q_t = q_t^T + \left[\alpha(p_t^{NT*} - p_t^{T*}) - \alpha(p_t^{NT} - p_t^T)\right], \quad (6)$$

$$q_t = q_t^T + q_t^{T,NT}, \quad (7)$$

$$q_t^{NT,T} = \alpha\left[\left(p_t^{NT*} - p_t^{T*}\right) - \left(p_t^{NT} - p_t^T\right)\right] \quad (8)$$

The first term in (6), q_t^T, represents the law of one price (LOOP), or violations of the LOOP**,** while the second term, $q_t^{NT,T}$ represents the so relative price ratio and is usually associated with the Balassa-Samuelson effect, considered in some detail in section 6, although it can also be driven by demand side influences, such as the effect of government expenditure or preference shifts. On the assumption that the LOOP holds, expression (6) predicts that if the home country has a relatively high internal price ratio it will have an appreciated real exchange rate defined using overall prices. This expression is useful because it allows us to think of the volatility, or trend, in the overall real exchange rate as being driven by the volatility or trend in either q_t^T, $q_t^{NT,T}$ or both.

How important is the relative price of traded goods, q_t^T, compared to the internal price ratio, $q_t^{NT,T}$ explaining the volatility and persistence in the overall real exchange rate q_t? Engel (1993) compares the conditional variances of relative prices within and across the G7 countries using disaggregated indices of CP1s, over the period April 1973 to Sept 1990. Out of a potential 2400 variance comparisons, Engel finds that in 2250 instances the variance of the relative price within the country is smaller than the variance of the relative price across countries; that is, $V(q_t^T) > V\left(q_t^{NT,T}\right)$ and that this difference is statistically significant. Rogers and Jenkins (1995) essentially confirm Engel's analysis using finer disaggregations of the prices entering the CP1s of 11 OECD countries. Additionally, however, they also examine the relative importance of trends in q_t^T and $q_t^{NT,T}$, in explaining the systematic element of q_t^T. They find little evidence that q_t^T is an I(0) process even when a fine level of dissagregation is used. Furthermore, they produce very little evidence that q_t^T and $q_t^{NT,T}$ are cointegrated. Taken together, the empirical evidence on the relative importance of the two right hand side elements in would seem to favour sticky price models, such as those of Dornbusch (1976) and Giovannini (1988). One alternative interpretation is to attribute it to the pricing to market policies of companies. However, both Rogers and Jenkins (1995) and Wei and Parsley (1995) show that adjustment speeds for disaggregate relative prices are similar to the adjustment speeds estimated for aggregate CPI real exchange rates, which seems inconsistent with the pricing to market hypothesis.

What are the implications of the stylised facts noted here for growth in the euro-zone area? This is the question we attempt to address in some detail in the remainder of this paper. For now, though, we present a summary of the likely answers. First, the removal of nominal volatility by locking currencies within Europe may have important implications for euro-zone trade, investment and growth. To the extent that the persistence in real exchange rates is driven by the persistence in nominal exchange rates this may also be beneficial since, in the absence of such volatility, internal euro-zone real exchange rates may be better able to reflect relative prices within Europe, rather than the capricious movements of the nominal rate and the misaligned real rates they can imply. Clear relative price signals are likely to improve resource allocation within Europe. The fact that the external value of the euro is mean-reverting means that it can adjust over time and this may have important implications for current account imbalances and growth. Additionally, how is volatility in the external value of the euro likely to affect growth within the euro-zone area? The above effects all relate to the exchange rate influencing economic growth. But our discussion in this section also suggests a way in which the growth process itself is likely to have an important influence on real exchange rates within the euro-zone area. Hence removing a major source of volatility in real exchange rates, by locking nominal rates, could mean that the so-called internal price ratio, $q_t^{NT,T}$, is now the dominant driving force of the overall real exchange rate. As we shall see, one of the main potential driving forces of $q_t^{NT,T}$ is productivity differentials in the traded goods sector relative to the non-traded sector. Does this growth effect have unpleasant consequences for internal euro-zone exchange rates?

Before closing this section we present a first pass at the exchange rate - economic growth linkage by presenting scatter plots of the relative growth rates of 8 key participants in the euro-zone project (Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, and Spain) against the corresponding real exchange rate changes, using three different numeraire: the German mark, the US dollar and the Japanese yen. These are presented in Figure 2 and indicate no clear-cut relationship between economic growth and real exchange rates. However, these kind of figures may in fact conceal more than they reveal. The rest of the paper may be seen as an attempt to gauge how robust the results in Figure actually are.

3. ESTIMATION METHODS - A DIVERSION

In some of the succeeding sections we present some new estimates of various propositions relating to the exchange rate - growth proposition. These estimates are designed to capture both the internal euro effects - that is, for the internal real exchange rate relationships within the euro area - and also for the external value of the euro - against the dollar and yen. Since most of the variables considered here are non-stationary we use single equation cointegration estimators to generate our results. In contrast, however, to the standard two-step Engle-Granger cointegration estimators, our estimators recognise potential simultaneity and serial correlation biases. In particular, we use the so-called single equation dynamic ordinary least squares (SDOLS) estimator of Stock and Watson (1993):

$$y_t = \alpha + \beta x_t + \sum_{j=-p}^{+p} \theta_j \Delta x_{t+j} + \xi_t , \quad (9)$$

where the leads and lags are included to account for potential endogeneity and serial correlation. The second estimator is the panel equivalent of (9), advocated by Kao (1999) and Mark and Sul (1999). Essentially, the panel DOLS estimator introduces a cross sectional dimension into (9):

$$y_{it} = \alpha_i + \beta x_{it} + \sum_{j=-p}^{+p} \theta_{ij} \Delta x_{it+j} + \xi_{it} , \quad (10)$$

where the constant now has the interpretation of a fixed effect. Our data, discussed on a case-by-case basis, are extracted from the OECDs CD-ROM (1999/2) disc and the IMF's IFS CD-ROM (March 2000).

4. EXCHANGE RATE MODELS AND ECONOMIC GROWTH

What is the relationship between income, growth and the exchange rate in macroeconomic exchange rate models? The flexible price monetary model has become something of a workhorse in open economy macroeconomics, being the long-run solution to the celebrated Dornsbusch (1976) overshooting model and a model in its own right (see, for example, Frenkel (1976) and Mussa (1979)). Although the monetary model is usually motivated as an asset market model, it is in fact a simple extension of PPP which fleshes out the determination of prices in each country by imposing continuous money market clearing. In particular, assume that the demand for money in the home and foreign country is given by a (log-linearised) Cagan money demand function and that the supply of money is continuously equal to the demand at some exogenous level, m_t

$$m_t - p_t = \alpha_0 y_t - \alpha_1 i_t, \qquad \alpha_0, \alpha_1 > 0, \quad (11)$$

$$m_t^* - p_t^* = \alpha_0 y_t^* - \alpha_1 i_t^*, \qquad \alpha_0, \alpha_1 > 0, \quad (12)$$

On rearranging (11) and (12) for the home and foreign country price levels, respectively, and substituting these into an absolute PPP condition we obtain the so-called flex-price monetary reduced form:

$$s = p_t - p_t^* = (m_t - m_t^*) - \alpha_0 (y_t - y_t^*) + \alpha_1 (i_t - i_t^*) \quad (13)$$

which simply states that the nominal exchange rate is driven by relative excess money supplies. Income, and therefore by implication growth, affects the exchange rate in this model indirectly through the demand for money. Other things equal a country enjoying positive income growth will enjoy an appreciating currency: positive income growth raises the real demand for money which, for an exogenously determined supply of money can only be satisfied by a fall in the price level and an exchange rate appreciation. Recent empirical research suggests that this kind of model has some validity both as a long- run and also a short-run relationship (see, for example, La Cour and MacDonald (2000)). MacDonald and Swagel (2000) survey the point estimates of no reported in a number of papers and find that the vast majority of estimates are significantly negative as predicted. Of course this effect could also arise in sticky price variants of the monetary model

(Dornbusch (1976) and Rankel (1979)), and in such models a rise in income can have a reinforced effect on income to the extent that it pulls up nominal and real interest rates in the process. The pattern of a strong exchange rate and strong economic growth (weak exchange rate and weak economic growth) is usually thought of as the business cycle growth - exchange rate relationship and is usually driven by interest rates. Indeed, to the extent that interest rates contain information about future growth, the exchange rate can appreciate in anticipation of strong economic growth.

The above growth - exchange rate relationship may have implications for intra-euro-zone inflation differentials which are the opposite of those implied by the Balassa-Samuelson effect, discussed in section 6. For example, with a common euro-zone wide monetary policy determined in effect by the average income and inflation growth acros the euro-zone, a country with above (below) average growth will, ceteris paribus, have negative (positive) inflation. How important is this effect likely to be? The α_0 coefficient is normally estimated at between -0.5 and -1. If we take an average number of -0.75 then this suggests that a country which has an annualised growth of 1 % above the average of its euro-zone partners will find its inflation rate falling by 0.75 per cent per annum. Relative to the inflation numbers mentioned below this effect is rather small but could, nevertheless, help to offset the implications of increased productivity growth in tradable sectors for inflation.

The real business cycle, or supply side, models of Stockman (1980) and Lucas (1982) essentially append a supply side to equation (13). A typical reduced form from this class of model would be:

$$s_t = z_t + [\alpha_0 t_t + \rho_t], \quad (14)$$

where z_t is a vector comprising the variables on the left hand side of (13), t_t is a relative taste shock and ρ_t is a relative technology shock. The latter variables are seen as driving a country's real exchange rate and this, in turn, is seen as providing an explanation for the close correlation between real and nominal exchange rates noted in section 2 (see Stockman (1987)). The model has no role for exchange rate movements causing economic growth. However, for causality to run from the real to the nominal exchange rate the volatility of fundamentals should have increased during the recent floating period. The fact that they have not is perhaps the most convincing piece of evidence against this class of model.

A model which does potentially have an explicit role for the exchange rate in the growth process is the standard textbook Mundell-Fleming model. In the most basic form of this model there are no supply side constraints and expectations are formed statically. A central relationship in this model is the aggregate demand function and a central element in this is the real exchange rate:

$$y_t^d = \eta(s_t - p_t) - \sigma r_t. \quad (15)$$

An expansionary monetary policy in this model can , for example, generate a permanent rise in output. We return to this kind of relationship in a couple of places later in the paper. However, it hardly needs saying that this model is no longer a particularly fashionable vehicle for thinking about exchange rate issues. The so-called Mundell-Fleming-Dornbusch model appends sluggish short-run price adjustment, and long-run price flexibility, along with forward looking expectations to (15) to produce a different steady state prediction between the exchange rate and income. The additional relationships in this model are:

$$p_t = (1-\theta)E_{t-1}\overline{p_t} + \theta\overline{p}_t, \quad (16)$$

$$m_t - p_t = y_t - \lambda i_t, \quad (17)$$

$$i_t = E_t \Delta s_{t+1} + \mu_t, \quad (18)$$

$$r_t = \left(i_t - E_t\left(\rho_{t+1}\right) - p_t\right). \quad (19)$$

Equation (15) is an IS-relation, relating aggregate demand (y^d) to the real exchange rate $(q_t \equiv s_t - p_t)$ and the expected real interest rate r_t. Equation (16) is just the price adjustment equation where the bar denotes the permanent component of the price level (p_t). A money market equilibrium condition is given by equation (17), while (18) is an uncovered interest parity condition augmented by (μ_t) that could be interpreted as a risk premium.

The supply side of the model is specified by two random walks:

$$y_t^s = y_{t-1}^s + z_t , \quad (19)$$

$$m_t = m_{t-1} + \nu_t , \quad (20)$$

where z_t and ν_t denote supply and money shocks, respectively.
The steady state of this model is given by:

$$\overline{y_t} = y_t^s , \quad (21)$$

$$\overline{q_t} = \frac{1}{\eta}\left[\overline{y_t} + \sigma\overline{r_t}\right], \quad (22)$$

$$\overline{p_t} = m_t - \overline{y_t} - \lambda\overline{i_t} . \quad (23)$$

This model predicts that output shocks can affect the long-run exchange rate. Although the exchange rate can affect output in the traditional way over the business cycle, it has no long-run effect (see Hoffman and MacDonald (2000)) for a further discussion of the empirical implications of this model.

5. EXCHANGE RATE REGIMES AND ECONOMIC GROWTH

This brings us into the issue of what has been the exchange rate regime most closely associated with economic growth. A number of papers have sought to address this issue. For example, Bordo and Schwartz (1998) provide a comprehensive comparison of the growth of real per capital income over a number of key regimes of the international monetary system, spanning the period 1881-1995. The regimes covered are: the classical gold standard, 1881-1913, the inter-war period 'mixed regime', 1919-1939, the Bretton Woods period, 1946-1970 and the recent floating rate period, 1973 to present. The Bretton Woods period is further subdivided into the preconvertible phase, 1946-1958, and the convertible phase 1959-1970. Also the recent floating period is subdivided into an inflation period, 1973-1982, and a disinflation period, 1983-1995. In summary, Bordo and Schwartz find the following: the Bretton Woods period, and particularly the convertible period, exhibited the most rapid average output growth of any monetary regime and the inter-war 'mixed regime' period produced the lowest. However, interestingly, taking the entirety of the Bretton Woods period, their is a higher variability of growth than in the recent floating rate period.

In contrast, however, Ghosh et al (1996) find that there is little correlation between an adherence to fixed exchange rates and economic growth, once account is taken of the 1960s period. Indeed, Bordo and Schwartz concede that the link between the kind of fixed exchange rates provided by Bretton Woods and high economic growth seems less compelling than for other aspects of economic performance, such as inflation, and they attribute this to a number of factors. First, they argue that there is an apparent absence of a link between exchange rate volatility and either investment or trade flows and economic growth. Thus, although Ghosh et al (1996) find evidence linking real growth to the growth of investment and trade for pegged countries, they also find total factor productivity growth to be an important channel of growth for floaters. Furthermore, institutions outwith the Bretton Woods regime may have been important for growth, such as OEEC, EPU, European Coal and Steel Community (ECSC). Third, Bordo and Schwartz argue that the Bretton Woods system may have contributed to growth by providing an overall framework of rules which allowed Western European nations to solve a hierarchy of co-ordination problems, which allowed them to encourage investment in growth-generating export sectors. Fourth, the Bretton Woods regime may have contributed to post-war growth by being part of an overall package generating political and economic stability - the so-called

Pax Americana. In their view, therefore, Bordo and Schwartz argue that it is difficult to disentangle the effects of the exchange rate regime *per se* from the institutional factors associated with that regime.

6. THE GROWTH - EXCHANGE RATE LINK

We now turn to two potential avenues through which growth can affect the real exchange rate and, in particular, generate the evident persistence in real exchange rates. The first of these, the Balassa-Samuelson effect, focuses on the internal price ratio in (6), and argues that unbalanced growth in a country's traded sector relative to its non-traded sector, can impart a secular trend into the real exchange rate. This story can have potentially important implications for the internal relative inflation rates of the euro-zone countries and, also, for real interest differentials within Europe. Although these relative effects are often seen in the context of a catch-up hypothesis, and therefore deemed to be only transitory, it is possible that there may be more permanent implications of these kinds of effects. The BS hypothesis is also likely to have implications for the external value of the euro. In particular, what are the implications for the stance of euro-zone monetary policy and, relatedly, the implications for the kind of exchange rate regime the euro should participate in? The BS effect is also likely to have important implications for countries, such as the central european countries, seeking to enter the euro-zone, since sectorally unbalanced growth can produce exchange rate and inflation combinations which are inconsistent with the convergence criteria. The Balassa-Samuelson hypothesis is a supply side effect relating to the longer run trend in the real exchange rate. The second strand in the growth-exchange rate link considered in this section is more closely associated with the relative price of traded goods across countries and is related more to the medium run trend in the real exchange rate. We label this effect the Houthakker-Magee-Krugman hypothesis, as it was first noted by Houtakker and Magee (1969) and formalised by Krugman (1989) into the so-called 45° rule. This hypothesis represents a partial equilibrium approach to interpreting secular trends in real exchange rates. In particular, the hypothesis suggests that if a particular lock does not hold between a country's relative growth rate and its relative export and import income elasticities, this could have important consequences for the secular drift in its exchange rate.

6.1 Decomposing the real exchange rate: Violations of the LOOP and the Balassa-Samuelson hypothesis

Perhaps the best known explanation for secular trends in the real exchange rate is the Balassa-Samuelson (BS) biased productivity growth hypothesis. The BS hypothesis focuses on the role that the so-called internal price ratio - the ratio of non-traded to traded goods prices - can play in introducing systematic trends into real exchange rates. In particular, the proposition is that a country with relatively high productivity in its traded goods sector will have an appreciated real exchange rate, defined using overall price levels. Furthermore, if that country exhibits relatively high productivity growth in its tradables sector over time it will have a secular appreciation of its real exchange rate. The BS hypothesis focuses on the implications of trends in productivity for long-run real exchange rates, ignoring short-run adjustments. The long-run nature of the model means that relative prices are driven by supply side factors, with demand side factors being ignored. The BS hypothesis may be explained in the following way.

Assume that production technology for the home country is given by a simple Cobb-Douglas specification (a similar set of relationships are assumed to hold in the foreign country):

$$T = \eta (K^{T})^{(1-\lambda)} (L^{T})^{\lambda} \quad (24)$$

$$NT = \upsilon K^{NT(1-\delta)} (L^{NT})^{\delta} \quad (25)$$

where T and *NT* denote production of traded and non-traded goods, respectively, η and ν represent shocks to total factor productivities. In the home and foreign country capital and labour are assumed to be fully employed in the production of traded and non-traded goods:

$$L^{T} + L^{NT} = L \quad (26)$$

$$K^{T} + K^{NT} = K \quad (27)$$

Assuming that competition ensures that labour is paid the value of its marginal product and that nominal wages, W, are equalised across sectors, then:

$$\frac{\delta T / \delta L^{T}}{\delta NT / \delta L^{NT}} = \frac{W / P^{T}}{W / P^{NT}} = \frac{P^{NT}}{P^{T}} \quad (28)$$

where P^{NT} / P^{T} *is* the internal price ratio referred to in section 2 and a similar expression is assumed to hold in the foreign country.

Given this set up, a shock to total factor productivity in the traded sector will increase the marginal product of labour in that sector, raise wages and the relative price of nontraded goods. Returning to equation (6) we see that if, as the BS hypothesis assumes, the LOOP is continually satisfied (and therefore q_t^T is always zero or constant) and productivity is unchanged in the foreign country, this productivity shock will appreciate the overall real exchange rate. If, furthermore, the home country has relatively rapid growth in its traded goods sector over time the prediction is that it will have a secular appreciation of its real exchange rate. Usually this effect is at its most dramatic when comparing a developed to a developing country.

The findings, discussed in section 2, indicated that the dominant source of volatility in real exchange rates comes from the relative price of traded goods, q_t^T. This, of course, does not necessarily imply that that the Balassa-Samuelson effect is in itself unimportant or insignificant, it is just that the above evidence suggests that with flexible exchange rates the dominant component of real exchange rate behaviour is nominal exchange rate volatility. So how important is the Balassa-Samuelson effect? A number of papers have examined the effect for both developing and developed countries (see Chinn and Johnston (1999) for a survey). Recent tests of the BS hypothesis (see for example Canzoneri, Cumby and Diba (1999), Chinn and Johnston (1999) and MacDonald and Ricci (2000)) use either total factor productivity or average labour productivity differences as the productivity measures are based on the following regression equation:

$$x = \alpha + \beta(pr^{T} - pr^{NT}) + \nu + \varepsilon \quad (29)$$

where x is either the real exchange rate, q, or the internal price ratio, ipr, and ν is a vector of other conditioning variables In sum, this strand or research finds significant and correctly signed effects of productivity differences on the internal price ratio, the relative productivity term tends to overpredict the ipr and a statistically significant relationship between relative productivity differences and the overall real exchange rate is found, especially if a panel estimator is used (and the relative productivity term tends to underpredict the real exchange rate) .

Canzoneri, Diba and Eudey (1996) test the BS hypothesis for a group of eleven European countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Portugal, Spain and Sweden) using annual data on average labour productivity in the traded and non-traded sectors for the period 1970 to 1990. Using some simple statistical tests and single equation cointegration tests Canzoneri et al show compelling evidence to suggest that trends in the productivity ratio are good predictors of long-run trends in overall real exchange rates. Kohler (1999) uses an unbalanced panel data set of 28 countries for the period 1960-1997 to examine how important sectoral productivity is in explaining past price movements. Using a standard fixed effects panel estimator she finds slope coefficients which are significantly above zero but also significantly below unity (a range of approximately 0.5 and 0.7) and interprets this as a reflection of a failure of wage equalisation across countries (some support for this is to be found in Aleberola and Tyrvainen (1998) who show that conditioning on this differential produces a coefficient on the relative productivity term of unity). Additionally, using the panel cointegration estimator of Pedroni, which allows for the estimation of the individual BS coefficients for each country, Kohler finds a fairly wide dispersion of point estimates ranging from -I for Italy, Belgium and Finland to -0.6 for Germany.

We interpret the above evidence as suggesting that the Balassa-Samuelson hypothesis is in the data for euro-zone countries. What, if any, are the likely consequences for this for the future of EMU? In particular, what are the implications for the behaviour of real exchange rates and inflation within the euro-zone and also for the euro-zone relative to its external trading partners? Assume, as before, that (3) and (4) hold. Then we may define the inflation rate, π, for the home country as:

$$\pi \equiv \Delta P / P \approx (1-\alpha)\Delta p^{T} + \alpha \Delta p^{NT} = \Delta p^{T} + \alpha \Delta ipr \quad (30)$$

where ipr is the internal price ratio. On using (5), (30) and (27) we may calculate the inflation differential between the home and foreign (numeraire) country as:

$$\pi - \pi^{*} = \Delta s + \alpha(\Delta ipr - \Delta ipr^{*}) \quad (31)$$

$$= \Delta s + \alpha\left[\Delta\left(mpl^{T} - mpl^{NT}\right) - \Delta\left(mpl^{T*} - mpl^{NT*}\right)\right] \quad (32)$$

where mpl denotes the marginal product of labour. If the nominal exchange rate is flexible $\Delta s \neq 0$ then as we have seen BS explains the evolution of the real exchange rate across countries: it is the role of monetary policy to decide how these external effects are split between nominal exchange rate changes and changes in the inflation differential. If, alternatively, the exchange rate is rigidly fixed, as in the euro-zone area, BS explains the inflation differential across participating countries, where the inflation differential is simply the change in the internal real exchange rate. How important are such inflation differentials likely to be within the euro-zone area? Are they likely to undermine the credibility of the fixed parities? Before answering these kinds of questions we note another implication of biased productivity growth. Expression *(31)* may be used to say something about the behaviour of real interest rates across countries participating in the euro-zone. For example, defining the change in the real exchange rate as $\Delta q = (\pi - \pi^{*} + \Delta s)$, with flexible exchange rates, or $\Delta q = (\pi - \pi^{*})$, with fixed rates, and assuming real interest parity holds:

$$\Delta q = (r - r^{*}) \quad (33)$$

then (31) implies that relative productivity differences will drive real interest rates over time:

$$(r - r^{*}) = \alpha\left[\Delta\left(mpl^{T} - mpl^{NT}\right) - \Delta\left(mpl^{T*} - mpl^{NT*}\right)\right] \quad (34)$$

In particular, if, say, home productivity is growing faster than foreign productivity, the home real interest rate has to be lower than the foreign real rate. This, in turn, could have implications for relative growth rates across euro-zone countries to the extent that these real interest differentials influence gross capital formation. In sum, the biased productivity growth amongst participants of a monetary union may cause both internal and external real exchange rate changes and there is therefore an issue of how sustainable these are likely to be.

In passing, it is worth mentioning an alternative explanation for productivity differences, refered to as the labour absorption hypothesis (Canzoneri *et al* (1996)). In this effect, increased integration in Europe has forced the traded goods sector to become more competitive and should shed excess labour. This surplus labour has been absorbed by government employment, thereby reducing average productivity of the nontraded sector and, since this sector is sheltered from competition, increasing the price. However, Canzoneri *et al* argue that for this effect to be a valid explanation of real exchange rate movements within Europe would require the real exchange rates to overpredict productivity trends (which are proxies for marginal costs); however, in their work the opposite appears to be the case.

How important is the BS effect likely to be for the euro-zone? A number of studies have examined the kind of relative price movements which seem to be consistent with the operation of existing monetary unions. For example, De Grauwe (1992) examines the relative price behaviour of five German Lander and finds inflation differentials between 0.2 and 1.2 per cent. Poloz (1990), Bayoumi and Thomas (1995) and Buti and Sapir (1998) examine inflation differentials within Canada and the United States, respectively, and find inflation differentials of between 0.5 and 2 per cent. Canzoneri *et* al (1996) use their estimated productivity equations discussed above to calculate the inflation differentials of their group of European countries relative to Germany implied by the trends in relative labour productivity. The countries can be divided into three groups: Belgium, Italy and Spain form a group in which productivity trends imply that they should have inflation rates which are about 2 % higher than German rates, while the relative productivity growths of Portugal, Denmark, Austria, France, UK and Sweden imply they should have inflation rates on average 1 % higher than German rates and Finland should have an inflation rate about the same as the German average. These kind of inflation differentials are not inconsistent with the Maastricht criterion, nor do they seem to be inconsistent with the size of differentials found within existing monetary unions, referred to above. Based on her estimates of productivity differentials, discussed above, Kholer (1999) estimates implied inflation (CP1) differentials for EMU countries. She finds that the upper band for this is in the range 1-3% with the higher figure representing the growth experience over the last 30 years, and the smaller number being derived from the growth experience over the last 15 years.

Although the inflation differentials implied by relative productivity growth rates do not seem inconsistent with inflation differentials in existing monetary unions, Canzoneri *et* al use the data set of Bayoumi and Eichengreen (1993) to demonstrate that there is much less regional variation in productivity within the US and indeed that the implied differentials in regional inflation are only about one fifth the size of Europe. Do countries with differing productivity trends belong in the same monetary union? Will full economic integration cause productivity trends to converge in Europe? We would argue that indeed this is what has caused the homogeneity in existing monetary unions.

We present some new empirical evidence on the importance of the Balassa-Samuelson hypothesis for the euro~zone area by running the following regression using a single equation DOLS estimator:

$$q_t = \alpha + \beta q_t^{NT,T} + \varepsilon_t . \quad (35)$$

In order for this equation to represent a test of the BS hypothesis we must assume that the LOOP holds up to a constant and that the internal price ratio is picking up productivity differences and not other demand side factors. However, even if it is not a pure test of BS it may nevertheless be instructive in indicating the importance of the internal price ratio in driving internal and external real exchange rates for the euro-zone. If the BS is valid, the β coefficient is expected to be significantly negative. As is standard in the exchange rate literature, we proxy the price of traded goods with the producer price index and the consumer price index is our proxy for non-traded goods. These data were extracted from the International Monetary Fund's International Financial Statistics CD-ROM (March 2000). We present sets of estimates for three sample periods. The full sample period, 1980q1-1998q4, and two sub-periods, 1980q1-1989q4, and 1990q1-1998q4. Estimating this relationship for the two sub-samples should give some indication of the stability of the relationship and, in particular, if the convergence process has affected it. The countries chosen for these tests are listed in Table 4 and most are members of the euro-zone area. Three numeraire currencies have been chosen for these tests: the US dollar, the Japanese yen and the German mark. The former two rates pick up the external euro real exchange rate, while the latter picks up the behaviour of internal real exchange rates.

For the US dollar and yen based systems we note that for the full sample period, and the two sub-samples, the majority of coefficients are correctly signed and statistically significant. We note also that in the majority of cases the coefficient for these two external systems suggests that a one per cent increase in the internal price ratio has a more than proportionate effect on the real exchange rate and this effect seems to be stable across the sub-samples. For the system based on the mark, we note that the majority of coefficients are correctly signed and significant but that for the full sample the absolute magnitude of the coefficients is less than unity indicating that a one percent rise in $q_t^{NT,T}$ has a less than proportionate effect on the overall real exchange rate. The results for the first sub-sample are similar to the full sample but in the second sample we note a number of coefficients are above unity and these tend to be for countries most likely to be involved in a catch-up process -Spain Italy and Ireland.

Panel DOLS estimates are constructed solely for the participants of the euro-zone area (that is excluding both Denmark and the UK) and are reported in Table 5. These results generally confirm the points made regarding the single equation estimates.

In sum, the results based on equation (35) suggest that the there is a significant and correctly signed Balassa-Samuelson effect for the internal real exchange rates of euro-zone countries and that the magnitude of this effect does not appear to be inconsistent with these countries participation in a monetary union. Furthermore, there also seems to be a correctly signed and significant Balassa-Samuleson effect for euro-zone countries relative to the two key external currencies. The larger magnitude of the external effect would perhaps suggest that the external nominal value of the euro should be flexible.

We conclude this section by arguing that the existence of productivity differentials within Europe is unlikely to generate movements of internal real exchange rates which would put a strain on EMU. There will, however, inevitably be important and, perhaps significant, differences in the short-run as countries catch-up with their monetary union partners (and Ireland is a classic example of this at the moment), but once such countries have caught up the differentials would not be expected to be any larger than those observed for existing monetary unions. If agents do indeed recognise that these inflation differentials are transitory it would seem unlikely that the implied real interest differentials will have significant implications for differential capital formation. To they extent that they do, this could actually moderate the internal real exchange rate movements to the extent that they increase productivity in the service sectors. At the end of the day the importance of the Balassa-Samuelson effect in the euro-zone context boils down to whether it is seen as a good or a bad in the European context. It would seem that one of the key rationales for EMU is to allow countries which were originally relatively poor to catch up. Fundamentally, what EMU does is to allow countries to trade-off real exchange rate variation due to nominal variability from q^T for variability due to $q^{NT,T}$. As we shall argue subsequently, the former is unambiguously bad, whereas the latter is a natural consequence of the catch-up process and is likely to be a transitory phenomenon.

6.2 The Houthakker-Magee-Krugman 45° Rule

Perhaps the relationship that many economists would reach for first when trying to think about the implications of growth differences across countries for real exchange rates is the standard partial equilibrium analysis of trade flows. Ceteris paribus, a relatively fast growing country should have a depreciating exchange rate for the maintenance of current account balance, while a relatively slow growing country should have an appreciating exchange rate. However, Houthaker and Magee (1969) first noted that this need not be the case if the slow growing country has a sufficiently favourable income elasticity of demand for its exports relative to its income elasticity of demand for imports. Krugman (1989) formalised this relationship into the so-called 45° rule: unless the relative growth rate between the home country and the rest of the world is equal to the ratio of relative income elasticities of demand, the country's real exchange rate will exhibit a long-run trend. We label this hypothesis the Houthakker-Magee-Krugman (HMK) relationship. In contrast to the Balassa-Samuelson hypothesis, which focuses exclusively on supply side effects in trying to understand secular movements of real exchange rates, the HMK approach focusses exclusively on demand side effects. It is also distinct from the Balsassa-Samuelson hypothesis in shifting the emphasis for secular movements in the real exchange rate from the internal price ratio to the external price ratio: traded goods are no longer perfect substitutes across countries and so systematic movements in their relative price can explain systematic elements in the real exchange rate.

To illustrate the HMK hypothesis, we use a standard partial equilibrium analysis of trade flows. Define the real exchange rate in natural units (instead of logarithms) as: $q = sp^*/p$, where p now relates to the price of output. A standard trade balance model may be written as follows, where export volume is assumed to depend of foreign output and the relative price of domestic goods:

$$x = x(q, y^*), \quad (36)$$

and import volume is assumed to depend on domestic income and the relative price term:

$$m = m(q, y). \quad (37)$$

Equations *(36)* and *(37)* imply that the trade balance in domestic currency terms may be written as:

$$nx \;=\; px - sp * m, \quad (38)$$

$$= \; p[x - qm]. . \quad (39)$$

Hence the trade balance in terms of domestic output is given by:

$$nx = x - qm. \quad (40)$$

If we now totally differentiate *(40)* we obtain:

$$dnx / dt = x\left[\delta_x \hat{y}^* + \xi_x \hat{q}\right] - qm\left[\delta_m \hat{y} + (1 - \xi_m)\hat{q}\right]. \quad (41)$$

where δ_x and δ_m are the income elasticities of demand for exports and imports, respectively, ξ_x and ξ_m are price elasticities of demand for exports and imports, respectively, $\hat{y}$ and $\hat{y}^*$ are the rate of growth of home and foreign income, respectively, and *q is* the rate of real depreciation. If we assume initially that *nx = 0,* so that x = *qm,* it follows that to ensure a zero trade balance the following condition must hold:

$$\delta_x \hat{y}^* - \delta_m \hat{y} + (\xi_x + \xi_m - 1)\hat{q} = 0, \quad (42)$$

which, in turn, implies:

$$\hat{q} = \frac{\delta_m \hat{y} - \delta_x \hat{y}^*}{(\xi_x + \xi_m - 1)} \quad (43)$$

Equation *(43)* would lead us to expect that rapidly growing countries would experience a secular exchange rate depreciation in order to sell even larger volumes on world markets. Equation *(43)* also indicates that different elasticities of import and export demand may also impart a trend into the real exchange rate.

These terms will cancel out if the so-called 45 degree rule (a phrase initially coined by Krugman (1989)) holds:

$$\frac{\xi_x}{\xi_m} = \frac{\hat{y}}{\hat{y}^*}. \quad (44)$$

So even if a country experiences a rapid growth rate relative to its trading partner(s), such as Japan for much of the post-war era, it will not necessarily suffer a secular real depreciation of its exchange rate as long as (44) holds. But does (44) hold? Houthaker and Magee (1969) were the first to explore this relationship in an informal way. They demonstrated that there was a wide dispersion of relative income elasticities across industrial countries in the 1950s and 1960s. Japan, for example, faced a highly favourable combination of a high income elasticity of demand for its exports and a low income elasticity of import demand, while the UK and US faced the opposite combination. Although Houthakker and Magee did not explicitly consider (44), they did note that Japan was a relatively rapid growing country while the US and UK were relatively slowgrowing. Krugman (1989) formally explored the relationship between relative growth rates and elasticities from the Houthakker-Magee study and obtained the following result:

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -1.81 + \underset{(0.21)}{1.210}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), \quad (45)$$

where the coefficient on the relative growth terms is insignificantly different from unity. The implication of this equation is that if country x grew twice as fast as country y, over the sample period, its estimated ratio of export to import elasticities was twice that of country y.

Krugman (1989) updated the work of Houthakker and Magee using data for the 1970s and 1980s and finds that 'on average' the rule continues to hold, although with much less confidence:

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.00 + \underset{(0.61)}{1.029}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right). \quad (46)$$

There are essentially two explanations for the 45 degree rule. First, it could be that income elasticities determine growth. For example, if a country faces an unfavourable configuration of income elasticities - high import, low export - it could face severe external imbalances if growth is relatively high. This, in turn, may force the authorities of that country to put a limit on economic growth to maintain a relatively stable real exchange rate. However, as Krugman and others have noted this seems an unappealing interpretation since if we accept that growth differences across countries are driven essentially by differences in total factor productivities, it is difficult to see what links balance of payments problems caused by unfavourable income elasticities to total factor productivity growth.

An alternative explanation for the 45° rule relies on a supply-side interpretation for the apparent differences in demand that countries face. More specifically, as a country grows this will shift its supply schedule for exports to the right, requiring a secular depreciation of the real exchange rate. Is there anything on the demand side which could neutralise this, producing the 45° rule? One story would be that of import biased growth. For example, the traditional literature on the effects of growth on a country's terms of trade (see Johnson (1958) and Bhagwati (1958,1961)) indicates that for a country not specialised in international trade, growth can have an ambiguous effect on the terms trade and the real exchange rate. This is because growth that is biased towards exports requires a secular deterioration in the terms of trade, while growth that is biased towards imports requires a secular improvement. It turns out that if growth reduces the demand for imports at a given terms of trade, which would be the case for sufficiently import biased growth, then a growing country's terms of trade will improve over time.

However, although the above explains why the income elasticities could be favourable for a fast growing country, it does not explain why they are favourable to an extent that almost precisely gives a zero trend in the real exchange rate. Second, this explanation is a contingent one - it could happen but there is no particular reason why it should. In particular, there is nothing to say that this relationship should be stable over time.

The new trade theory of Krugman (1980) and others offers an alternative supply-side explanation for the 450 rule. In particular, Krugman argues that the specialisation among industrial countries is primarily due to increasing returns (i.e. the inherent advantages of specialisation itself) rather than the traditional concept of comparative advantage. Relatively fast growing economies expand their share of world markets by expanding the range of goods their country produces rather than reducing the relative price of their goods. In this view 'imports' and 'exports are seen as aggregates whose composition changes over time as more goods are added to the list. So, for example, the euro-zone's exports face a downward sloping demand curve at any point in time, but as the euro-zone economy grows over time the definition of the aggregate changes in such a way as to make the apparent demand curve shift outwards (as the supply shifts down) and therefore there is no need for a secular depreciation of the real exchange rate[4].

To what extent is the 45° relationship in the data for our euro-zone countries? In order to make our estimates comparable with those of Houthakker, Magee and Krugman we have used compatable specifications of export and import functions. In particular, the volume of imports is assumed to be a function of home CDP, in constant prices, and the relative price of manufactures imports, calculated as the ratio of manufacturers import unit value to the GDP deflator. The volume of exports is assumed to be a function of 'foreign' real CDP and the OECD index of the relative export price of manufactures. We used four alternative measures of foreign GDP: the eu15 geometric average of real GDP, German real G13P, OECD total real GDP and US real GDR The first two measures are designed to capture the CDP of the internal euro-zone trading partners, whereas the latter two are intended to capture the CDP of the external trading partners - the idea being that there may be a different internal and external effects for the currencies. The sample period is 1980, quarter 1 through to 1998 quarter 4 and all data have been extracted from the OECD database. It turns out that for the external income measures, there was practically no difference between the point estimates obtained using the OECD and US GDPs, and therefore we only report the numbers for the US, The estimated import and export functions are not reported here, but all of them had correctly signed and significant income elasticities and most had correctly signed relative price effects, although the significance levels of these were rather mixed.

4 Krugman (1988) uses a Dicit-Stiglitz model in which two economies trade with each other but grow at different rates. In such a model the relative prices of the representative goods produced in each country will remain unchanged and so any differences in export and import growth are attributable to income elasticity differences.

Table 6 reports the growth and elasticity ratios for the full and sub-sample periods used in our earlier tests. The full sample results for the equations with Germany indicate a remarkably close correspondence between the two ratios it is most striking for the Netherlands which has a higher income growth rate than Germany, but has a favourable ratio of elasticities, which suggests that the 450 rule holds exactly. The countries for which this does not hold particularly well are Ireland, Portugal and Belgium. However, the full sample masks some interesting sub-sample patterns. For example, in the first sub-sample, the gap between the two ratios widens somewhat for France, Italy and Spain giving an overall impression that the relationship does not hold as strongly. In the second sample, however, the rule holds quite tightly for all countries apart from the Netherlands. In Tables 7 and 8 we summarise these results by presenting regressions of the income elasticities on the growth rates for the three sample periods:

Table 7 - The 45°Rule - Relative to German Growth

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.12 + \underset{(0.58)}{1.261}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), \text{Full Sample}$$

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.00 + \underset{(0.23)}{1.049}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), 1980{,}1 - 1989{,}4$$

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.00 + \underset{(0.30)}{1.215}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), 1990{,}1 - 1998{,}4$$

These results show that the 45° rule holds pretty accurately for the internal euro-zone exchange rates: the coefficient on the relative growth term is insignificantly different from zero and numerically close to unity in all periods, and indeed is also insignificantly different from unity in all three periods.

As Table 6 also indicates, the 45° rule seems to hold quite tightly for the external relationship, where the US is the foreign country. For the full sample period only the Netherlands and Ireland produce an important mismatch. However, we note that for the second sub-sample the relationship seems to hold less tightly. These results are summarised in Table 8.

Table 8 - The 45°Rule - Relative to US Growth

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.31 + \underset{(0.17)}{1.376}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), \text{Full Sample}$$

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.83 + \underset{(0.14)}{0.0848}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), 1980{,}1 - 1989{,}4$$

$$\ln\left(\frac{\xi_x}{\xi_m}\right) = -0.00 + \underset{(0.62)}{1.546}\ln\left(\frac{\hat{y}}{\hat{y}^*}\right), 1990{,}1 - 1998{,}4$$

Again all of slope coefficients in Table 8 are statistically different from zero and the full sample point estimate of 1.38 masks some sub-sample differences. For example, in the first sub-sample the coefficient on the relative income term is below unity, whilst in the second sub-sample it is 50% greater than the relative income term. To the extent that the latter has any predictive power for the behaviour of the euro, it would imply a trend appreciation of the euro-dollar exchange rate - that is, the relatively slower average growth of the euro-zone for this period combined with a favourable ratio of elasticities implies a secular appreciation of q. However, we note that although the coefficient for the full sample is numerically greater than unity it is statistically indistinguishable from unity.

7. THE EXCHANGE RATE - GROWTH LINK

In this section we examine the causality link running from the exchange rate to growth. There are two main components here: the effect of exchange rates on economic growth, through their influence on international trade, and the effects of exchange rate movements on investment. As we shall see there are a number of important overlaps between these topics.

7.1 Exchange rates and international trade

7.1.1 Theory

In the introduction we noted that the effects of exchange rate movements on international trade may be one way in which the exchange rate can affect economic growth. The beneficial effects of international trade on a country's welfare have been discussed extensively in the economics literature at least since Adam Smith's famous example of specialisation due to comparative advantage. Such specialisation can affect growth by changing the allocation of resources across industrial sectors; i.e. if sectors have different equilibrium growth rates then specialisation due to comparative advantage could affect the economy's overall growth rate. The trade literature also suggests a number of additional channels, which have their effect at the sectoral level, such as: the ability of a country to exploit increasing returns due to the exposure to larger markets; the transferance of technology across countries, through exposure to new goods and also investment; trade may cause a spillover of ideas across countries, thereby raising the productivity of research; and by increasing the size of the market may increase the incentive of researchers to undertake research[5]. Furthermore, the role of export-led growth and import substitution are sometimes discussed in policy circles as important driving forces for economic growth. But how does the exchange rate affect international trade and therefore growth?

[5] Proudman and Redding (1996) asess the consequences of these different effects for growth in the UK in the 1970s and conclude that comparative advantage itself is unlikely to explain the relatively fast growth of manufacturing output in the 1970s. This study is discussed in more detail below.

The main way in which exchange rate movements affect trade is through their impact on the profitability of companies engaged in international trade, or those considering engaging in international trade. Here we distinguish a level and a volatility effect. The levels effect, which is essentially the effect contained in traditional open economy macroeconomic models, suggests that there is a positive relationship between the level of the real exchange rate and growth. For example, starting from a position where PPP, or some other measure of the equilibrium exchange rate, holds, a depreciation of the nominal exchange rate will likely produce a change in the real exchange rate which is persistent. The depreciation of the nominal and real exchange rates could, in turn, imply strong relative price changes for exports and import competing goods. For example, an exchange rate depreciation, by increasing the profitability of domestic producers, could lead them to work the existing capital stock more intensively in the short term and, to the extent that such effects persist, increase investment in the medium term. An appreciation of the domestic currency could have the opposite effects, initially reducing the utilisation of the existing capital stock, reducing investment and eventually perhaps leading to the closure of the existing capital stock. Perhaps the best known example of the latter is the consequences of the tight monetary policy pursued in the late 1970s/ early 1980s by the Thatcher government in the UK. It is now widely accepted that the real an nominal exchange rate overshoots as a consequence of this policy led to around twenty per cent of the UKs traded sector being shut down.

However, the above discussion of the effects of the level of an exchange rate on a country's trade and growth ignores a number of broader factors. First, it ignores the implications of exchange rate changes for the cost of imported intermediate inputs into production. The inclusion of the latter into the calculation of the effects of exchange rate changes can produce offsets to the effects on price and quantity. Of course these kinds of effects are specific to the firm or, more generally, to the tradable sector. There will be wider macroeconomic consequences of the initial exchange rate movement which could offset or perhaps even reverse the initial effects. For example, the reduction of real income associated with a depreciation may at least, in part, offset the expansionary effects coming from the traded sector. So the results of what we are calling the level effect on trade and growth may well be ambiguous for a particular country. Furthermore, the net effects on international trade of the levels effect are also likely to be ambiguous since a depreciation in one country will have a counter part in a foreign country. Perhaps it is because of the ambiguous nature of the levels effect that has led most commentators to focus on the effect of exchange rate volatility on international trade and growth. At first blush the effects of volatility on international trade seems unambiguous.

The early literature on the relationship between exchange rate volatility and trade suggested a negative relationship; that is, the volatility that is so evident when exchange rates are flexible has a deleterious effect on international trade. This negative association is usually refered to as the traditional relationship. For example, the early theoretical literature on the implications of volatility for trade focussed on the combination of a risk averse trading company and the uncertainty of exchange rate movements reducing both trade and output (see, for example, Ethier (1973), Artus (1983) and Brodsky (1984)). The basic idea in these papers may be summarised in the following way. Exchange rate risk is assumed to be the main source of profit risk for a risk averse firm. So as exchange rate volatility increases, profit risk will also increase and for a risk averse firm this reduces the benefits of international trade and therefore ultimately the volume of international trade. Demers (1991) showed how even in the presence of risk neutral agents a negative association between volatility and trade can be generated. For example, a risk neutral firm which is uncertain about the state of demand due to exchange rate driven price uncertainty will cut back its production and trade volumes if it has undertaken an irreversible investment in physical capital.

However, a number of papers have demonstrated that the effect of exchange rate volatility on trade is not as clear-cut as the above discussion might suggest. For example, De Grauwe (1988) considers a variant of the Newbery-Stiglitz model of production and consumption with a risk averse exporter. He shows that although an increase in risk unambiguously decreases welfare in this kind of model it can also lead the exporter to increase exports depending on how risk averse he or she is. Essentially this result comes about because of the interaction between an income and substitution effect. The former is the effect which usually comes to mind when one thinks about the effects of risk on trade - an increase in risk lowers the attractiveness of these activities and leads firms to reduce them. The income effect leads to the opposite outcome - when risk increases the expected total utility of export revenues declines. However, this fall can be offest by increasing resources in the export sector and, if the income effect dominates the substitution effect, higher exchange risk can generate increased export activity.

An alternative way of generating a positive association between exchange rate volatility and trade is to appeal to the 'new' theory of investment. For example, Franke (1991), building on the option pricing literature and the entry and exist decision of firms by Dixit (1989), demonstrated that a risk neutral firm operating in a monopolistically competitive market may produce a positive association between trade and exchange rate volatility. To generate this result, Franke assumes that the firms export strategy is dependent on the level of the exchange rate - when the exchange rate is high relative to a parity level (defined as the position where internationally traded commodities are equally expensive in the home and foreign market) exports increase and when it falls below a certain level exports fall to zero. Such an export strategy is driven by transaction costs: a firm entering a foreign market incurs costs, and if it stops exporting it incurs exit costs. Exporting is therefore analogous to an option which is exercised only if profitable. Similar to the value of a stock option the value of this strategy depends on the volatility of the underlying price - the exchange rate. For a so-called disadvantaged firm (that is, a firm which has a comparative disadvantage in international trade and makes a loss when the exchange rate is at its parity rate) the value of this export strategy increases with increases in volatility. In particular, for this kind of firm the expected cash flow from exporting grows at a faster rate with exchange rate volatility than the expected entry and exit costs. Therefore, the value of exporting grows with exchange rate volatility. Franke presents sufficient conditions for there to be a positive effect of exchange rate volatility on the steady state export volume. The key prediction of this model is that firms will enter a market sooner and exit later when exchange rate volatility increases and that the number of trading firms will also increase.

Some of the issues raised above with respect to both levels and volatility effects may be formalised by taking a simple representative firm operating in either the export sector or the nontraded goods sector which faces the following product demand and supply curves[6]:

$$Q^d(t) = A_1(t)\left(P^T(t)/P^{NT}(t)\right)^{-\eta}, \quad (47)$$

$$Q^s(t) = A_2(t)L(t)^{\alpha}K(t)^{1-\alpha}, \quad (48)$$

where $Q^d(t)$, represents goods demand, $p^T(t)$ and $p^{NT}(t)$ represent the prices of traded and non traded goods, respectively, η is the price elasticity of demand for traded goods, (in absolute value), $Q^S(t)$ represents the supply of goods and $L(t)$ and $K(t)$ are labour and capital inputs into production. $A_1(t)$ and $A_2(t)$ are assumed to be arbitrary functions of time. If real wages are assumed to be constant, then in this kind of set up the only source of

6 This model is analytically similar to that used by Baballero and Corbo (1989) and Goldberg (1993).

uncertainty comes through the exchange rate process and the profit function of the firm may be written as:

$$\pi(K(t),t) = B(t)K(t)^{\gamma_1} Q(t)^{\gamma_2}, \quad (49)$$

where *B(t)* summarises the remaining state variables. The parameters $\gamma 1$ and $\gamma 2$ are industry-specific and may be defined as:

$$\gamma_1 = \mu(1-\alpha)/(1-\alpha\mu), \quad (50)$$

and

$$\gamma_2 = 1/(1-\alpha\mu), \quad (51)$$

where $\mu = (\eta - 1)/\eta$ is an inverse index of monopoly power. The level of the exchange rate and its volatility, $\sigma(t)$, can affect profits through the demand and pricing effects summarised in μ and through production costs summarised by α. For exporters, $\gamma_1 < 1$ and $\gamma_2 > 1$ so that differentiating (49) yields:

$$\frac{\delta\pi(t)/\delta Q(t)}{\pi(t)/Q(t)} = \gamma_2, \quad (52)$$

which shows that an exchange rate depreciation increases profits for net exporters and that this elasticity is increasing (falling) in the labour (capital) intensitivity of production and declining in the competitiveness of the industry. If investment is irreversible, and capital is purchased before it is actually used, the marginal operating profit will be convex in the real exchange rate. For a risk neutral firm real exchange rate variability will increase the profitability of production. However, if producers are risk averse and this risk aversion is sufficiently large that the concavity of the utility function is large enough to offest the convexity of the production function, exchange rate uncertainty will unambiguously decrease the utility from profits relative to the risk neutral case[7].

---

[7] See Broll (1994), for an extension of this kind of model to a multinational trading firm which has monopoly power in the foreign trading market and faces exchange rate uncertainty. See also Kumar (1992) for a discussion of the role of exchange rate uncertainty in the context of a two country general equilibrium model in which each country produces two goods.

So exchange rate volatility is likely to have an ambiguous effect on international trade. One way of recovering the traditional story of volatility on trade is to take a longer term perspective of volatility, what De Grauwe (1988) labels the 'political economy of exchange rate variability'. In particular, if exchange rate volatility persists over periods of months or quarters then it is likely to lead to exchange rate misalignments which may have the kind of consequences for output and employment referred to earlier. Of course these can be two sided for the depreciated country their will be a stimulus to growth while in the appreciated country growth worsens. The political economy idea is that in such a country individuals organise themselves to pass different forms of protectionist legislation so that international trade is negatively affected. The problem with this story is that volatility is a relatively high frequency concept whereas the kind of effect that is being referred to here is more the long-run / hysteresis effect on the real exchange rate and so it becomes difficult to distinguish the volatility effect from the misalignment/ levels effect.

It is often thought that the existence of capital markets, and in particular forward markets, should short-circuit the effects of exchange rate volatility on international trade. However, hedging is costly, especially in periods when exchange rate volatility is high and, more fundamentally, forward markets are notoriously incomplete - they may be relatively deep for periods of up to a year but thereafter there are often important missing markets. Indeed, a number of papers have demonstrated that the basic effects of exchange rate volatility on trade are unchanged in the presence of capital markets (see, for example, Demers (1991) and Viane and de Fries (1992)).

So in terms of the volatility effect the benefits of a country, or group of countries, moving from flexible to fixed exchange rate are unclear, even although this move should reduce such volatility to zero. However, it is worth emphasising that moving to a rigidly fixed set of exchange rates, as in a monetary union, may in itself be trade enhancing. For example, Mundell (1961) argued that the removal of a number of separate currencies and their replacement with a single currency should facilitate and stimulate trade. Furthermore, the adoption of a common currency by a nation state represents a very real commitment to longterm integration and this could induce the private sector to engage in more trade (Rose (2000)). Perhaps, also, the existence of a common currency in the eurozone area will induce greater financial integration which, in turn, will produce more trade in goods and services.

7.1.2 Evidence

From a theoretical perspective, the sign on the effect of exchange rate movements on trade is ambiguous. Does the empirical literature shed any light on this issue? A number of empirical studies have examined the influence of some measure of exchange rate uncertainty - both real and nominal - on aggregate import and export volumes (see, inter alia, Hooper and Kohlhagen (1978), Bailey, TavIas and Ulan (1986), Kenen and Rodrick (1986), Caballero and Corbo (1989) and Chowdhury (1993)). These results are based on standard trade equations, of the type introduced in our discussion of the H-M-K effect, with the addition of some measure of exchange rate uncertainty (a variety of measures are used in the literature ranging from the absolute percentage change of the exchange rate, moving averages of the standard deviation to ARCH-based estimates)[8]. Usually an OLS estimator, or variant of this estimator, is used in these papers and they do tend to confirm the standard levels effect of the exchange rate on trade - a depreciation of the real exchange rate increases trade volumes. However, there is no clear sign pattern on the coefficient on the exchange rate uncertainty term: it is equally likely to be positive or negative (furthermore few of the coefficients are significant). By its nature, however, aggregate data may not be best-suited for testing the impact of exchange rate volatility on trade because it implicitly assumes that the impact of exchange rate volatility is uniform between countries and commodities in terms of direction and magnitude.

Indeed, it turns out that studies which have used disaggregate data have been much more successful in achieving significant effects from the exchange rate uncertainy term. For example, Cushman (1983) uses bilateral sectoral data spanning the period 1965-1977 for a group of developed countries and finds statistically negative effects of his measure of uncertainty on trade flows. In follow-up papers, Cushman (1986,1988) repeats this exercise using data for the recent floating experience and does obtain clear evidence of a statistically significant negative effect of volatility on trade flows. Cushman also reports a small number of statistically positive coefficients. DeGrauwe (1987) uses bilateral intra-EMS trade volume data and a period which encompasses both a pre-EMS period (1973-78) and an EMS period. He demonstrated that for the EMS period exchange rates were substantially less variable than non-participating countries and the more stable exchange rate environment was more conducive to higher growth rates in international trade.

8 See McKenzie (1999) for a survey of this literature.

Both the aggregate and bilateral studies implicitly constrain the income, price and exchange rate risk elasticities to be the same across sectors. Since it is possible that volatility impacts differently across sectors it may be best to focus on sectoral equations. Bin-Srnaghi (1991) estimates export manufactuting equations for countries participating in the ERM, over the period 1976-1984, and finds a very clear statistically significant negative impact of exchange rate volatility on such trade. Sectoral work using US trade data also finds significant effects of exchange rate volatility although the sign is positive (see Klein (1990) and McKenzie (1998)).

We assess the empirical evidence for the euro-zone area as suggesting there is a significant traditional effect between exchange rate volatility and international trade. To reinforce this point we present some new estimates of this linkage. In particular, we present some simple panel DOLS estimates of export functions for the euro-zone area. As before, we focus on an internal and external effect. We take the export volume of manufacturing goods as our dependent variable (the same variable used in our HMK tests). The internal equation uses the real German mark bilateral exchange rate for the level and volatility effects and German income as the foreign income level. The external equation takes the US dollar real bilateral exchange rate to construct both the level and volatility effects and US income as the foreign income level. In both cases the volatility is measured simply as the percentage change in the real exchange rate. These equations are clearly very simple and intended to be illustrative rather than definitive. They ignore, for example, third country effects. The estimated euro, external' (i.e. US-based) is reported here as equation (53):

$$\ln X_{it} = fixeff + \underset{(0.05)}{1.855} \ln Y_{it}^{US} + \underset{(0.04)}{0.184} \ln Q_{it}^{US} + \underset{(0.29)}{0.546} vol_{it} + \Delta leads + \Delta lags. \quad (53)$$

To the extent that we can think of US income as a proxy for world growth, we note a strong relationship between world growth and trade within the eurozone area - a 1 per cent rise in world income raises euro-zone trade by 1.86 per cent. The level effect of the exchange rate is significantly positive, suggesting a 'traditional' association between the exchange rate and export volumes. The volatility term is also positive in the export equation and is marginally significant (at the 7 per cent significance level). The combined influence of these terms on euro-zone exports perhaps suggests that their are beneficial effects from having the euro-dollar rate flexible.

For the 'internal' euro-zone export equation, reported as equation (54), we also find a significantly positive export elasticity, although it suggests that the trade creation effects are slightly smaller compared to the world income effects. There is also a significantly positive effect on internal trade of the level of the exchange rate and, perhaps most interestingly, there is a significantly negative relationship between internal real exchange rate volatility and exports. So although real exchange rate volatility for the euro-zone area was of a lesser order of magnitude prior to EMU than for US dollar based rates, there would nevertheless still seem to be a very significant effect of removing this volatility.

$$\ln X_{it} = fixeff + \underset{(0.03)}{1.373} \ln Y_{it}^{DM} + \underset{(0.09)}{0.104} \ln Q_{it}^{DM} - \underset{(0.64)}{1.851} vol_{it} + \Delta leads + \Delta lags. \quad (54)$$

In the above we have extensively discussed the effect of exchange rate movements on international trade. But is there empirical evidence to suggest that international trade actually increases economic growth? A number of empirical studies have addressed this issue. For example, some studies have considered cross country regressions of per capita income on the ratio of exports or imports to GDP (and other conditioning variables) and have typically found a positive association (see, for example, Michaely (1977), Fischer (1993) and Haxrison (1996)). However, such studies run into the problem of the potential enodgeniety of trade: countries whose incomes are high for reasons other than trade may trade more. Using instruments for trade, such as measures of trade policy (De Long and Summers (1991), Fischer (1993) and Edwards (1993)), does not help since such policies are usually part of an overall reform package (i.e. adoption of free market policies) and are likely to have a direct effect on income (i.e. will be correlated with factors omitted from the income equation). A recent interesting paper by Frankel and Romer (1999) offers an alternative method of assessing the impact of trade on growth which appears to be immune to the problems a- icting previous studies.

To circumvent the problems associated with measuring the effects of trade on growth Frankel and Romer propose using a gravity model of trade. As we noted in section 2, in the gravity model geography is a powerful determinant of international trade (of both bilateral and aggregate trade). Since geographic factors are not a consequence of income or government policies it is difficult to see how they can have an effect on income other than through their impact on trade, and they should therefore provide a clean instrument for the potential endogeneity of trade. Frankel and Romer's strategy proceeds in the following way. First, they estimate a gravity model for 63 countries for 1985. In particular, they regress bilateral trade as a proportion of GDP on a measure of distance, and the relative populations and sizes of the two countries. They control for the size of countries since residents of large countries tend to trade more with each other than residents of small countries. In this kind of regression, distance is shown to have a negative and highly significant effect on bilateral trade - the elasticity is close to A; the size and population terms also have significant explanatory power. Next, they use the coefficients to calculate the geographic component of the trade of 150 countries from the PermWorld Table, and this fitted value is then used as their instrument in a second stage regression of the following form:

$$\ln Y_i = a + bT_i + c_i \ln N_i + c_2 \ln A_i + \mu_i, \quad (55)$$

where y_i is income per person in country i, T_i is the trade share, and N_i and A_i are population and area, respectively. Using data for the 150 countries from the Penn World Table for 1985 they produce the following instrumental variables regression:

$$\ln Y_i = \underset{(2.20)}{4.96} + \underset{(0.99)}{1.97} T_i + \underset{(0.09)}{0.19} \ln N_i + \underset{(0.10)}{0.09} \ln A_i + \mu_i, \quad (56)$$

where the constructed trade share from the first round regression discussed above is used. These estimates imply that a one percentage point increase in the trade share raises income per person by 2 per cent and the point estimate is marginally significant at the 95% level. The combined effect of raising both population and area by one per cent is to raise income by approximately 0.3 per cent, the larger the country the more internal trade that takes place and the higher the growth. Frankel and Romer show that these point estimates are reasonably robust to a number of specification changes. Additionally, they attempt to determine the mechanisms through which trade influences growth by regressing the components of income (from a simple production function) on the trade shares, population and country area. They find that trade raises income through both physical and human capital accumulation, although the significance levels are weak when an instrumental variables estimator is used. These results would seem to imply that trade does indeed cause growth although the mechanisms by which this comes about are perhaps not well defined.

One finding of the Frankel-Romer paper is that size matters for trade. This result seems to tie in with the advantages of having a common currency that we referred to earlier. Rose

(2000) also uses a version of the gravity model to try to unravel the relative effects that exchange rate volatility and participation in a currency or monetary union can have on the logarithm of bilateral trade. He uses a panel of 186 countries for five different years (1970, 1975, 1980, 1985 and 1990) and focuses on nominal measures of exchange rate volatility. He finds that the coefficient on exchange rate volatility is around -0.017 and is statistically significant at the 5% level. Reducing exchange rate volatility to zero from its sample mean value of 5% would increase trade by approximately 8 per cent. However, the coefficient on the currency union effect is 1.21 (and statistically significant), suggesting a much larger effect on bilateral trade of 3.35 (i.e. $e^{1.21}$); that is, countries with the same currency trade over three times as much as with countries with different currencies. This result suggests that the trade creating effects of participation in a currency union are likely to be very large. For a number of reasons, however, the implications of this latter result for the euro-zone area should be interpreted cautiously. For one thing, the panel constitutes a large number of non-euro-zone participants and it is unclear, for example, if the categorisation of these countries as participating in a monetary union is actually picking up this or, perhaps, the effect of other institutional effects, such as common legal systems. Indeed, some of the countries classed as members of a monetary union are not formally in a monetary union but simply a fixed exchange rate arrangement. In fact only 1 per cent of the total number of observations countries in the panel represent participants of a monetary union. However, Rose's results are provocative and perhaps suggest an upper bound on what the currency union point estimate is likely to be.

7.2 Exchange Rates and Investment

As we have seen in our discussion of the effects of the exchange rate on trade, one of the key ways in which the trade link can affect growth is through it initially impacting on investment. So there is inevitably a relationship between the literatures on the effects of exchange rate movements on trade and investment. In the previous section we discussed the effects of exchange rate movements both levels and volatility effects - on both sectoral profitablity and investment. However, in addition to leading to capacity adjustments in existing industries, exchange rate movements can also alter the relative attractiveness of domestic versus foreign production - that is, the relocation of production facilities across countries in the form of foreign direct investment (FDI). Although FDI could have a direct effect on a country's growth rate by increasing the capital stock there are a number of perhaps less transparent ways that it could affect the growth process[9]. Inward FDI, for example, may produce positive spillovers for the whole economy in terms better business organisation and technology spillovers (i.e where the introduction of superior technology or production process is emulated by other firms or spread by workers). Equally, outward FDI may increase domestic productivity to the extent that it results in the appropriation of foreign technology.

In the theoretical literature, the location effect on investment crucially depends on the entry and exit decisions of firms to the foreign market. In the traditional theory of foreign investment under uncertainty (see, for example, Itagaki (1981) and Cushman (1985)) the firm is assumed to decide to enter the foreign market when the expected returns, or dividends, are greater than the sunk cost of entry. This effect is summarised in equation (57):

$$\int_0^{\infty}(S_{t,}p-\omega)e^{-\rho t}dt=\frac{R_0 p}{\rho-\mu}-\frac{\omega}{p}\geq Sk. \quad (57)$$

where of terms not previously defined, p is the dollar price of the good (the US is assumed to be the foreign country in this example), ω is the variable costs, in home currency, of producing the good, it is the drift in the exchange rate, p, is the discount rate and *k* is the cost of entry. According to this expression the firm will enter the foreign market as long as the expected value of future dividends is greater than the cost of entry. This would be the

9 The discussion here is based on Proudman and Redding (1996).

solution for a risk neutral firm: the present discounted value of future returns is not affected by the uncertainty of the exchange rate, only its level. A risk averse firm, however, will only enter the foreign market when the expected return is greater than the sum of the cost of entry and compensation for the degree of uncertainty.

However, as in the literature on the effects of exchange rate behaviour on trade, the investment literature has been developed using the tools of option pricing to understand investment decision making under uncertainty (Dixit (1989)). In the Dixit model (see Campa (1994) and Carruth, Dickerson and Henley (1998) for overviews), uncertainty about future returns can still have a deterrent effect on entry even for a risk neutral firm. The firm faces a dynamic problem of trading off the gain from entering the foreign market in the current period with the opportunity cost of waiting another period. This problem can be defined more precisely in terms of an analogy from the option pricing literature. The firm has the option of entering the foreign market at any point in time at an exercise price which is simply the sunk cost of entering the market, k. If the firm exercises this option then the return is the expected present discounted value of future profits from entering this market. However, as in standard option pricing theory, the value of the option increases as the volatility of the underlying asset price increases. So the more exchange rate volatility there is, the more likely the firm will wait-and-see before entering the market. So higher volatility deters entry irrespective of whether the firm is risk averse or not. A model based on option pricing theory (see, for example, Campa (1994)) would therefore transform equation (57) to the following:

$$\frac{Sp}{\rho-\mu}-\frac{\omega}{p}-\frac{\hat{S}p}{(\rho-\mu)x(\beta(\sigma))}=\hat{S}k \quad (58)$$

where $\hat{S}$ is the critical value of the exchange rate that triggers entry, $\beta(\sigma)$ is a known function of the volatility of the exchange rate s and ß'(s) < 0. Expression (58) therefore shows that the higher is or the higher the level of exchange rate required for the firm to decide to exercise its option and enter the foreign market. This kind of model gives some clear predictions regarding the effects of exchange rate volatility on foreign investment: the higher are either, s and *k* the higher is the value of the option and therefore there will be fewer entrants. The higher is the exchange rate and its rate of change as represented by µ the higher are expected future profits from entering the foreign market and so there should be a positive association between these variables and entry.

One final effect worth noting in the investment decision-making context is the affect of portfolio or wealth effects (see Froot and Stein (1991) for an explicit model). For example, a revaluation of the local currency makes home investors wealthier and this effect could offset or reinforce the kind of investment effects referred to above. For example, changes in the euro-dollar exhange rate will, through such revaluation effects, 'shift' portfolio wealth between the US and the euro-zone area. Whether this leads to more home or foreign investment will very much depend on the preferences of investors - in particular, if they have a home or foreign bias. If investors have a foreign bias then an exchange rate appreciation will lead to more investment in the foreign country.

Cushman (1985) uses a pooled cross sectional-time series analysis to examine the effects of expectational and risk factors on FDI flows from the United States to Canada, Ranee, Germany, Japan and the UK over the period 1963 to 1978 (annual observations). Various expectations mechanisms - such as regressive and stabilising expectations - are used to generate measures of the expected change in the real exchange rate. Real exchange rate risk is defined as the standard deviation of the quarterly change in the real exchange rate. In sum, Cushman finds that the level of the real exchange rate has a positive sign although statistical significance is weak across specifications, the expected change in the real exchange rate is significantly negative in all specifications and the risk term is positive although the statistical significance is rather weak. The coefficient on the expected exchange rate variable is largest, indicating that a 1 per cent change affects direct investment flows in a given year by 19 to 28 per cent.

Froot and Stein (1991) examine the effects that the level of the exchange rate has on aggregate and 13 disaggregate components of foreign direct investment (FDI) into the US (sample period 1974-1987, annual). They find a statistically significant negative relationship between all of the FDI components and the level of the real effective exchange rate. They additionally regress Ms for Canada, Japan, the UK, West Germany, on the level of the relevant real effective exchange rate and a constant. All of the coefficients on the level of the exchange rates are negative, apart from Canada, although only the coefficient in the West German equation is statistically significant. Froot and Stein use the kind of wealth effect referred to above to argue that a weak dollar, with imperfect capital markets, increases the relative wealth of foreign investors compared to home investors (US) and will therefore increase the attractiveness of investments in the US.

Goldberg (1994) examines the effects of the volatility and level of the real exchange rate (and other control variables) for aggregate and disaggregate US investment for the period 1970 quarter 1 through to 1989 quarter IV[10]. Although she finds very little evidence of exchange rate effects on the aggregate measures of investment, there is some evidence to suggest that it is important for disaggregate measures. For example, it is shown that in the 1980s dollar depreciations (appreciations) reduced (stimulated) investment in manufacturing nondurables sectors and had mixed effects in nonmanufacturing sectors. Goldberg argues that this result could arise if the portfolio/ wealth effects of exchange rates oil investment dominate the demand effect for traded goods and the production effects. This result tends to conflict with the standard argument in favour of having a depreciated exchange rate. Exchange rate volatility is shown to have resulted in a contraction of investment in some sectors of US industry in the 1980s but these effects are small. She argues that this is consistent with the model of risk averse investors, irreversibilities of investment and profit convexities in the presence of imperfect competition discussed in the previous section.

Using a panel data set based of 6I US wholesale trade industries for the period 198I to 1987, Campa (1994) examines the effects of exchange rate volatility and the level of the exchange rate on entry of firms into the US market. The literature on foreign investment has shown that the effect of the exchange rate on investment depends on where the good is produced, the national source of the inputs used in production and the country where the final good is sold. To avoid these complications, Campa focuses on entry in the wholesale trade industries in the US by foreign manufacturing companies. The reduced form estimated is based on (58):

$$n_t = f\left(\overset{+}{\mu}, \overset{-}{S}, \overset{+}{\sigma}, \overset{-}{k}, \overset{-}{\omega}\right) \quad (59)$$

The dependent variable is the number of firms that entered an industry in a given year and μ and σ are the average and standard deviation of the monthly change of the exchange rate. Since μ and σ embody the firms expectations of the future levels of these variables there will in general be no unique assumption about how firms form these expectations. Campa makes two assumptions: static expectations, in which the firms take the exchange rate behaviour in the two years previous to entry, and perfect foresight expectations in

[10] It is worth that this kind of test could be picking up the combined effect of what we have called the trade induced effects of exchange rate changes and also the locational effects.

which the expost value for the next two years is used. Sunk costs are estimated using two variables: the ratio of fixed assets to net wealth of all US firms in an industry and the ratio of media expenditures to company sales by all US firms in each area. The measure of the variable costs abroad, ω, is taken as a weighted average of the annual cross country index of unit labour costs, where US has a value of 1. Since the right hand side variable is a limited dependent variable, a Tobit estimator is used. To summarise the findings: exchange rate volatility has a significantly negative effect on the numbers of firms entering the industry. Both sunk costs and the level of advertising costs are found to be deterrents to entry. The level of the exchange rate has a significantly positive effect on the entry level. This latter results conflicts with the findings of Froot and Stein (1991) and Goldberg (1994), although it is not necessarily inconsistent since this study focuses on the number of entrants rather than the level of foreign direct investment. The empirical estimates also reveal that interaction between sunk costs and the exchange rate is significant.

In sum, the extant empirical evidence on the effects of exchange rate movements on FDI suggests that exchange rate volatility has a significantly negative effect. The empirically estimated levels effect is ambiguous, although the balance of evidence seems to suggest an opposite effect to that found in the trade literature and this may perhaps be explained by appealing to a wealth effect.

Proudman and Redding (1998), summarising a number of research papers produced by the Bank of England, analyse the effect of openness on growth in the UK economy for the period 1970-92. Their measures of openness encompass trade factors, discussed in the last section, and also FDI. In summary, their main empirical findings are: at the industry sector level, average rates of sectoral productivity are positively correlated with a number of measures of openness. Using discriminant analysis to classify sectors as relatively open or closed, they find that open sectors have higher average growth rates of total factor productivity than closed sectors. Over the sample period their estimate of the average long-run rate of productivity in UK manufactures, relative to the US, rose from 58% to 69% and around one-half of this increase was estimated to be due to openness. The openness measures that are most important in explaining this increase are due to flows of goods and indeas, rather than the flow of capital. Furthermore, it would seem that it is technological change that is the main driving force behind the result and not specialisation due to comparative advantage.

8. CONCLUSIONS

Exchange rates when flexible are highly volatile, and nominal exchange rate movements can impart a considerable degree of persistence into real exchange rates. These are two of the so-called stylised facts we discussed in Section 2 of this paper. In terms of the euro-zone area, we have tried to distinguish the implications of such behaviour for both internal and external exchange rates. What are the advantages and disadvantages of fixing the level of the internal nominal exchange rate? First, the unpleasant consequences of an appreciation of the nominal rate generating an uncompetitive real rate of one participating country vis-à-vis its euro-zone competitors is ruled out. This would seem to be a particular problem at the moment for the UK economy relative to its EU trading partners. To set against this, however, there is the advantage of having some flexibility in the exchange rates if business cycles are nonsynchronised across trading partners. Although there is some evidence to suggest that this may indeed be the case within Europe, it is our contention that both exchange rate unification and the single market project are likely to make this less of an issue in the future. Also, the danger in having some exchange rate flexibility within a free trade area is that it will be abused by countries pursuing competitive beggarthy-neighbour type policies, and these policies are, at best, likely to amount to a zero sum game. The second advantage of fixing internal exchange rates within Europe is that it squeezes out the unpleasant consequences of exchange rate volatility for trade and investment. Although the theoretical evidence is actually ambiguous regarding the effect that such volatility should have on trade and investment, our reading of the empirical evidence suggests that it is significantly negative for the countries participating in the euro-zone project and therefore there must be real welfare gains, both static and dynamic, from locking these currencies.

In terms of the external euro exchange rate, some of the arguments used above to justify locking internal exchange rates may be used in reverse to argue for some flexibility in the euro. We have noted, for example, that euro-zone exchange rates, as an entity, exhibit mean-reverting behaviour and this implies that the real value of the euro can potentially move to adjust external imbalances and also to assist if business cycle movements are non-synchronous between the euro block and her trading partners. Our empirical estimates suggest that there is a significant levels effect of the real exchange rate on euro-zone trade and some economic commentators have argued that around three-quarters of euro-zone growth in the current year is likely to emanate from the external consequences of the depreciated value of the euro. Since the euro-zone area is a relatively closed economy it is unlikely that volatility in the external value of the euro will have much effect on inward investment and external euro-zone trade and, indeed, our empirical estimates seem to confirm this.

An additional theme in this paper has been the effects of growth, particularly productivity growth, on real exchange rates. We have argued that there does seem to be evidence which suggests that Balassa-Samuelson type effects are statistically important for euro-zone members and this will necessarily have implications for the behaviour of internal real exchange rates, or inflation differentials, and real interest differentials between member states. However, although these inflation differentials are likely to be important in the short to medium run, as countries which were relatively slow growing prior to EMU 'catch-up', it seems unlikely that these differentials are inconsistent with the operation of a monetary union. They may, however, prove problematic for countries seeking to participate in monetary union, such as countries currently in the accession stages of EMU.

We have also examined the implications of the differential overall growth rates (as opposed to just productivity growth) for the intra euro-zone real exchange rates and also in terms of the euro-zone against the dollar. A standard partial equilibrium analysis of the current account suggests that a country growing fast relative to its trading partners may have to incur a secular depreciation in its real exchange rate. However, it has been noted by a number of researchers that this need not occur if the ratio of the country's income elasticity of exports to its income elasticity of imports equals the ratio of its growth to foreign growth. A number of researchers have in fact demonstrated that this kind of relationship - the 45° rule - holds pretty well for a period from the 1950's through to the 1970's. We have presented updated estimates of the 45° rule for the 1980s and 1990's, with a particular emphasis on the euro-zone countries. We find that the rule holds pretty tightly, on average, both in terms of internal euro-zone real exchange rates and also for the external value of the euro. Indeed, the latter estimates suggests that the euro dollar rate should have appreciated since its inception, although, of course, the 45° rule ignores the implications of the capital account of the balance of payments for exchange rate movements.

In sum, the current exchange rate arrangements in the euro-zone area are we believe beneficial for both business cycle related growth and also longer run, or permanent, growth. As always, the empirical estimates presented in this paper could be refined and checked for robustness. It seems unlikely, however, that such extensions will change the main conclusion of this paper: irrevocably fixing internal exchange rates, and having some flexibility in the external value of the euro, will enhance the growth prospects of the euro-zone area.

9. REFERENCES

Alberola, E. and Tyrvainen (1998), "Is there scope for inflation differentials in EMU? An empirical evaluation of the Balassa-Samuelson model in EMU countries", *Bank of Finland Discussion Papers* 15198, Bank of Finland.

Artus, JR. (1983), "Toward a more orderly exchange rate system, *Finance and Development,* 20, 10-13.

Bailey, M., Tavlas, G.S., and Ulan, M. (1986), "Exchange rate variability and trade performance: Evidence for the big seven industrial countries, *Weltwirschaftliches Archiv,* 122, 466-77.

Balassa, B. (1964), "The Purchasing Power Parity Doctrine: A Reappraisal, *Journal of Political Economy,* 72, 584-596.

Bayourni, T. and R. MacDonald (1999), "Deviations of Exchange Rates from Purchasing Power Parity: A Story Featuring Two Monetary Unions", *IMF Staff Papers.*

Beveridge, Steven, and Charles R. Nelson, (1981), "A New Approach to the Decomposition of Economic Time Series Into Permanent and Transitory Components, with Particular Attention to the Measurement of Business Cycles", *Journal of Monetary Economics, Vol.* 7, pp. 151-74.

Bhagwati, J. (1958), " Immiserizing growth: A geometrical note", *Review of Economic Studies,* 25, 201-205.

Bhagwati, J. (1969), "International trade and economic expansion". In *Trade, Tariffs and Growth,* Cambridge: MIT Press.

Bini-Srnaghi, L. (1991), "Exchange rate variability and trade: why is it so difficult to find any relationship?" *Applied Economics,* 23, 927-36.

Bordo, M. and A. Schwartz (1999), "Policy Regimes and Economic Performance: The Historical Record", in J. Taylor and M. Woodford (eds), *Handbook of Macroeconomics.* Amsterdam: North-Holland

Brodsky, D. A. (1984), "Fixed versus flexible exchange rates and the measurement of exchange rate instability", *Journal of International Economics,* 16, 295-306.

Broll, U. (1994), "Foreign production and forward exchange markets", *Australian Economic Papers,* 62, 1-6.

Caballero, R.J. and V. Corbo (1989), "The effect of real exchange rate uncertainty on exports: empirical evidence", *The World Bank Economic Review,* 3, 263-278.

Campa, J.M. (1993), "Entry by foreign firms in the United States under exchange rate uncertainty", *Review of Economics and Statistics,* LXXV, 614622..

Canzoneri, M.B., R.E. Cumby and B. Diba (1996), "Relative Productivity and the Real Exchange Rate in the Long Run: Evidence for a Panel of OECD Countries", CEPR Discussion Paper No. 1464.

Canzoneri, M.B., R.E. Cumby and Eudy (1996), "Trends in European productivity and real exchange rates: implications for the Maastricht convergence criteria and for inflation targets after emu, CEPR Discussion Paper, No 1417.

Carruth, A. A. Dickerson and A. Henley (1998), "What do we know about investment under uncertainty?", University of Kent, Working paper No., 98/4.

Chinn, M. (1997), " Sectoral Productivity, Government Spending and Real Exchange Rates: Empirical Evidence for OECD Countries", in R. MacDonald and J. Stein (eds), Equilibrium Exchange Rates, Amsterdam: Kluwer.

Chinn, M. and L. Johnston (1996), "Real Exchange Rate Level, Productivity and demand Shocks: Evidence from a Panel of 14 Countries", NBER Discussion paper No 5709.

Chowdhury, A.R. (1993), "Does exchange rate volatility depress tarde flows? evidence from error correction models", *Review of Economics and Statistics,* 75, 700-6.

Clarida, R. and J. Cali (1995), "Sources of Real Exchange Rate Fluctuations: How Important are Nominal Shocks?", *Carnegie-Rochester Series on Public* Policy, 41, 1-56

Clark, P.B. and R. MacDonald, (1998), "Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs" in R. MacDonald and J. Stein (eds), *Equilibrium Exchange Rates,* Amsterdam: Kluwer.

Cushman, D. (1983), " The effects of exchange rate risk on international trade", *Journal of International Economics,* 15, 45-63.

Cushman, D. (1986), " Has exchange risk depressed international trade: the impact of third country international trade", *Journal of International Money and Finance,* 5, 361-79.

Cushman, D. (1988), "US bilateral trade flows and exchange risk during the floating period", *Journal of International Economics,* 24, 317-30.

De Grauwe, P. (1987) "International trade and economic growth in the european monetary system", *European Economic Review,* 31, 389-98.

De Grauwe, P. (1988), "Exchange rate variability and the slowdown in the growth of international trade", *IMF Staff Papers,* 35, 63-85.

De Long, B.J. and L. Summers (1991), "Equipment, Investment and Economic Growth", *Quarterly Journal of Economics,* 106, 445-502.

Demers, M. (1991), "Investment under uncertainty, irreversibility and the arrival of information over time, *Review of Economic Studies,* 58, 333-50.

Dixit, A.K. (1989), "Hysteresis, Import Penetration, and Exchange Rate Pass Through", *Quarterly Journal of Economics,* 104, 205~228.

Dornbusch, Rudiger, (1976) "Expectations and Exchange Rate Dynamics", *Journal of Political Economy,* Vol. 84, pp. 1161-76.

Engel, C. (1993) "Real Exchange Rates and Relative Prices: An Empirical Investigation", *Journal of Monetary Economics,* 32, 35-50.

Engel, C. and J.11. Rogers (1996), "How Wide is the Border?", *American Economic Review,* Vol. 86, 1112-1125

Ethier, W. (1973), "International trade and the foreign exchange market", *American Economic Review,* 63, 494-503.

Fischer, S. (1993), "The role of macroeconomic factors in growth", *Journal of Monetary Economics,* 32, 485-512.

Flood, R. and A. Rose, (1999) "Understanding exchange rate volatility without the contrivance of macroeconomics", *Economic Journal,* 109, F660-F672.

Franke, G. (1991), "Exchange rate volatility and international trade strategy, *Journal of International Money and Finance, 10,* 292-307.

Frankel, J. (1979), "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials", *American Economic Review,* 69, 610-22.

Frankel, J and A. Rose (1995) "A Panel Project on Purchasing Power Parity: Mean Reversion Within and Between Countries", *NBER Working Paper* No. 5006 (Cambridge, Massachusetts: National Bureau of Economic Research.

Frankel, J. and D. Romer (1999), "Does trade cause growthT' *American Economic Review,* 379-399

Frenkel, J. and M. Mussa, (1986) "Asset Markets, Exchange Rates, and the Balance of Payments", Chapter 14 in E. Grossman and K. Rogoff (eds) *Handbook of International Economics,* Vol. 2 Amsterdam: North Holland.

Froot, K. and J Stein (199 1), "Exchange rates and foreign direct investment% *Quarterly Journal of Economics,* 106, 1191-1218.

Ghosh, A.R., A. Gulde, 1D Ostrey and H Wolf (1995), "Does the nominal exchange rate matter, IMF Working Paper, 121.

Goldberg, L. (1993), "Exchange rates and investment in United States industry", *Review of Economics and Statistics,* LXXV, 575-588.

Group of Ten (1985), "The Functioning of the International Monetary System", Report by the Deputies of the Group of Ten, Washington DC.

Group of Twenty Four (1985), "The Functioning and Imprivement of the Inetrnational Monetary Sysyetm", Report by the Deputies of the Group of Twenty Four.Washington DC.

Harrison, A. (1996), "Openness and growth: a time series cross-country analysis for developing countries", *Journal of Development Economics,* 48, 41947.

Hoffinarm M. and R. MacDonald (2000), "A real differential view of real exchange rates", mimeo, University of Strathclyde.

Hooper, P. and S. Kohlhagen (1978), "The effect of exchange rate uncertainty on the price and volume of international trade", *Journal of International Economics* 8, 483-511.

Houthakker, H. and S. Magee (1969), "Income and Price Elasticities in World Trade, *Review of Economics and Statistics,* 51, 111-125.

Johnson, H. (1958), *International Trade and Economic Growth: Studies in Pure Theory,* London: Allen and Unwin.

Juselius, K. (1995), 'Do purchasing power parity and uncovered interest rate parity hold in the long run? An example of likelihood inference in a multivariate time-series model' *Journal of Econometrics,* 69, 211-240.

Kao, C. (1999), "Spurious regression and residual-based tests for cointegration in panel data", *Journal of Econometrics,* 90, 1-44.

Kenen, P. and D. Rodrick (1986), "Measuring and Analysisng the effects of short-term volatility on real exchange rates, *Review of Economics and Statistics,* 71, 708-12.

Kohler, M. (1999), "The Balassa-Samuelson Effect and Monetary Tragets", *mimeo,* Bank of England.

Krugman, P. (1989), "Differences in Income Elasticities and 'kends in Real Exchange Rates, European Economic Review, 33, 1031-1054.

Kumar, V. (1992), "Real effects of exchange risk on international trade", working paper 92-5, Fegeral Reserve Bank of Australia.

La Cour, L. and R. MacDonald (2000), "Modelling the ECU-US Dollar Exchange Rate: A Structural Monetary Interpretation", Journal *of* Business Economics and Statistics, forthcoming.

Levin A. and C-F Lin (1994), "Unit root tests in panel data: Asymptotic and finite-sample properties", mimeo, Federal Reserve Board.

Lucas, R. (1982), "Interest rates and currency prices in a two-country world" Journal *of* Monetary Economics, 10, 335-60.

MacDonald, R. (1993) "Long-Run Purchasing Power Parity: Is It for Real7 Review *of* Economics and Statistics, Vol. 75, pp. 690-5.

MacDonald, R. (1995) "Long-Run Exchange Rate Modeling: A Survey of the Recent Evidence" Staff Papers, International Monetary Fund, Vol. 42, 3, 437-489.

MacDonald, R. (1999b), "Exchange Rates: Do Fundamentals Matter?", Economic Journal, 109, F673-17691

MacDonald, R.(2000), Exchange Rate Economics: Theories and Evidence, second edition, London: Routledge Keegan Paul.

MacDonald, R. and LW. Marsh (1997), "On Casselian PPP, Cointegration and Exchange Rate Forecasting" Review *of* Economics and Statistics, November, MacDonald, R. and L Ricci (2000), 'Deviations from Purchasing Power Parity: Does the Distribution Sector Make a Difference?", forthcoming IMF working paper.

MacDonald, R. and P. Swagel (1998), "Real Exchange Rates and the Business Cycle" forthcoming as IMF Working Paper.

McKenzie, M.D. (1999), "The impact of exchange rate volatility on international trade flows", Journal of Economic Surveys, 13, 71-106.

Mark, N. and D. Sul (1999), A computationally simple cointegration vector estimator for panel data", mimeo, Ohio State University.

Michaely, M. (1977), "Exports and growth: An empirical investigation", Journal *of* Development Economics, 4, 49-53.

Mundell, R. (1961), "A theory of optimum currency areas", American Economic Review,

Mussa, M. (1978), "Empirical regularities in the behaviour of exchange rates and theories of the *foreign exchange* market", in Carnegie-Rochester Series on Publci Policy, Vol 11, 9-57

Officer, Lawrence H., (1976), "The Purchasing Power Parity Theory of Exchange Rates: A Review Article", Staff Papers, International Monetary Fund, Vol. 23, pp. 1-60.

Proudman, J. and S. Redding (1998), "The relationship between openness and growth in the United Kingdom: a summary of the Bank of England Openness and Growth ProjecC, Bank *of* England Quarterly Bulletin, 390-405.

Rogers J.H. and M Jenkins (1995), "Haircuts or hysteresis" sources of movements in real exchange rates", Journal *of* International Economics, 38, 339-360.

Rose, A. (2000) "One money, one market: the effect of common currencies on trade" *Economic Policy,* 9-45

Samuelson, P. (1964), "Theoretical Problems on Trade Problems", *Review of Economics and Statistics,* 46, 145-154.

Stock, J.H. and M Watson (1993), "A simple estimator of cointegrating vectors in higher order integrated systems", *Econometrica,* 61: 783-820.

Stockman, A. (1987), "The Equilibrium Approach to Exchange Rates", *Federal Reserve Bank of Richmond Economic Review,*

Stockman, A. (1988), "Real Exchange Rate Variability Under Pegged and Floating Nominal Exchange Rate Systems: An Equilibrium Theory", *Carnegie Rochester Conference Series on Public* Policy, 29: 259-294.

Stockman, A. (1995), "Sources of Real Exchange-Rate Fluctuations: A Comment, *Carnegie Rochester Conference Series on Public Policy,* 41, 57-65.

Viaene, J.M. and C.G de Vries (1992), "International trade and exchaneg rate volatility% *European Economic Review,* 36, 1311-21.

Weber, A. (1997), "Sources of Purchasing Power Disparities between the G3 Economies", *Journal of Japanese and International Economies, 11,* 548-583.

Wei, S-J and D. Parsley (1995), "Purchasing Power Disparity during the Recent Floating Rate Period: Exchange Rate Volatility, Trade Barriers and Other Culprits", *Quarterly Journal of Economics.*

Table 2 - Coefficients of Variation for Nominal and Real Bilateral Exchange Rates

	Full(S)	Sub1(S)	Sub2(S)	Full(Q)	Sub1(Q)	Sub2(Q)
Au	1.77	1	0.47	0.86	4.07	0.17
Au1	0.038	0.027	0.025	0.13	0.09	0.03
Au2	1.46	0.9	0.73	0.42	0.03	0.23
Be	1.73	1.5	0.4	0.45	0.32	0.14
Be1	0.62	0.55	0.028	0.12	0.08	0.04
Be2	1.76	1.09	0.64	0.96	0.71	0.55
Dk	1.60	0.92	0.45	0.84	0.53	0.25
Dk1	0.57	0.43	0.08	0.27	0.13	0.16
Dk2	2.02	1.20	0.69	0.37	0.24	0.24
Fr	1.63	1.12	0.43	0.81	0.58	0.28
Fr1	0.95	0.74	0.07	0.23	0.15	0.15
Fr2	2.03	1.60	0.65	0.4	0.23	0.23
Ir	5.34	1.17	0.43	3.07	2.62	1.09
Ir1	1.00	0.75	0.34	0.64	0.33	0.47
Ir2	2.25	1.35	0.98	0.26	0.12	0.17
It	1.28	0.86	1	0.20	0.24	0.09
It1	2.21	0.86	0.98	0.13	0.05	0.12
It2	3.38	1.66	1.46	0.66	0.24	0.49
Ne	1.78	1.12	0.50	2.04	1.38	0.81
Ne1	0.08	0.07	0.02	3.85	1.60	0.90
Ne2	1.28	1	0.4	0.31	0.21	0.14
Sp	1.12	1.50	0.75	0.36	0.22	0.13
Sp1	1.97	1.12	0.78	0.18	0.08	0.13
Sp2	3.07	1.81	1.35	14.40	21.00	12.75
Uk	1.29	1.14	0.43	2.93	2.59	0.91
Uk1	1.86	0.90	0.64	0.97	0.46	0.67
Uk2	2.25	1.80	1.20	0.35	0.21	0.21
Ge	1.83	1.11	0.49	2.59	1.47	0.28
Ge2	0.75	1.09	0.6	0.20	0.19	0.13

Notes: Where Au=Austria, Be=Belgium, Dk=Denmark, Fr=France, Ir=Ireland, It=Italy, Ne=Netherlands, Sp=Spain, Uk=United Kingdom, Ge=Germany. A 1 after the country mnemonic indicates the exchange rate has the DM as numeraire, a 2 indicates the exchange rate has the Y en as numeraire and no number indicates that the USD is the numeraire currency. The column headings indicate the 'Full' sample period, 1980Q-1998Q4 and the two sub-samples, 'Sub1' 1980Q1 to 1989Q2 and 'Sub2' 1989Q3 to 1998Q4. An S or Q in parenthesis after the sample definition indicates a nominal or real exchange rate, respectively.

Table 3 - Univariate Unit Root Tests - Full Sample

Currency	USD	DM	YEN
Au	-0.02(0.9)	-0.07(2.58)	-0.21(3.15)
Be	-0.08(2.18)	-0.13(2.79)	-0.16(3.40)
Dk	-0.06(1.67)	-0.09(2.04)	-0.16(3.08)
Fr	-0.09(2.12)	-0.10(2.17)	-0.13(2.9)
Ir	-0.11(1.96)	-0.07(1.96)	-0.09(2.18)
It	-0.67(1.69)	-0.08(1.97)	-0.09(2.20)
Ne	-0.11(2.29)	-0.03(1.02)	-0.13(2.96)
Sp	-0.05(1.62)	-0.08(1.88)	-0.12(2.16)
Uk	-0.11(2.17)	-0.12(2.33)	-0.07(2.11)
Ge	-0.08(1.94)	-	-0.16(3.27)

Table 3 - Univariate Unit Root Tests - First Sub-Sample

Currency	USD	DM	YEN
Au	-0.08(1.31)	-0.04(1.17)	-0.15(2.40)
Be	-0.08(2.33)	-0.13(1.96)	-0.13(2.94)
Dk	-0.10(1.87)	-0.10(1.17)	-0.14(2.48)
Fr	-0.12(2.21)	-0.22(2.47)	-0.09(2.12)
Ir	-0.13(1.78)	-0.19(2.77)	-0.11(1.56)
It	-0.087(1.62)	-0.08(0.06)	-0.18(2.44)
Ne	-0.14(2.34)	-0.20(1.07)	-0.09(1.90)
Sp	-0.07(1.78)	-0.22(1.88)	-0.15(2.36)
Uk	-0.13(2.08)	-0.22(2.09)	-0.06(1.28)
Ge	-0.13(2.31)	-	-0.10(2.09)

Table 3 - Univariate Unit Root Tests - Second Sub-Sample

Currency	USD	DM	YEN
Au	-0.33(2.89)	-0.31(1.84)	-0.28(2.33)
Be	-0.26(2.29)	-0.12(1.13)	-0.23(2.06)
Dk	-0.31(2.44)	-0.08(1.40)	-0.17(1.79)
Fr	-0.28(2.31)	-0.07(1.22)	-0.19(1.19)
Ir	-0.26(2.15)	-0.10(1.72)	-0.12(1.48)
It	-0.12(1.39)	-0.09(1.56)	-0.08(1.37)
Ne	-0.27(2.30)	-1.10(1.55)	-0.23(1.99)
Sp	-0.16(1.88)	-0.05(1.00)	-0.10(1.53)
Uk	-0.29(2.38)	-0.12(1.60)	-0.10(1.55)
Ge	-0.25(2.27)	-	-0.29(2.28)

Notes: For country mnemonics see Table 2. The numbers in parenthesis are augmented Dickey-Fuller t-ratios (where a constant has been included in the regression) while the numbers not in parenthesis indicate 1 minus the mean reversion speed. The approximate critical value for the t-ratio is -2.97.

Table 4 - Internal Price Ratio Effects Relative to Germany

	$ß_0$	$ß_1$	$ß_3$
Au	-0.39(16.22)	-0.54(16.30)	-0.33(2.58)
Be	-0.01(0.26)	-0.18(1.72)	-0.86(2.99)
Dk	-0.72(6.24)	-0.71(4.99)	-1.41(5.62)
Fr	0.61(5.13)	-0.04(0.14)	-0.16(0.41)
Ir	-0.82(4.71)	-0.59(3.66)	-1.72(8.33)
It	-1.98(8.15)	-1.06(8.64)	-3.53(10.03)
Ne	0.57(11.06)	0.22(4.97)	1.15(6.67)
Sp	-0.43(3.64)	-0.92(4.21)	-4.78(9.55)
Uk	-0.82(3.26)	0.43(1.01)	-1.26(4.12)

Table 4 - Contd. Internal Price Ratio Effects Relative to US

	$ß_0$	$ß_1$	$ß_3$
Au	-5.88(12.01)	-7.57(9.46)	-1.21(2.39)
Be	-4.75(23.12)	-4.44(25.88)	-3.61(2.66)
Dk	-1.27(2.12)	-2.23(4.43)	-3.38(2.74)
Ge	0.16(0.52)	-0.41(1.22)	-3.23(3.25)
Fr	0.12(0.25)	0.08(0.17)	0.87(1.15)
Ir	1.46(2.12)	2.23(1.50)	-2.24(5.59)
It	-2.10(1.38)	-2.30(0.88)	-4.16(3.84)
Ne	-3.56(6.40)	-4.19(6.55)	-1.12(1.34)
Sp	-3.18(17.34)	-3.66(17.07)	-0.20(0.15)
Uk	-0.25(0.78)	-0.95(1.69)	-0.92(4.03)

Table 4 - Contd. Internal Prices Ratio Effects Relative to Japan

	$ß_0$	$ß_1$	$ß_3$
Au	-2.13(7.48)	-2.30(7.27)	-4.82(2.72)
Be	-3.12(9.76)	-3.26(7.85)	-2.76(3.54)
Dk	-1.12(8.39)	-1.36(7.61)	-3.59(6.38)
Ge			
Fr	-1.45(12.44)	-1.25(12.75)	-2.03(1.85)
Ir	-1.66(15.17)	-1.62(14.02)	-2.78(8.51)
It	-1.64(7.08)	-0.93(4.05)	-4.46(11.38)
Ne	-2.09(12.73)	-3.30(15.15)	2.10(0.74)
Sp	-2.50(9.78)	-2.01(14.31)	-5.14(9.03)
Uk	-1.49(11.82)	-2.17(16.10)	-1.96(5.62)

Notes: For country mnemonics see Table 2. The numbers in het columns labeled $ß_{0,}$ $ß_1$, $ß_{2\ are}$ the point estimates of the parameter ß in equitation (36) for the full sample (=0) and the first (=1) and second (=2) sub-samples, respectively.

Table 5 - Panel DOLS Estimates of Coefficient on Internal Price Ratio

	ß$_0$	ß$_1$	ß$_3$
US Based	-1.84(9.95)	-1.81(6.96)	-1.23(5.23)
DM Based	-0.28(5.81)	-0.41(8.09)	-2.03(12.12)
Yen Based	-1.54(25.63)	-1.67(29.78)	-3.33(13.32)

Notes see Table 4.

Table 6 - Houthaker-Magee-Krugman Results

	Yrf15	Grf15	Yr115	Gr115	Yr215	Gr215	Yrfge	Grfge	Yrlge	Grlge	Yr2ge	Gr2ge
Be	0.86	0.89	0.86	0.81	1.21	0.97	1.96	0.66	1.09	0.88	0.51	0.5
Dk							0.71	0.74	1.20	1.04	0.78	0.63
Fr	0.78	0.97	0.49	1.03	1.13	1.12	0.54	0.72	0.62	1.04	0.61	0.50
Ir	2.87	2.04	1.65	1.6	1.00	3.25	2.41	1.49	2.56	2		1.62
It	0.75	0.81	0.41	0.98	0.78	0.66	0.51	0.61	0.66	1.04	0.43	0.38
Ne	2.43	2.24	1.87	2.40	4.16	1.71	1.66	1.66	2.29	2.62	2	1
Po	0.95	1.02	0.74	1.30	1.01	0.75	0.33	0.83	0.87	1.25	0.19	0.34
Sp	1.02	1.28	0.74	1.33	1.58	1.10	0.70	0.94	1.09	1.43	0.83	0.62
Uk	0.98	1.1	0.94	1.23	1.56	0.98	0.67	0.80	1.06	1.33	0.68	0.50
Ge	1.04	1.36	0.68	0.96	1.45	1.71	-	-	-	-	-	-

Notes: For country Mnemonics, see Table 2. The column headings indicate income elasticity ratios (Yr), and growth ratios (Gr) for the full sample (f) and two sub samples (1 and 2) defined in Table 2. The growth rates are calculated relative to the average of the Eu15(15), Germany(Ge) and the United States(US).

Table 6 - Contd.

	Yrfus	Grfus	Yr1us	Gr1us	Yr2us	Gr2us
Be	0.71	0.66	0.60	0.57	0.96	0.57
Dk	1.03	0.83	0.79	0.78	0.70	0.83
Fr	0.67	0.66	0.42	0.72	1.21	0.61
Ir	2.40	1.66	1.80	0.92	-	-
It	0.60	0.66	0.41	0.72	0.56	0.50
Ne	2.09	1.66	1.53	1.82	2.96	1.33
Po	0.73	0.83	0.58	0.92	1.07	0.64
Sp	0.78	0.95	0.66	1	1.324	0.83
Uk	0.84	0.83	0.67	0.92	1.15	0.66
Ge	0.88	1.02	0.50	0.69	1.19	1.33

Figure 1

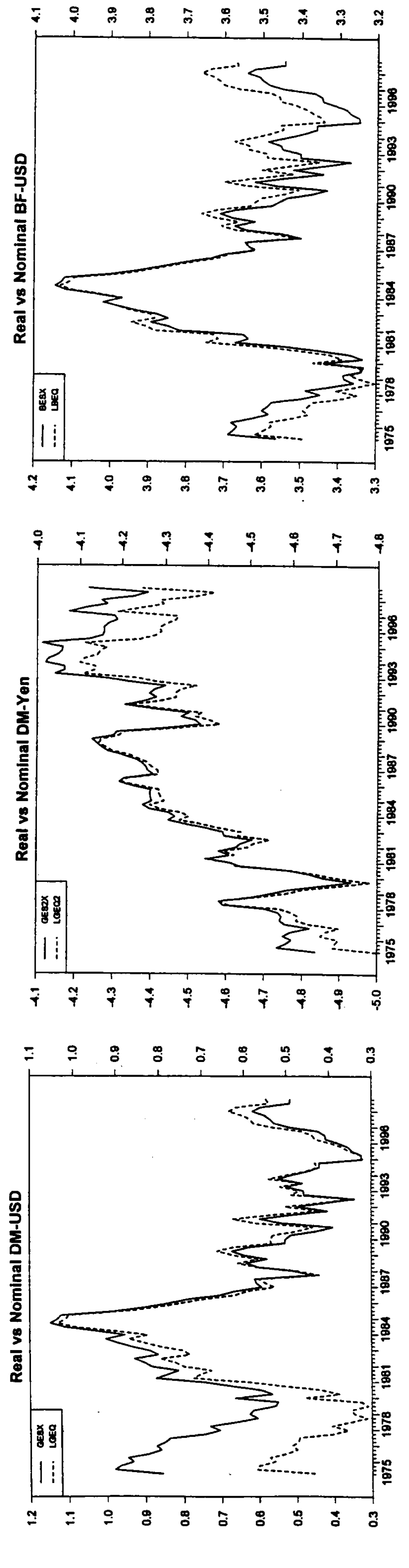

Real vs Nominal BF-USD
Real vs Nominal DM-Yen
Real vs Nominal DM-USD

Figure 1 (continued)

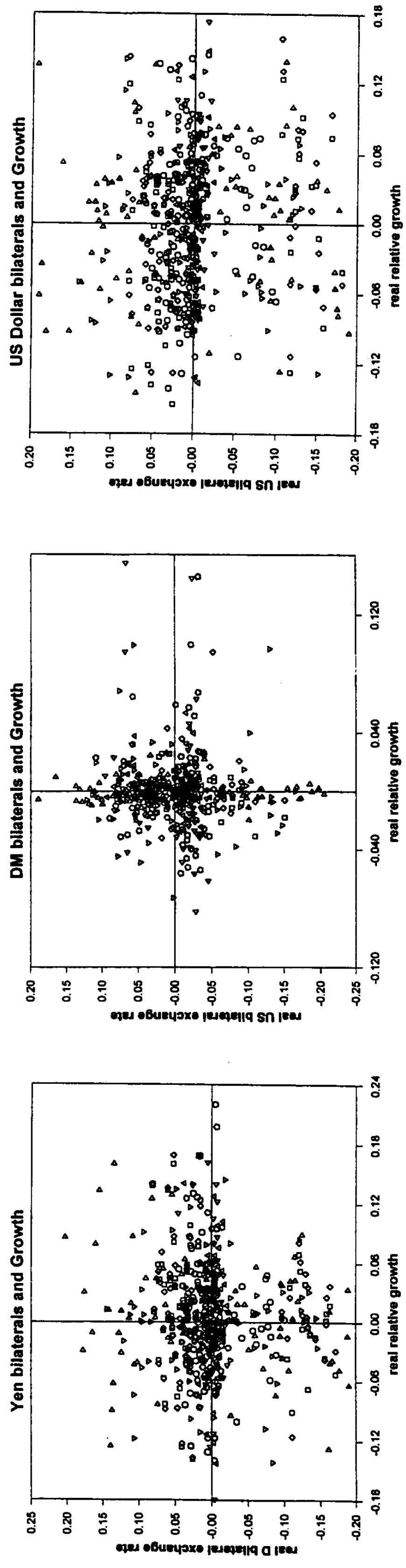
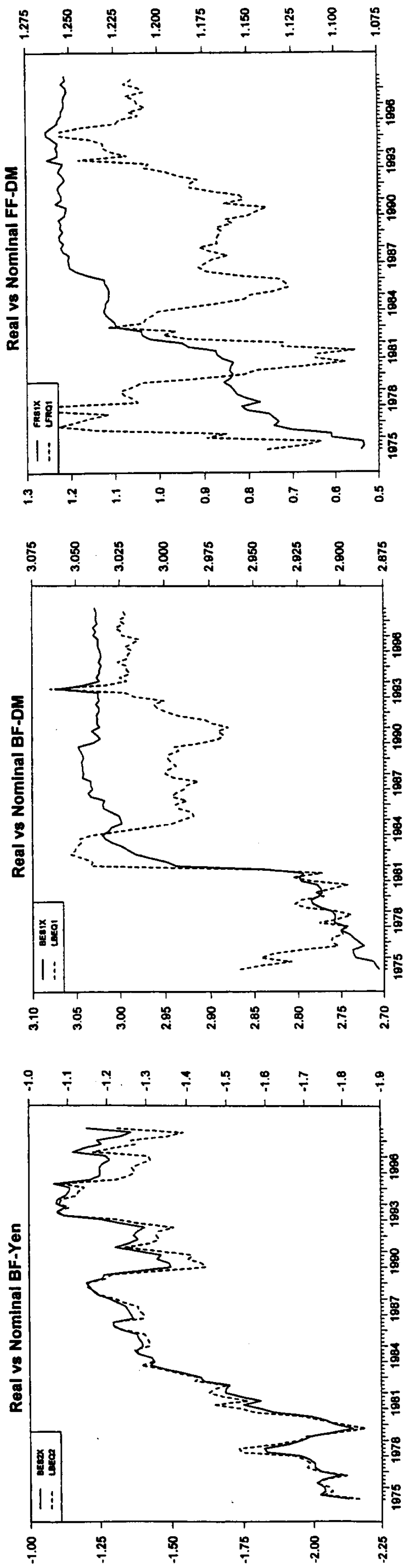


Figure 2



Real vs Nominal FF-DM
FRS1X
LFRO1
Real vs Nominal BF-DM
BES1X
LBEO1
Real vs Nominal BF-Yen
BES2X
LBEO2

NATIONAL BANK OF BELGIUM - WORKING PAPERS SERIES

1. "Model-based inflation forecasts and monetary policy rules" by M. Dombrecht and R. Wouters, *Research Series*, March 2000

2. "The use of robust estimators as measures of core inflation" by L. Aucremanne, *Research Series*, March 2000

3. "Performances économiques des Etats-Unis dans les années nonante" by A. Nyssens, P. Butzen, P. Bisciari, *Document Series*, March 2000.

4. "A model with explicit expectations for Belgium" by P. Jeanfils, *Research Series*, March 2000.

5. "Growth in an open economy: some recent developments" by S. Turnovsky, *Research Series*, May 2000

6. "Knowledge, technology and economic growth: an OECD perspective" by I. Visco, *Research Series*, May 2000

7. "Fiscal policy and growth in the context of European integration" by P. Masson, *Research Series*, May 2000

8. "Economic growth and the labor markets: Europe's challenge" by C. Wyplosz, *Research Series*, May 2000

9. "The role of the exchange rate in economic growth" by R. MacDonald, *Research Series*, May 2000

10. "Economic growth and monetary union" by J. Vickers, *Research Series*, May 2000