REAL EXCHANGE RATES AND THE GLOBALISATION OF FINANCIAL MARKETS

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Research Discussion Paper
9203

March 1992

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The authors are grateful especially to Jeffrey Shafer for incisive comments, and also to Robert Ford, Jorgen Elmeskov and Philip Lowe. The views expressed are not necessarily shared by them, and nor by the respective employers of either author.

ABSTRACT

A presumption in much of the earlier literature on real exchange rates suggests their behaviour is decoupled from fundamentals. This paper develops a theoretical model which allows for increased globalisation and integration of international financial markets in a world where goods markets are not perfectly integrated. Both cumulated current account balances and real interest differentials may be non-stationary within this framework. Appropriate portfolio diversification as net foreign asset positions diverge implies that the real exchange rates should be cointegrated with real interest differentials and net foreign asset (or liability) positions. Thus, for example, a cumulating overall current account surplus should lead to long-run appreciation of a country's bilateral real exchange rate with any other country (given expected net returns) for portfolio diversification reasons. Real interest differentials, on the other hand, have an ambiguous impact on long-run real exchange rates. Empirical tests of this model show that three out of four major real exchange rates are cointegrated with these "fundamentals" variables. The underlying assumptions of the model -- increasing financial integration and lack of goods market equilibrium -- are supported by a series of supplementary tests.

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1. INTRODUCTION

The failure of exchange rate models to forecast movements in currency values is widely documented. Structural equations cannot outperform the random walk model, which states that exchange rate changes are unforecastable. Proponents of the idea that markets are efficient argue that exchange rate movements are dominated by errors in the markets' forecast of fundamentals. Others argue that markets are not efficient, and the exchange rate is dominated by expectations cycles independently of the behaviour of fundamentals. For whatever reason, these observations suggest that the exchange rate is largely disconnected from information available about economic fundamentals. Even taking a longer-view of the real exchange rate, most empirical studies have failed to find mean-reverting behaviour. Thus, for example, purchasing power parity (PPP) is rejected on post-Bretton Woods data (Adler and Lehman (1983), Huizinga (1987), Meese and Rogoff (1988), and Corbae and Ouliaris (1988)). Similarly, tests to find long-run relationships between the real exchange rate and variables such as real interest differentials have failed (Meese and Rogoff (1988), Coughlin and Koedijk (1990)).

Tackling these puzzles concerning the exchange rate may require relaxing an important implicit assumption of most previous studies. This assumption is that the international financial environment is unchanging or, if changing, has no consequences for the exchange rate. An important thesis of the present paper is that explicitly recognising the effects of the progressive globalisation of world financial markets in the 1970s and 1980s has important implications for the understanding of exchange rate behaviour.

World financial market integration has proceeded rapidly in the past decade, far exceeding that in goods markets, labour markets or markets for physical capital[1]. Capital controls and limitations on entry of foreign financial institutions into the domestic market have been dismantled in most major OECD countries and many of the smaller ones. At the same time the rapid growth of offshore financial markets, removal of exchange controls, the development of 24 hour screen-based global trading, the increased use of national currencies outside the country of issue and innovations in internationally-traded financial products have all contributed to the globalisation of capital markets.

In the extreme case of financial autarky, only a zero current account balance is sustainable, except for periods when official reserves can be run down. The real exchange rate and the rate of interest adjust to ensure that this is so. As capital controls are removed, creditworthiness and exchange risk considerations alone replace official restrictions as the only limitations on market access. These developments bring with them many benefits. With only solvency (as opposed to liquidity) constraints likely to limit access to international capital markets in the liberalised environment of the 1980s and 1990s, the scope for divergences between domestic savings and investment is greatly increased, as foreign savings are readily available to bridge such gaps. That is, countries can choose paths for consumption and investment which are largely independent of each other. The allocation of savings and investment in the world economy may be improved, and national consumption paths may be more easily "smoothed" in the face of temporary exogenous shocks to national income affecting one country differently from all others.

The internationalisation of world financial markets, permitting the emergence of large external imbalances, may have permanent effects on the equilibrium real exchange rate. This is because of the cumulation over time of net foreign assets or liabilities. There is no reason to believe that the optimal levels of such financial stocks are zero. Debt accumulation can continue as long as countries can service their obligations -- no-one expects the major debtor countries to repay their cumulated debts in full nor countries like Japan to relinquish their assets

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1 See Bryant (1987).

within any specified time period. The process of liberalisation and globalisation then, by reducing liquidity constraints between countries, is likely to cause permanent shifts in net foreign asset and liability positions. This leads to shifts in net property income obligations which, in turn, change the underlying equilibrium trade balance, and hence the long-run real exchange rate associated with it.

The internationalisation of world financial markets, then, may be important for unravelling some of the above-mentioned puzzles about real exchange rate behaviour. Such a possibility does not seem to have been considered by others. Meese, for example, in a recent survey of exchange rate modelling, confines himself to the following remark on financial liberalisation:

> "Financial innovation and the mitigation of international capital controls over the post-Bretton Woods era complicates inference just as peso problems do." (1990, p. 129)

Section 2 of the paper introduces a model which links the long-run real exchange rate with real interest differentials and cumulated current account balances, which are driven by the process of financial liberalisation. This model is tested on data for four major real exchange rates. The model and empirical work is based on the assumptions that i) financial liberalisation and globalisation has been an important phenomenon over the sample period, and ii) that the globalisation of financial markets does not imply the integration of goods markets, so that there is no necessary tendency for real interest rate parity to emerge. Section 3 of the paper examines both of these assumptions using alternative measures of integration. The findings in this section are consistent with the interpretation of the earlier econometric results. The final section provides some concluding remarks.

2. REAL EXCHANGE RATES AND THE GLOBALISATION PROCESS

(a) Theoretical Model

The effects of financial liberalisation can be thought about in terms of balance of payments equilibrium. A reasonably precise statement of the balance of payments identity between two countries is:

$$A(t) = p(t)B(t) + (1+r^*(t))(1+\Delta s(t))\,A(t-1) \qquad [1]$$

where:

- $A(t)$ is bilateral net foreign assets measured in domestic currency in period t;
- $p(t)$ is the price of output in period t;
- $B(t)$ is the bilateral real balance of trade surplus in domestic currency in period t;
- $r^*(t)$ is the average nominal interest rate on bilateral net foreign assets in period t[2];
- $s(t)$ is the bilateral nominal exchange rate, domestic currency per unit of foreign currency, in period t.

The inclusion of the nominal depreciation term is to capture valuation effects on the net interest component of the balance of payments and the stock of net foreign assets valued in domestic currency at the end of the previous period. It is convenient to divide both sides of [1] by nominal output, $Y(t) = p(t)y(t)$:

$$\frac{A(t)}{Y(t)} = \frac{p(t)B(t)}{p(t)y(t)} + \frac{(1+r^*(t))(1+\Delta s(t))}{1+g(t)}\,\frac{A(t-1)}{Y(t-1)} \qquad [2]$$

Where $g(t)$ is the growth rate of nominal GDP in period t. Defining $a(t)$ to be bilateral net foreign assets as a share of GDP and $b(t)$ as the nominal or real share of the bilateral trade balance in nominal or real GDP, the change in $a(t)$ expressed now in continuous time is given by:

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2 This is not the same as the nominal value of R^*. Fixed interest debt is acquired over time at different interest rates and maturities. The concept here is an average rate.

$$\mathring{a}(t) = b(t) + \psi\, a(t) \qquad [3]$$

where $\psi = \bar{r}^* + \bar{\mathring{s}} + \bar{r}^*\bar{\mathring{s}} - \bar{g}$

For simplicity, the net interest component of the balance of payments is always subsequently evaluated by replacing the average interest rate on net foreign assets; nominal exchange rate depreciation and the nominal growth rate in equation [3] with their steady-state values, indicated by a bar.

The bilateral trade surplus as a share of GDP is assumed to be given by:

$$b(t) = \gamma\,[q(t) - z(t)] \qquad [4]$$

where:

- $q(t)$ is the logarithm of the real exchange rate in period t;
- $z(t)$ summarises exogenous real factors that affect domestic excess demand and foreign excess demand for domestic goods in period t.

The final building block of the system is the capital account equilibrium condition. Capital flows adjust the actual stock of net foreign assets a(t) towards the desired stock, with a possible lag measured by η. The desired stock depends on the net return differential and the desired net stock of the foreign country's assets at a zero return differential[3].

$$\mathring{a}^d(t) = \eta\,[a^d(t) + R^{e*}(t) - R^e(t) + \mathring{q}^e(t) - a(t)] \qquad [5]$$

where:

- $a^d(t)$ is a variable reflecting the desired bilateral net foreign asset position as a share of GDP, when the rate of return differential is zero;
- $R^{e*}(t)$ is the exogenous expected foreign real interest rate in period t;

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[3] A similar specification is used in Frenkel and Mussa (1985), (p. 729).

$R^e(t)$ is the exogenous expected domestic real interest rate in period t;

the "d" superscript indicates the desired value of a variable and "e" denotes an expected value.

In equilibrium this collapses to the interest rate parity condition in real terms with allowance for a risk premium equal to $a^d(t) - a(t)$. Balance of payments equilibrium where the current account between the two countries is matched by desired capital flows is given by substituting equation [4] into equation [3] and setting it equal to desired capital flows in equation [5].

$$\eta\,(a^d(t) + R^{e*}(t) - R^e(t) + \mathring{q}^e(t) - a(t)) = \gamma[q(t) - z(t)] + \psi a(t) \qquad [6]$$

This together with equations [3] and [4] constitutes a simultaneous system of forward-looking differential equations that may be solved for the expected time paths of the endogenous variables q(t) and a(t). Assuming rational expectations, this system may be written as:

$$\begin{bmatrix} \mathring{q}(t) \\ \mathring{a}(t) \end{bmatrix} = \begin{bmatrix} \frac{\gamma}{\eta} & 1+\frac{\psi}{\eta} \\ \gamma & \psi \end{bmatrix} \begin{bmatrix} q(t) \\ a(t) \end{bmatrix} + \begin{bmatrix} -\frac{\gamma}{\eta}z(t) - (a^d(t) + R^{e*}(t) - R^e(t)) \\ -\gamma z(t) \end{bmatrix} \qquad [7]$$

The characteristic equation is given by:

$$\lambda^2 - (\frac{\lambda}{\eta} + \psi)\,\lambda - \gamma = 0 \qquad [8]$$

and the solution for λ is:

$$\lambda = \frac{1}{2}\,[\,(\frac{\lambda}{\eta} + \psi) \pm \{(\frac{\lambda}{\eta} + \psi)^2 + 4\gamma\}^{1/2}\,] \qquad [9]$$

Given the positive sign restrictions on the coefficients, one eigenvalue λ is positive and one is negative. Choosing the negative value of λ, the solution for the time paths of the variables is:

$$\mathring{q}(t) = \lambda\,(q(t) - \bar{q}(t)) \qquad [10]$$

$$\mathring{a}(t) = \lambda\,(a(t) - \bar{a}(t)) \qquad [11]$$

The steady-state levels, shown with a bar, are solved by setting $\mathring{q}(t) = 0$ and $\mathring{a}(t) = 0$ in equation [7]. That is:

$$\bar{q}(t) = z(t) - \frac{\psi}{\gamma}\,[a^d(t) + R^{e*}(t) - R^e(t)] \qquad [12]$$

$$\bar{a}(t) = a^d(t) + R^{e*}(t) - R^e(t) \qquad [13]$$

The steady-state value of q(t) in equation [12] could be the basis of cointegration tests concerning the long-run behaviour of the real exchange rate.

(b) Globalisation and Cointegration

Meese and Rogoff (1988), in following up their earlier paper on the out-of-sample forecasting properties of standard exchange rate models, investigated the associations between real exchange rates and real interest differentials by testing for cointegration between these variables. Their tests over the period 1974 to 1984 (using monthly data) suggested that these variables were not cointegrated, and the authors took this to imply that the relationship between the two variables was "at best tenuous". A number of other authors using a variety of exchange rates and estimation approaches also support this view[4].

The failure to find cointegration between bilateral real interest differentials and bilateral real exchange rates over post-Bretton Woods sample periods may be related to the process of financial liberalisation. This process has reduced liquidity constraints between countries,

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[4] See, for example, Shafer and Loopesko (1983), Sachs (1985), Isard (1988), Meese (1990), Coughlin and Koedijk (1990), and Canarella et al (1990) who require a time varying parameter technique to find any relationship.

permitting world financial capital to be reallocated from relatively high saving and low investment return countries towards those in the reverse situation. This may be represented in equation [12] by the way in which the behaviour of the exogenous variables is specified, i.e. the expected real interest differentials, the desired bilateral stock of net foreign assets at a zero real interest differential, and z(t) which represents exogenous variables influencing the domestic and foreign excess demand for domestic goods. The following assumptions are made:

(i) financial liberalisation and globalisation does not imply goods market integration. In the absence of perfect real factor mobility, the real interest differential is assumed to be a non-stationary process of the form:

$$R^{e*}(t) - R^{e}(t) = R^{*}(t) - R(t) + \varepsilon_1(t) \qquad [14]$$

where $\varepsilon_1(t)$ is a random error term.

(ii) in the absence of capital controls, the desired net stock of another country's assets (as a share of income) at a zero net return differential is assumed to be proportional to the total net stock of foreign assets a^T (as a share of income). That is, if the return differential is zero, domestic residents will hold a fixed proportion δ of their total net foreign assets a^T in the assets of a given foreign country. The fixed weight δ, for example, could be derived from an optimisation problem where agents hold net foreign assets in proportion to the weight of the foreign country's output in domestic consumption. Here a^T is the cumulated current account surplus vis-a-vis all other countries, and is assumed to be an exogenous non-stationary process of the form:

$$a^d(t) = \delta a^T(t) + \varepsilon_2(t) \qquad [15]$$

Thus as financial liberalisation leads to non-mean-reverting movements in the overall net foreign asset position vis-a-vis the rest of the world as a share of GDP, all desired bilateral net foreign asset positions at a zero net return differential are affected.

(iii) domestic and foreign excess demand for domestic goods is assumed to be positively related to the expected real interest differential favouring the foreign country:

$$z(t) = \alpha + \beta\,[R^*(t) - R(t) + \varepsilon_1(t)] + \varepsilon_3(t) \qquad [16]$$

Substituting equations [14], [15] and [16] into [12] yields the following steady-state relationship:

$$\bar{q}(t) = \alpha + (\beta - \frac{\psi}{\gamma})\,[R^*(t) - R(t)] - \frac{\psi\delta}{\gamma}\,a^T(t) + \omega(t) \qquad [17]$$

where $\omega(t) = (\beta - \frac{\psi}{\gamma})\,\varepsilon_1(t) - \frac{\psi}{\gamma}\,\varepsilon_2(t) + \varepsilon_3(t)$

The long-run real exchange depends on the real interest differential, with an ambiguous sign, and on the stock of net foreign assets with a negative sign (a rise in net foreign assets causes the long-run real exchange rate to appreciate as net property income transfers from the rest of the world permanently increase). This equation forms the basis of the cointegration tests below. It differs from previous cointegration studies of the real exchange rate by explicitly allowing for the effects of financial liberalisation.

(c) Testing for Cointegration

The sample period chosen for testing the cointegration of the real exchange rate, the real interest differential and net foreign asset positions between the countries is 1974Q1 to 1990Q4 -- wholly within the floating exchange rate era. Mussa (1986), for example, attributed a major role to the nominal exchange rate regime as a determinant of the behaviour of the real exchange rate. It is impossible to eliminate this exchange-rate regime influence entirely, though, since the French franc/Deutschemark rate within the EMS over the sample period is one of the currencies selected for study. The series used are defined as follows:

- -- the logarithm of the bilateral nominal exchange rate of currency A per unit of currency B, deflated by the CPI levels for countries A and B. The yen/dollar (yen/$), Deutschemark/dollar (DM/$), sterling/Deutschemark (£/DM) and French franc/Deutschemark (FF/DM) rates are considered;

- -- the long-term real interest rate of country A minus that of country B, the series which has had most success in obtaining significant and correctly signed estimates in other studies[5]; and

- -- the cumulated total current account surplus as a share of GDP for country A minus that of country B.

Tests for unit roots of the data were conducted first using the augmented Dickey-Fuller procedure with four lagged differences. The null hypothesis that the variable under investigation has a unit root is tested against the alternative that it does not. The results reported in Table 1 indicate that the null hypothesis is only rejected for the FF/DM real exchange rate. Subsequently, first differences of the remaining variables were also tested. The results (not shown) suggest rejection of the null hypothesis in each case. These results are consistent with the hypothesis that each series -- with the exception of the FF/DM rate -- is an integrated process of order one, I(1). If the globalisation of financial markets is the common factor explaining the non-stationarity

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5 See, for example, Shafer and Loopesko (1983), Sachs (1985) and Isard (1988). One reason often advanced for this is that real exchange rates take time to revert towards equilibrium, so that choice of a similarly long-term interest rate (which is the average of expected future short rates) is appropriate. The ten-year bond rate is employed, with inflation expectations being proxied by a centred three-year moving average. This is also used in Danker and Hooper (1989). Ten-year inflation expectations are unlikely to have much meaning in practice -- witness that most official and model-based forecasts of inflation have an eighteen-month to two-year horizon. Attempts to generate ten-year forecasts of inflation with econometric techniques have never found support in empirical work on real exchange rates, e.g. Shafer and Loopesko (1983). The quarterly formulation assumes the rational forward-looking component has an eighteen month horizon. The long-run forecast is an average of this and the previous eighteen months of inflation experience.

of these variables, for the reasons outlined above, then it is important to include all three in any test for cointegration.

Tests for cointegration between the real exchange rate, real interest differential and cumulated current account difference are conducted using the methodology proposed by Johansen (1988) and Johansen and Juselius (1990). For the Johansen procedure there are two test statistics for the number of cointegrating vectors, i.e., the maximum eigenvalue and trace tests. For the maximum eigenvalue test the null hypothesis of zero cointegrating vectors, r=0, is tested against the alternative that r=1; r=1 against the alternative that r=2; and r=2 against the alternative that r=3. For the trace test, the null hypothesis is that the number of cointegrating vectors is less than or equal to r, where r is 0, 1 or 2. This is tested against the more general alternative. Critical values are reported in Johansen and Juselius (1990).

The results for these tests are presented in Table 2. For the maximum eigenvalue tests the hypothesis r=0 is rejected for the yen/\$, £/DM and FF/DM real exchange rates (but not for the DM/\$ rate). For the yen/\$ rate the hypothesis r=1 is also rejected in favour of r=2, suggesting the presence of a second cointegrating vector. This was not the case for the £/DM and FF/DM rates, where the test of r=1 versus r=2 fails to reject the null hypothesis, suggesting one cointegrating vector in each case. These results are also borne out by the trace test. Thus r=0 is rejected for the yen/\$, £/DM and FF/DM rates, while $r \leq 1$ is also rejected for the yen/\$ rate.

In contrast to other studies then, three of the four real exchange rates considered are cointegrated with real interest rate and cumulated current account differences (yen/\$, FF/DM, £/DM rates) over the floating rate period 1974Q1 to 1990Q4. The corresponding estimated cointegrating vectors are shown in the two right-hand columns of Table 2. In all cases, the vectors are of the correct sign, i.e. an improvement in the cumulated current account surplus favouring currency A is associated with an appreciation vis-a-vis currency B. In the cases where cointegration is found, a shift in the real interest differential favouring the foreign country causes the real exchange rate to depreciate.

The residuals from the cointegrating relationship are plotted in Chart 1 for the yen/$, FF/DM and £/DM real exchange rates. It is interesting to note that for the yen/$ and £/DM rates there are periodically substantial unexplained residuals over the floating rate era. A casual inspection of the charts suggests that the amplitude and periodicity of these swings -- which presumably reflect inefficient expectational episodes -- is similar in the 1980s compared to the 1970s, in spite of any liberalisation and globalisation of international financial markets. In the case of the FF/DM rate, on the other hand, there appears to have been a marked reduction in the amplitude of the residuals during the 1980s. From 1983, these lie within a range of 2 per cent on either side of the equilibrium rate, compared to about 10 per cent for the other currencies. This corresponds with France's decision in 1983 to favour the hard currency option within the EMS and the gradual establishment of credibility for this policy, reflected in the reduced frequency of realignments in the second half of the 1980s.

Two points are worth noting about the unexplained residuals. First, while they can be large and persistent (up to two years), they are, nevertheless, mean-reverting. Second, the trend towards globalisation and liberalisation of financial markets does not appear to have influenced the extent of these unexplained movements. That the amplitude of the residuals declined noticeably in the case of the FF/DM rate only, suggests that the exchange rate regime may be more important than the degree of financial liberalisation in explaining the extent to which inefficient expectation cycles influence nominal exchange rates. This latter finding is consistent with the view that a credible target zone for the nominal exchange rate exerts a stabilising influence on real exchange rate movements (as claimed in Krugman, 1988).

The above results suggest that it is necessary to account for both real interest differentials and cumulated current account imbalances when analysing the longer-run behaviour of real exchange rates. Moreover, the apparent non-stationarity of all three variables individually and their cointegration as a system for some major currencies is consistent with predictions arising from the increased globalisation of financial markets.

While the econometric results are consistent with the financial liberalisation interpretation given above, this nevertheless rests on two important assumptions:

(i) that globalisation has indeed increased over the sample period, reducing liquidity constraints by allowing the free flow of capital between countries which, in turn, should be associated with some reduction in national saving and investment correlations; but

(ii) that globalisation of financial markets has not led to the integration of goods markets and a tendency for real interest rate disparities to be eliminated.

These issues are examined in the following section.

3. THE CHANGING DEGREE OF INTERNATIONAL FINANCIAL MARKET INTEGRATION

The removal of officially-imposed barriers to the international movement of capital commenced in the United States shortly after the breakdown of the Bretton Woods system of fixed exchange rates. The severity of both capital and exchange control barriers has been progressively diminished elsewhere since then, with the result that these controls have now been virtually eliminated in the major OECD countries[6]. This should have facilitated the integration of international financial markets. Financial innovation, spurred by tremendous advances in telecommunications technology, should also have contributed to the increasing pace of integration. The growing international availability of new financial instruments such as currency and interest rate swaps and financial futures and options has encouraged international portfolio diversification by providing a wider

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6 This process began in the mid-1970s with the removal of capital controls in Germany, the United States and Canada amongst the major OECD countries. Liberalisation measures in Japan and the United Kingdom followed at the end of the decade, and France, Italy and some other EC countries have moved steadily towards the complete elimination of controls by the middle of 1990's. See Blundell-Wignall and Browne (1991) for a more complete discussion.

array of financial instruments than are likely to be available on domestic financial markets. The level of cross-country integration is also likely to have been further facilitated by internationalisation in the provision of financial services, with foreign-based financial intermediaries playing an increasingly important role in domestic banking and securities markets.

A variety of approaches has been suggested for quantifying the degree of international financial market integration. These different measures, presented in Table 3 in descending order of specificity, do not typically give the same impression of the degree of integration. There are a few reasons for this. Some measures are more narrowly based (1, 2 and 3) than others, in the sense that the array and maturity of the assets implicitly included is restricted. Also, some tests are based on nominal magnitudes (1, 2 and 3) while others concern real variables (4 and 5). Most are based on the co-movement of relative prices, but 5 is based on the absence of co-movement between domestic saving and investment. To obtain a more comprehensive perspective on the degree of international financial integration, how this is changing over time, and how it might be related to goods market integration, all the measures presented in Table 3 are reviewed.

(a) Closed, Covered and Uncovered Interest Parity

The first definition of financial market integration is closed interest parity. This says that capital flows equalise interest rates on comparable financial instruments issued in different countries but denominated in the same currency. Of the five definitions this is the least stringent in that, for it to be valid, it requires the least number of conditions to be fulfilled. However, it is also the most narrrowly based in that it refers only to that subset of assets traded in Eurodeposit or Eurobond markets. These constitute only a small proportion of the value of financial instruments issued on the domestic market. Thus a conclusion that closed interest parity is valid clearly does not permit one to infer that international financial markets are completely integrated, but simply that the markets under consideration are.

The only reason for deviations from closed interest parity is the existence of a political risk premium. This is interpreted very widely here as representing not only existing capital controls and asset tax arrangements in different political jurisdictions, but also the prospect that existing barriers and taxes will change in the future[7]. A higher interest rate locally than offshore indicates barriers preventing capital inflows, while a negative differential reflects barriers preventing capital flight (except in countries such as the US and Switzerland where "safe haven" factors may be important). Reduced political barriers to trade in assets between onshore and offshore financial centres, or the prospect of such a development, will manifest itself as smaller deviations from closed interest parity[8]. Chart 2 displays the differential between three-month onshore (interbank) and offshore (Eurodeposit interbank) rates for seven OECD countries over periods for which data were available[9]. Even for assets denominated in the same currency, interest rate differentials have been very large in the past but have now, to all intents and purposes, disappeared. In most cases the elimination of the differential dates from the moment when capital controls were finally removed.

The second definition of international financial market integration is covered interest parity. This relates to yields on comparable assets issued in different countries and denominated in different currencies, namely the currencies of the issuing countries. Therefore, in addition to political risk, there is also currency risk. But insurance can be bought against the latter by resorting to the forward foreign exchange market or, for longer-term maturity instruments, the swap market. The

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7 According to Aliber's (1973) definition, political risk has nothing to do with existing capital controls per se, but rather relates to the uncertainty about the intensification or relaxation of future capital controls. For the purposes of the present exercise the distinction between international interest rate differentials arising from these two separate effects is not considered particularly important.

8 Uninhibited capital mobility is only a necessary condition for closed interest parity. It is not sufficient since the assets in question may not be perceived, for other reasons, as perfect substitutes by market participants.

9 The duration of the time periods displayed in the graphs coincides broadly with the periods of which the relevant Euromarket has been in existence.

difference between foreign asset yields hedged in the forward market (to compensate for expected exchange rate changes) and domestic yields also constitutes a measure of "political" risk. Thus, to the extent that currency transactions costs in the forward foreign exchange market are relatively small, covered interest rate disparities between any two countries should display similar patterns over time to the difference between the closed interest rate disparities for each of the two countries[10]. Covered disparities between US and other countries' three-month interest rates are graphed in Chart 3. The graphs corroborate visually the hypothesis that deviations from covered interest parity between national markets have declined substantially in recent times. While convergence to zero is not guaranteed because of minor conceptual differences in the data used, volatility in yield differentials has been reduced for most currencies (although not nearly as dramatically as in the case of closed interest parity).

The third measure set out in Table 3 is uncovered interest parity, which requires the domestic interest rate to equal the foreign interest rate on a comparable asset plus the expected depreciation of the domestic currency over the period to the maturity of the asset. If covered interest parity is assumed to be valid, a weak assumption especially for the Eurocurrency market, tests of uncovered interest parity are essentially tests of the efficiency of the market for foreign exchange[11]. The null hypothesis of uncovered interest parity is unanimously rejected

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[10] Covered interest parity has some practical advantages over closed interest parity for the purposes of the present exercise. Closed interest parity can only be examined for the limited number of countries for which Eurodeposits are issued in their own currency. Furthermore, for some of these countries the Eurodeposit market is a relatively recent development. These data problems are not as severe for covered interest parity tests.

[11] Covered interest parity in the Eurocurrency market can confidently be regarded as valid. Thus $fd_m = i_{mt} - i^*_{mt}$ where fd_m is the forward discount on the domestic currency to maturity m and i_{mt} and i^*_{mt} are interest rates on domestic and foreign assets with m periods to maturity. Uncovered interest parity says that $i_{mt} - i^*_{mt} = E[\Delta(S_{mt})]$ where the last expression is the expected change in the exchange rate between t and t+m given information available at t. Assuming covered interest parity to be true, testing for uncovered interest parity is essentially a test for: $fd_m = E[\Delta(S_{mt})]$ or, equivalently, $F_{mt} = E(S_{t+m})$ i.e. the m-period forward rate at time t is an unbiased predictor of the future spot rate at t+m.

virtually without exception. The agnostic inference following from this is that either expectations are not rational (there are systematic errors in forecasting exchange rates over the period concerned), a time-varying risk premium exists, or both conditions prevail. Recent evidence (e.g. Frankel and Froot (1987), Froot and Frankel (1989)) tends to suggest that inefficient expectational episodes dominate time-varying risk premia as explanations in this respect. Indeed the rejection of the null hypothesis is also consistent with a host of other phenomena such as bubbles, bandwagon and peso effects. The failure of uncovered interest parity to hold is, therefore, perfectly consistent with the removal of all administrative barriers to the free flow of capital - it does not undermine the assumption of increasing integration of world financial markets.

(b) Real Interest Parity

It is natural to presume that international investors are concerned with the expected purchasing power of the return on their investments, domestic and foreign, rather than just the nominal returns. If the exchange rate is expected to move to eliminate discrepancies between expected national inflation rates over the relevant asset holding period, then real interest rates may be the relevant relative price determining capital flows (as in the above model). It is arguable, accordingly, that real interest parity may be the appropriate criterion of international financial market integration. For real interest parity to hold it is necessary for ex ante real rates to equal, or to move to equality rapidly after a disturbance. This requires both uncovered interest parity and ex ante PPP to be valid (see Annex for an algebraic treatment). The evidence concerning short-run real interest rates, for which precise ex ante measures can be constructed is reviewed first. Subsequently longer-term real rates are considered.

Results of econometric tests for the co-movement of short-term real rates with those of the United States are reported in Table 4 and with those of Germany (for European countries) in Table 5. The co-movement of other countries' real short rates with that of the larger country is reflected in the size and significance of the estimated γ coefficients:

$$R^e(t) = \alpha + \gamma R^{e*}(t) \qquad [18]$$

where expected real interest rates refer to short rates. The Annex describes how precise ex ante real rates are calculated. In this framework $\alpha=0$, $\gamma=1.0$ implies complete equality of rates; $\alpha\neq0$, $\gamma=1.0$ implies integration since real rates move together; $0<\gamma<1.0$ implies lack of complete integration; and $\gamma=0$ implies zero intergration.

The equations for rates vis-a-vis the United States were estimated for three time periods. The first two periods (August 1974 to October 1979) and (November 1979 to February 1990) were chosen in an attempt to identify whether the ongoing process of financial liberalisation and innovation altered the nature of the real interest parity relationship. The third period (January 1986 to February 1990) was chosen to see if the estimated results are robust to the sample selection involved in choosing October 1979 as the important breakpoint. If the closeness of the co-movement of real interest rates across countries was a reliable measure of the degree of international financial market integration, then one would expect to observe a stronger relationship and higher values of γ in the second compared to the first period.

The hypothesis of zero linkage between real rates in the United States and those in Germany is accepted in the first sub-period[12]. The hypothesis of only partial linkage is accepted for Japan, France and Canada. The hypothesis that rates were fully linked cannot be rejected for Italy, the United Kingdom, the Netherlands and Switzerland. The same equations estimated for the 1980s see the γ coefficient fall in value in all instances. It falls to zero for the Netherlands and Switzerland, to about a third of its 1970s' values for the United Kingdom and Canada, and becomes significantly negative for Italy. The coefficient falls slightly for Japan and France, and remains effectively zero for

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[12] The absence of a freely-fluctuating market rate for treasury bills in Japan meant that estimates had to be confined to the post-1978 period. Note also that Treasury bills were not issued on a regular basis in Italy before February 1979. The sample division for Japan and Italy is therefore different than that for the other countries investigated. It is respectively May 1978 to May 1984 and November 1979 to January 1985.

Germany. Estimating this same relationship from January 1986 to the end of the sample period at February 1990 indicates zero or perverse relationships for France, Italy and the Netherlands. In most other cases the value of γ is significantly less than unity, the one exception being Switzerland.

The existence of the EMS and closer monetary policy co-operation between member countries might suggest closer linkages between European rates than with the United States. Tests carried out using Germany as the base country are reported in Table 5. The division of sample periods is now August 1974 to March 1979 (the commencement of the EMS, first period). April 1979 to February 1990 (second period) and January 1984 to February 1990 (the third period in which EMS realignments have been relatively unimportant). In conformity with those in Table 4, the weakest results are again for the second period. The strongest links are between Germany and the United Kingdom, Switzerland and the Netherlands. These results make sense since the exchange rate mechanism of the EMS during the second period, and particularly since the start of the third period, was employed to ensure monetary policies were directed at reducing inflation differentials. France and Italy, as high inflation countries, have been forced to pursue much higher real interest rates at the short end.

If the degree of co-movement between real rates across countries is a measure of the degree of international financial market integration, then the evidence that emerges from these results would not indicate consistent and substantial progress (see Caramazza et al. (1986) for a similar conclusion). Cumby and Mishkin (1986), whose test procedure is employed here, reject the extreme hypothesis of no relationship between real rates in different countries, and also that of fully linked rates across countries, in favour of the conclusion that, for most countries in the sample, the foreign/domestic real interest rate coefficient varies between 0.5 and 0.8. Thus, while there is substantial contemporaneous dependence in short-run real interest rate movements across countries, there remains considerable scope for independent national stabilisation policies and divergence in real rates resulting from asymmetric real shocks.

Longer-term real interest rates require some arbitrary assumption about the treatment of inflation expectations. In Section 2 a three-year centred moving average of inflation was employed. Since unit root tests are relatively robust to short-run measurement error, the results presented in Table 1 are appropriate for considering whether there is a tendency towards long-term real interest parity. These tests suggest in all cases that long-term real differentials possess a unit root - there is no evidence of mean-reverting behaviour.

The failure of real interest parity has been attributed by some (Dornbusch (1976) and Mussa (1983), for example) to sticky prices causing deviations from PPP. Others (Roll (1979); Frenkel (1981); Adler and Lehman (1983); Darby (1983); Mishkin (1984)) infer that deviations from PPP are never reversed or that, equivalently, the real exchange rate follows a random walk. If this is correct, then real interest disparities are permanent, caused by permanent relative goods price movements. Obstfeld (1983), for example, presents an intertemporal maximisation model in which real interest rate disparities are generated by changes in the terms of trade.

(c) The Correlation of Domestic Saving and Investment Rates

This final definition of the degree of international capital mobility was initially proposed by Feldstein and Horioka (1980). A high correlation between national saving and investment implies that the domestic economy cannot tap the world savings pool to increase its level of investment beyond that made possible by the supply of savings from domestic sources. Feldstein and Horioka inferred from their results that a sustained one percentage point increase in the saving rate resulted approximately in a one percentage point increase in the investment rate, which is consistent with the proposition that foreign savings are not internationally mobile. In a recent update of this work, however, Feldstein and Bacchetta (1989) report a savings retention coefficient of 0.79 for the 1980-86 period, which is lower than the 0.91 and 0.86 estimates for the 1960s and 1970s respectively.

Although the Feldstein and Bacchetta paper takes on board most of the criticisms, both theoretical and statistical, that have been directed against the original Feldstein-Horioka paper, domestic saving and investment correlations are still important, though reduced[13]. The overriding issue, however, is whether these results can be interpreted as reflecting imperfect capital mobility. Some economists argue that they cannot (see, for example, Frankel (1989) and Obstfeld (1986)). For the Feldstein-Horioka definition to be a valid measure of the degree of capital mobility, certain necessary conditions are required. First, real interest parity must hold; second, the foreign real interest rate must be determined exogenously to the country in question; and third, all variables that condition the country's investment rate, other than the real interest rate, must be independent of that country's savings rate. When the appropriate instrumental variable technique is employed to deal with this last potential source of bias, the Feldstein-Horioka conclusions remain largely intact. The non-exogeneity of the real rate of interest can be dealt with by using international cross-section data in which the real rate of interest is a constant, and therefore not responsible for the observed savings-investment correlation[14]. This leaves real interest parity. As we have already seen, the bulk of the evidence is unfavourable to the real interest parity hypothesis.

Several models which focus on the distinction between traded and non-traded goods have recently been proposed (see Murphy (1986), Engel and Kletzer (1989) and Wong (1990)) in which it is demonstrated that it is possible to generate a positive correlation between national saving and investment even with fully integrated international capital markets. These results are again unfavourable to the interpretation of the saving-investment relationship as reflecting exclusively the degree of international capital mobility. They serve to demonstrate that the crucial implicit assumption in the Feldstein-Horioka model is that all goods are traded and that PPP for traded goods is fully established within the duration of the typical business cycle. The key assumption is

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13 Other authors have also reported declining saving retention effects in more recent years. See, for example, Turner (1986), Frankel (1989) and Dean et al (1990).

14 Even using time-series analysis this issue can be successfully addressed, but is found not to be responsible for the high correlations reported (see Frankel (1989)).

therefore an implicit one about commodity markets rather than financial markets.

Increased capital mobility may, for reasons put forward by Feldstein and Horioka, nevertheless, see some decline in savings and investment correlations. Evidence supporting this can be demonstrated by regressions involving pooled savings and investment data across countries, as in Dean et al (1990). This work is updated and a noticeable decline in the savings/investment correlation can be seen from the evidence presented in Chart 4. While these correlations are an imperfect measure of capital mobility, recent data are not wholly inconsistent with the evidence favouring international financial market integration based on closed and covered interest parity presented earlier.

(d) Overall Assessment

Tests that do not confuse goods and financial market integration and are independent of the accuracy of exchange rate expectations (i.e. tests 1 and 2 in Table 3) show a rapid move to almost complete globalisation of financial markets during the 1980s. While it is an imperfect measure of financial integration, test 5 suggests an increasing trend towards greater independence of national saving and investment in OECD countries. This is consistent with the earlier evidence that cumulated current account imbalances as a share of GDP show no evidence of mean reversion when compared between countries. These findings are entirely consistent with the emphasis placed on the importance of the globalisation process in Section 2.

Finally, if real interest parity were observed empirically, the long-run model in Section 1 would collapse to dependence on developments in cumulated current account imbalances alone. The results in Tables 1, 4 and 5 suggest there is no implication of increasing goods market integration implied by the globalisation of financial markets, so that a potentially important role emerges for real interest differentials in long run real exchange rate determination.

4. CONCLUDING REMARKS

An important puzzle about real exchange rates in the post-Bretton Woods era concerns their non-stationarity. A presumption in much of the earlier literature is that such behaviour suggests that real exchange rates are decoupled from fundamentals, with inefficient expectations cycles dominating outcomes in a non-mean-reverting fashion. The above analysis suggests that this view is too strong, and may derive from failing to take sufficient account of the globalisation of financial markets. Three of the four real exchange rates considered, and all of the real interest differentials and cumulated current account balance differences possess a unit root. These variables are shown to be cointegrated during the floating exchange rate period in three out of the four cases examined.

This finding about the behaviour of the long-run real exchange rates was interpreted in the context of financial liberalisation and the greater integration of world capital markets. This process reduces liquidity constraints in a world where default and currency risks remain. As desired net foreign asset and debt positions shift in a non-stationary fashion, so too will long-run net interest receipts or burdens, which shifts the long-run real exchange rate over time. The cointegration finding means that unexplained residuals - possibly driven by inefficient expectations cycles - are mean-reverting. It is interesting to note here that these residuals do not themselves seem to have been affected by the process of globalisation - the notion that unfettered financial markets might display increased "noise". Indeed, the case of France suggests that the nature of the exchange rate regime is likely to be much more important in determining unexplained residuals. There has been a marked decline in the amplitude of the FF/DM residuals as financial liberalisation has proceeded - to about 2 per cent on either side of the equilibrium rate, compared to more like 10 per cent for the yen/$ and £/DM rate over the sample period. But this unique experience is thought to be more a direct consequence of France's participation in the EMS - an example of an exchange rate target zone.

A separate careful examination of the globalisation process yields results which are consistent with the interpretation given. That closed and covered interest parity should emerge over the sample period is the predictable consequence of the removal of official impediments to the free movement of capital. This latter process, in turn, is associated with reduced liquidity constraints. But reduced liquidity constraints do not imply perfect integration of international financial and goods markets. Increasing globalisation of financial markets combined with lack of goods market integration opens the way for both net foreign assets and real interest differentials to play a role in long-run exchange rate behaviour.

Table 1: Unit Root ADF Statistics
Real Exchange Rates, Real Interest Differentials
and Cumulative Current Accounts

(Sample Period: 1974Q1 to 1990Q4)

	Real Exchange Rates	Real Long-Term Interest Differential	Cumulated Current Balances
Yen/$	-1.6	-1.7	-0.5
DM/$	-2.2	-1.9	-0.05
£/DM	-1.9	-1.6	-1.3
FF/DM	-4.1*	-1.2	1.1

Note: The augmented Dickey-Fuller (ADF) unit root statistic is employed to test the null hypothesis that the variable concerned possesses a unit root. Critical values are reported in Fuller (1976), Table 8.5.2. An asterisk denotes rejection of the null hypothesis at the 5 per cent level.

Table 2: Cointegration Tests For Bilateral Real Exchange Rates

(Sample Period: 1974Q1 to 1990Q4)

	Eigenvalues λ	Conditional Hypothesis Max λ Tests		Unconditional Hypothesis Trace Tests		Long-run Coefficients: Real Interest Differential R*-R	Long-run Coefficients: Cum. Current Account Surplus
yen/$	0.000	Ho:r=2	0.0	Ho:r≤2	0.0		
	0.224	Ho:r=1	17.2**	Ho:r≤1	17.2**	0.125	-0.585
	0.319	Ho:r=0	26.1**	Ho:r≤0	43.4**	0.027	-0.302
DM/$	0.005	Ho:r=2	0.4	Ho:r≤2	0.4		
	0.073	Ho:r=1	5.1	Ho:r≤1	5.5		
	0.212	Ho:r=0	16.2	Ho:r≤0	21.6	-0.008	-0.102
FF/DM	0.002	Ho:r=2	0.1	Ho:r≤2	0.1		
	0.072	Ho:r=1	5.0	Ho:r≤1	5.1		
	0.393	Ho:r=0	33.5**	Ho:r≤0	38.6**	0.007	-0.043
£/DM	0.001	Ho:r=2	0.1	Ho:r≤2	0.1		
	0.092	Ho:r=1	6.6	Ho:r≤1	6.7		
	0.279	Ho:r=0	22.3**	Ho:r≤0	28.9*	0.064	-0.426

Note: The conditional maximum eigenvalue test is based on the largest squared eigenvalue. The unconditional trace test is based on the null hypothesis that there are k or less cointegrating vectors. Critical values are given in Johansen and Juselius (1990). One asterisk denotes rejection of the null hypothesis at the 10 per cent level and two asterisks denotes significance at the 5 per cent level.

Table 3: Alternative Suggested Measures of Financial Market Integration

Measure	Context	Test Equation Typically Used	Definitions	Perfect Capital Mobility Null Hypothesis
1 Closed interest parity	a) Same currency b) Different country (i.e. "onshore"-"offshore")	$i = \alpha_1 + \beta_{11} i^* + \beta_{12}(prp)$	i = Domestic interest rate i* = Foreign interest rate prp = Political risk premium	$\alpha_1 = 0$ $\beta_{11} = 1$ $\beta_{12} = 0$
2 Covered interest parity (CIP)	a) Different currency b) Same or different country c) Investors cover themselves in the forward market	$i = \alpha_2 + \beta_{21} i^* + \beta_{22}(fpd) + \beta_{23}(prp)$	fpd = Forward premium or discount	$\alpha_2 = 0$ $\beta_{21} = \beta_{22} = 1$ $\beta_{23} = 0$ (Required if different country)
3 Uncovered interest parity (UIP)	a) Different currency b) Same or different country c) Investors take open positions in foreign currency	$i = \alpha_3 + \beta_{31} i^* + \beta_{32} E(\Delta S) + \beta_{33}(prp) + \beta_{34}(erp)$	erp = Exchange risk premium $E(\Delta S)$ = Expected change in the spot exchange rate	$\alpha_3 = 0$ $\beta_{31} = \beta_{32} = 1$ $\beta_{33} = 0$ (Required if different country) $\beta_{34} = 0$ (Risk neutrality)

Table 3: (cont'd)

Measure	Context	Test Equation Typically Used	Definitions	Perfect Capital Mobility Null Hypothesis
4 Real interest parity	a) Different currency b) Same or different country c) Different commodity bundles d) Investors take open positions in foreign currency	$R = \alpha_4 + \beta_{41} R^* + \beta_{42} E(\Delta RS) + \beta_{43}(prp) + \beta_{44}(rerp)$	R = Domestic real interest rate R^* = Foreign real interest rate $E(\Delta RS)$ = Expected change in the real exchange rate rerp = Real exchange rate risk premium	$\alpha_4 = 0$ $\beta_{41} = 1$ $\beta_{42} = 0$ (Because $E(\Delta RS) = 0$) $\beta_{43} = 0$ (Required if different country) $\beta_{44} = 0$ (Risk neutrality)
5 Independence of domestic saving and investment ratios	See Section 3 of paper for further discussion	$(I/Y) = \alpha_5 + \beta_{51}(NS/Y)$ $(I/Y) = a - bR + u$	I = Investment NS = National saving Y = GNP u = Other factors affecting domestic investment other than R	$\beta_{51} = 0$, all conditions required for 4 i.e. $R=R^*$ and, in addition, R^* exogenous, $\rho(u, NS/Y) = 0$, and no non-traded goods

Note: This table summarises algebraically the various definitions of international financial market integration which have been proposed and sets out the conditions required to be fulfilled by each definition if capital markets are indeed fully integrated (refer to column entitled "Perfect Capital Mobility Null Hypothesis"). Uncovered interest parity (UIP) is rarely tested in the full form in which it is presented in the table. The table serves to highlight the number of hypotheses that are required to be maintained for the Feldstein-Horioka national savings-investment measure to be a valid measure of the degree of international financial market integration.

Table 4: Real Interest Rate Linkages With the United States: Three-Month Interest Rates and Consumer Prices

(Absolute t Values in Parentheses)
(The Data are Monthly)

	First Period		Second Period		Third Period	
	α	γ	α	γ	α	γ
Japan	0.595	0.316	0.659	0.291	0.357	0.634
	(10.17)	(4.48)	(8.14)	(2.93)	(2.04)	(6.36)
Germany	0.219	0.199	0.900	0.022	0.548	0.595
	(4.12)	(1.15)	(25.77)	(0.60)	(7.24)	(5.64)
France	-0.16	0.566	0.54	0.424	1.27	0.007
	(1.34)	(3.50)	(4.46)	(3.31)	(17.72)	(0.09)
Italy	-0.40	0.944	1.77	-0.500	1.65	-0.261
	(2.78)	(7.20)	(28.95)	(5.26)	(25.18)	(2.48)
United	-0.54	1.920	0.425	0.730	0.824	0.757
Kingdom	(1.55)	(3.01)	(4.11)	(8.00)	(10.68)	(7.41)
Canada	0.480	1.374	0.860	0.397	0.874	0.524
	(5.54)	(14.75)	(8.99)	(3.40)	(6.49)	(2.63)
Netherlands	-0.046	0.937	1.004	-0.064	1.155	0.189
	(0.27)	(2.69)	(9.52)	(0.58)	(6.14)	(0.79)
Switzerland	0.406	1.024	0.408	0.059	0.175	0.739
	(2.91)	(3.51)	(7.15)	(0.89)	(1.48)	(5.3)

Note: See Annex for an explanation of the model used. The hypothesis that foreign and domestic ex ante real rates move together and thus that the domestic and foreign markets are completely integrated implies $\gamma = 1$. $\gamma = 0$ implies complete disintegration. The first, second and third periods are August 1974 to October 1979, November 1979 to February 1990 and January 1986 to February 1990, respectively.

Table 5: Real Interest Rate Linkages With Germany: Three-Month Interest Rates and Consumer Prices

(Absolute t Values in Parentheses)

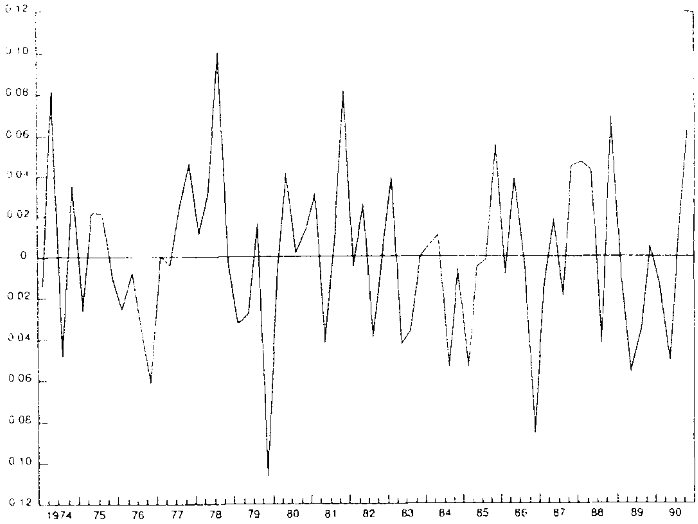
	First Period		Second Period		Third Period	
	α	γ	α	γ	α	γ
France	0.357	0.476	0.645	0.331	0.827	0.363
	(5.13)	(2.52)	(2.25)	(1.02)	(3.69)	(1.68)
Italy	0.758	-0.398	1.361	0.058	1.305	0.083
	(3.66)	(1.81)	(8.84)	(0.35)	(7.96)	(0.50)
United Kingdom	-1.745	3.27	1.351	-0.383	0.460	0.865
	(7.26)	(4.27)	(3.76)	(0.91)	(3.26)	(6.00)
Netherlands	-0.732	1.301	0.356	0.699	0.162	1.014
	(7.77)	(12.32)	(1.70)	(2.97)	(1.77)	(10.91)
Switzerland	0.031	0.966	-0.399	0.923	-0.487	1.101
	(0.79)	(6.73)	(1.65)	(3.50)	(8.98)	(17.28)

Note: See Annex for an explanation of the model used. The hypothesis that foreign and domestic *ex ante* real rates move together and thus that the domestic and foreign markets are completely integrated implies $\gamma=1$. $\gamma=0$ implies complete disintegration. $\gamma=1$ and $\alpha=0$ imply equality of domestic and foreign rates.

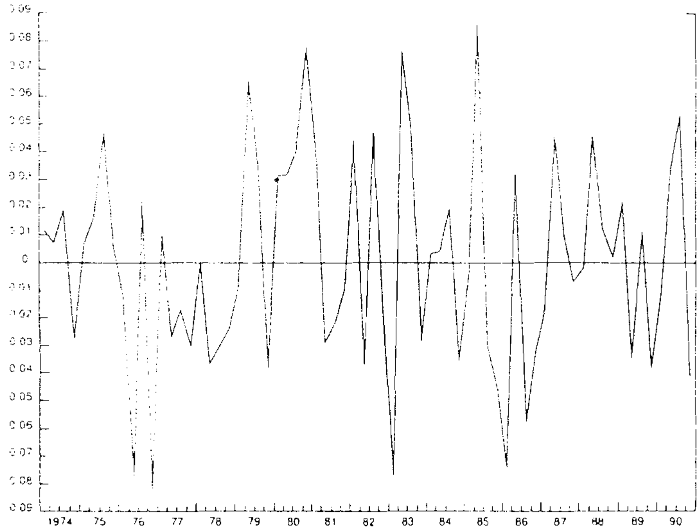
Chart 1

Unexplained Real Exchange Rate Movements About Equilibrium: the Cointegrating Residuals

Yen/Dollar Real Exchange Rate



£/DM Real Exchange Rate



FF/DM Real Exchange Rate

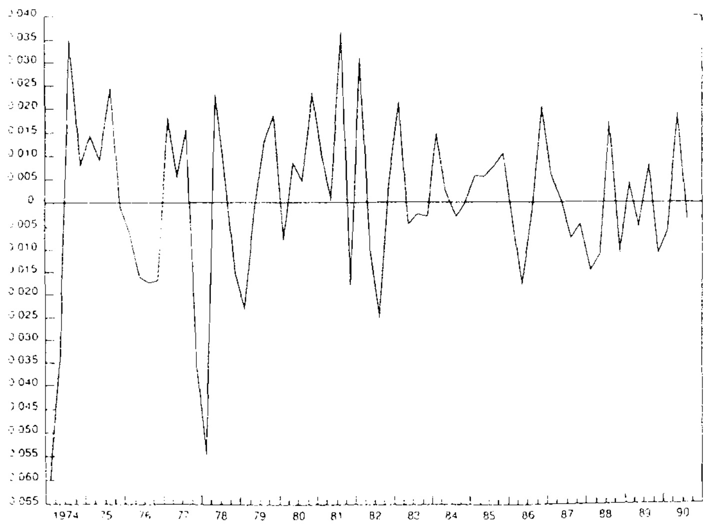


Chart 2

3-Month Interest Rates Differentials
-- on-shore deposits minus off-shore deposits --

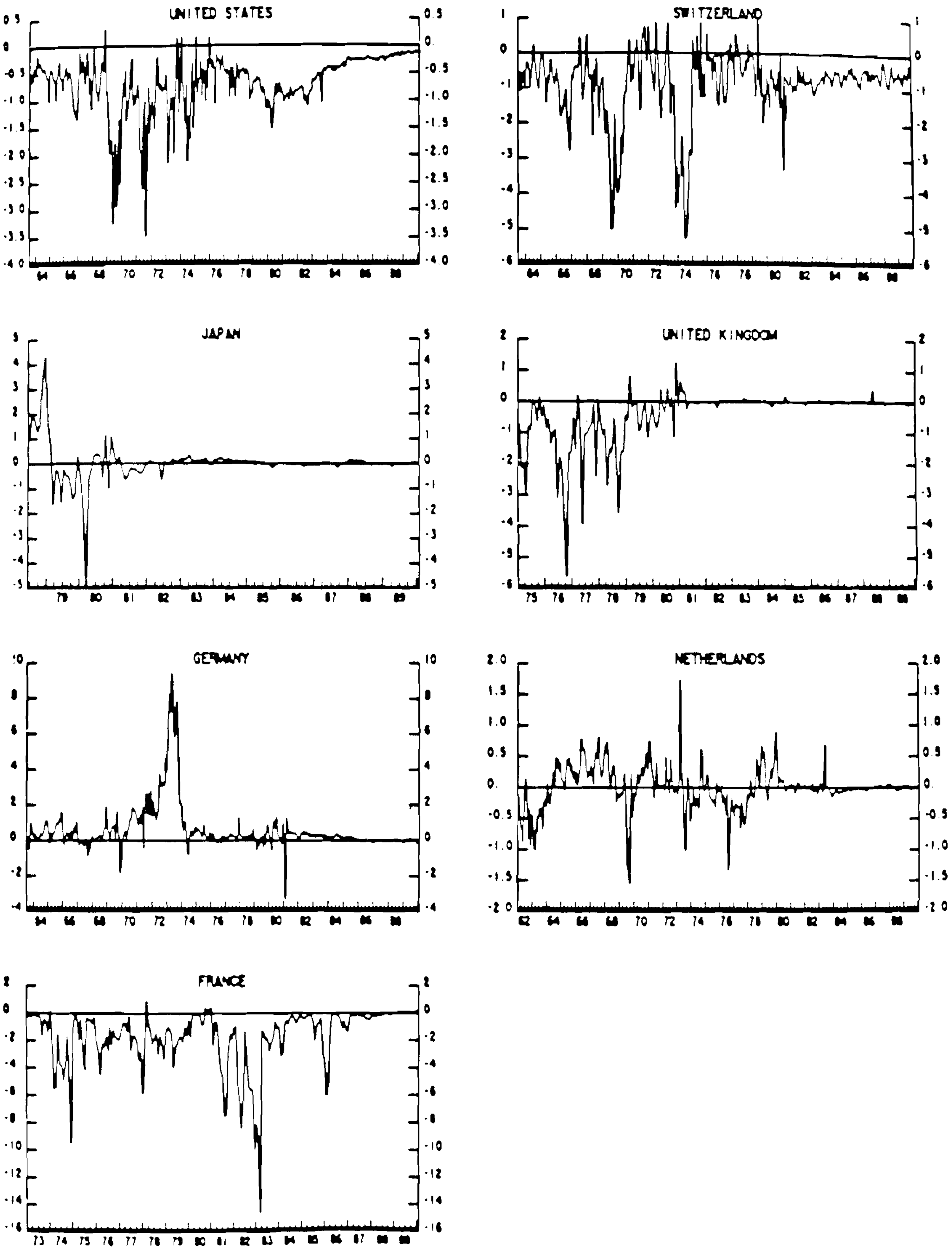


Chart 3

Covered Interest Disparities Using Treasury Bill Rates

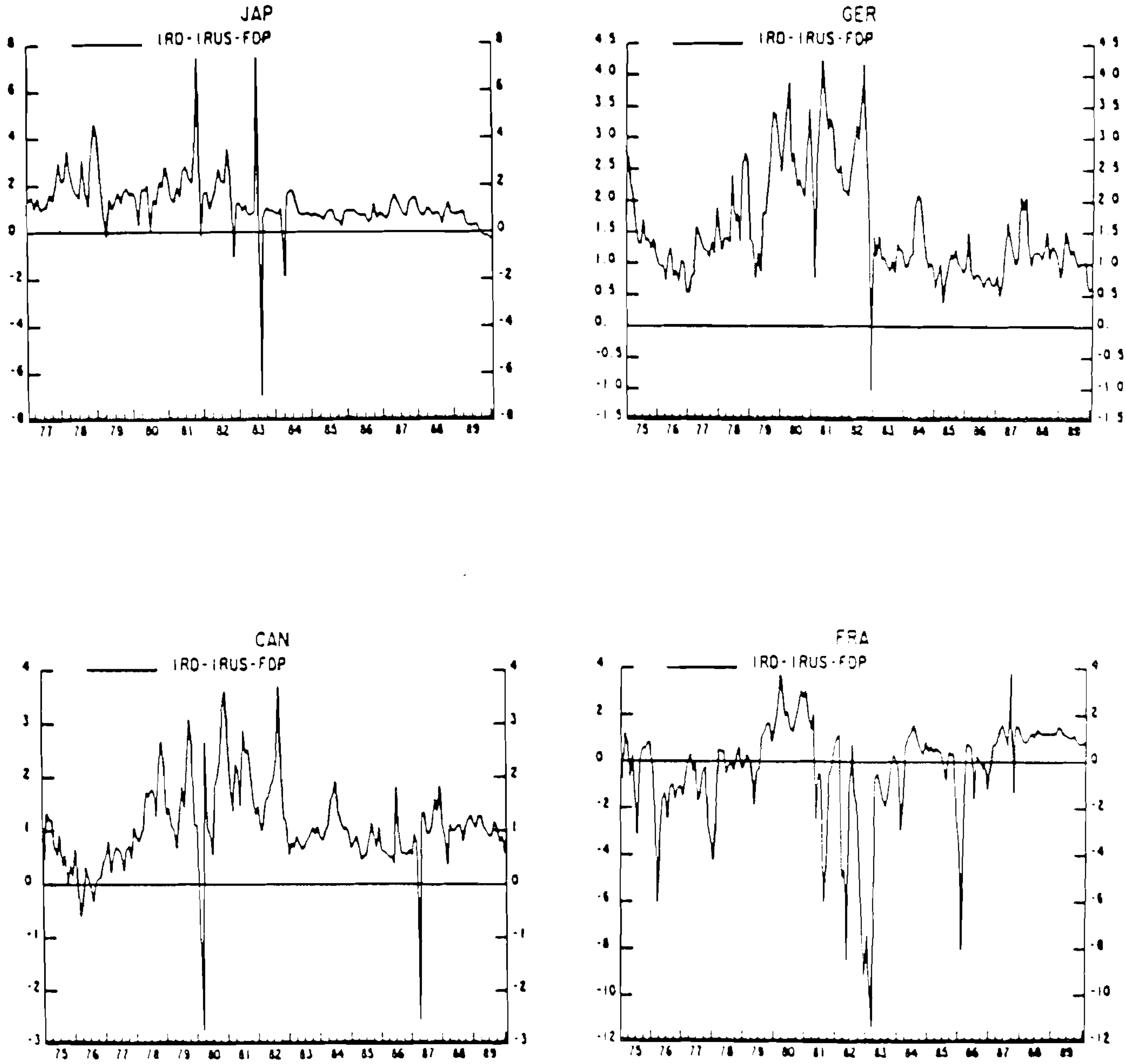


Chart 3 (cont'd)

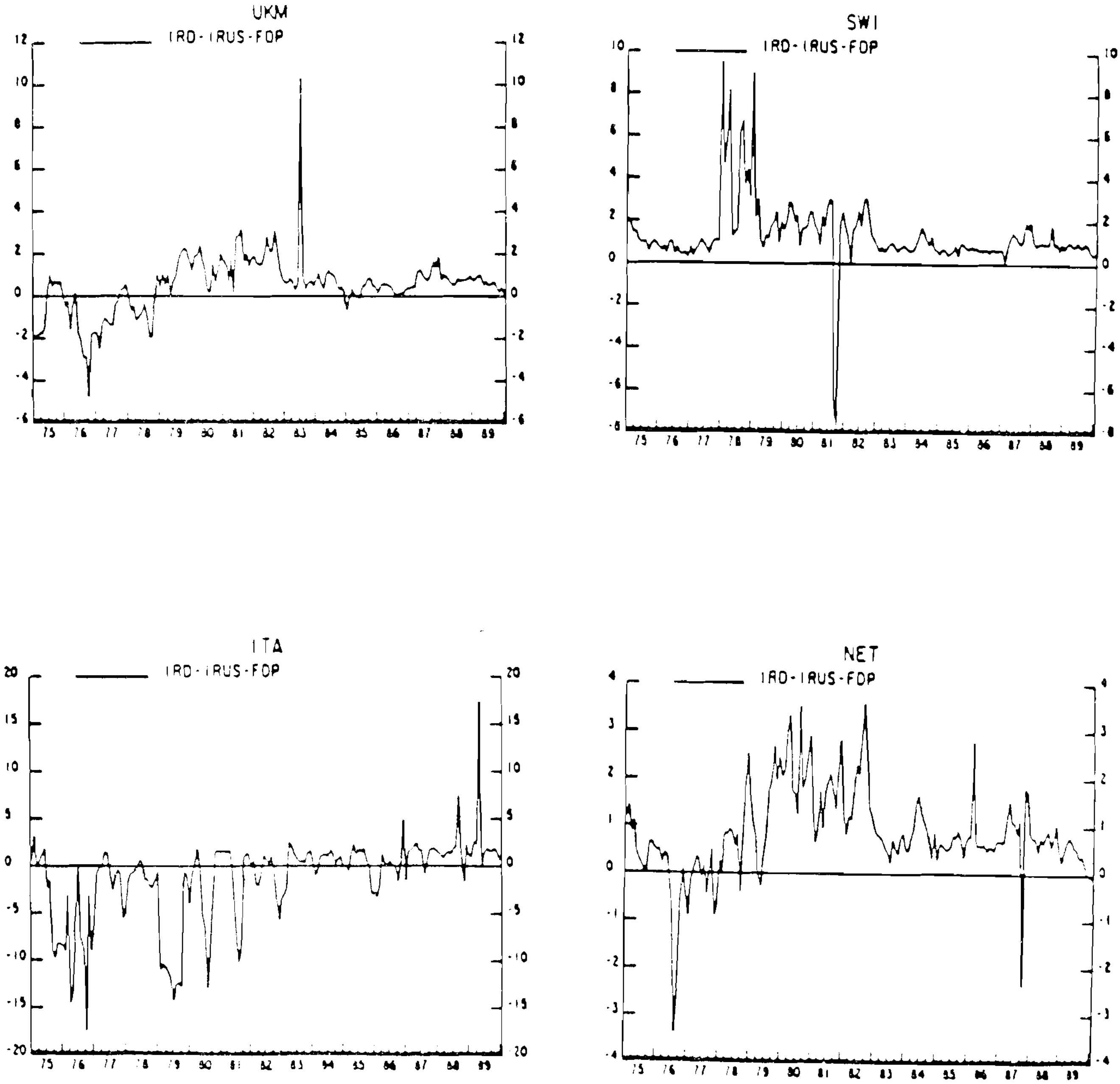
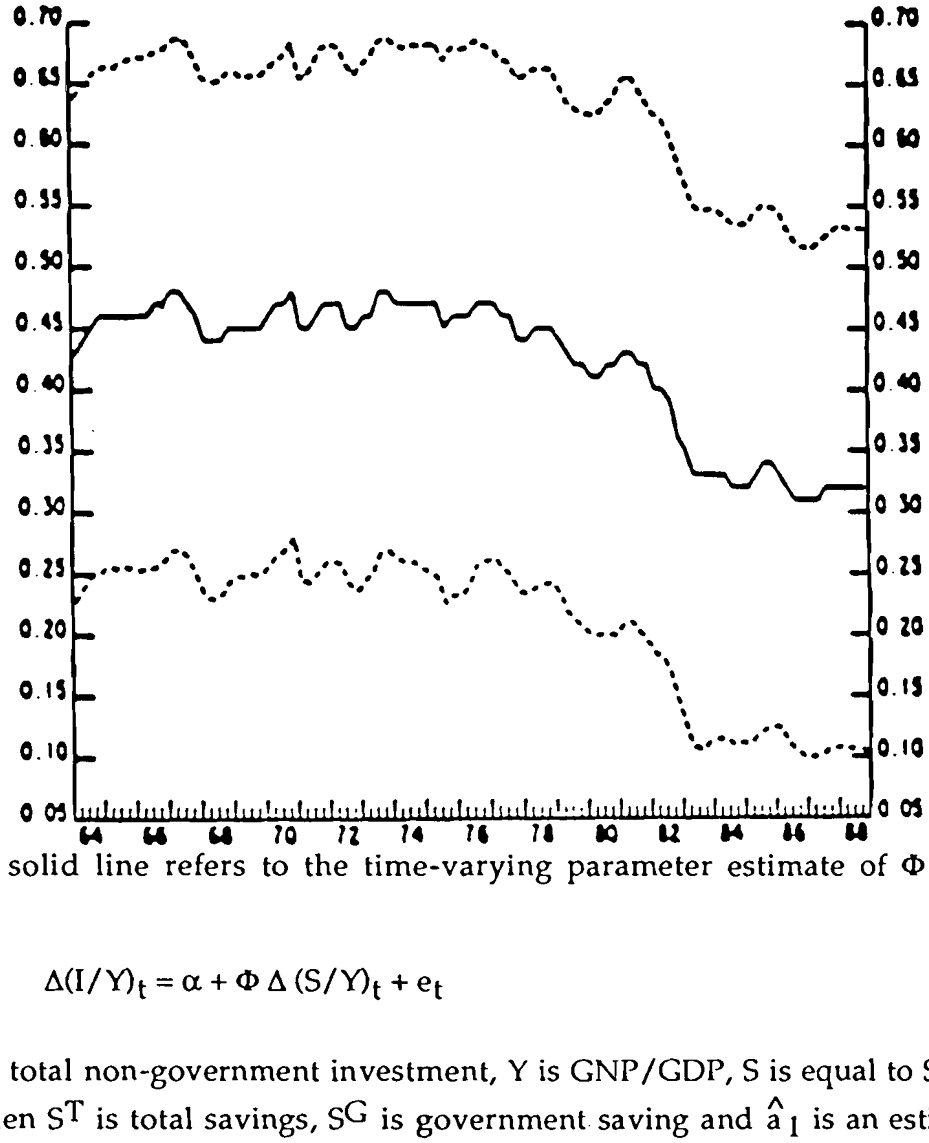


Chart 4

Estimated Savings-Investment Correlations: Pooled Data



Note: The solid line refers to the time-varying parameter estimate of Φ in the equation:

$$\Delta(I/Y)_t = \alpha + \Phi \, \Delta(S/Y)_t + e_t$$

where I is total non-government investment, Y is GNP/GDP, S is equal to $S^T - (1-\hat{a}_1)S^G$ when S^T is total savings, S^G is government saving and $\hat{a}_1$ is an estimated Ricardian effect. Estimating this equation using only cross-section data on the countries in the sample, the United States, Japan, Germany, France, Italy, the United Kingdom, Canada, Australia and Switzerland does not yield a sufficient number of observations to provide reliable estimates of Φ. Thus pooled time-series-cross-section data are employed. A constant inventory of 40 observations (10 countries by 4 quarters) were maintained in the sample with quarter t's estimate of Φ, $\hat{\Phi}_t$, obtained by adding the quarter's values of the relevant variables for all the countries and deleting those for quarter t-4. The discontinuous lines represent two standard error estimates for the $\hat{\Phi}_t$.

ANNEX: REAL INTEREST PARITY

The linkage between bilateral ex ante real rates is examined using the following equation:

$$E(R_{mt}) = \alpha + \gamma E(R^{*}_{mt}) + e_{mt} \qquad [A1]$$

where $E(R_{mt})$ and $E(R^{*}_{mt})$ are the ex ante or expected domestic and foreign real interest rates.

The hypothesis that foreign and domestic ex ante real rates move together and thus that the domestic and foreign markets are completely integrated implies $\gamma=1$. $\gamma=0$ implies complete disintegration. $\gamma=1$ and $\alpha=0$ implies equality of domestic and foreign rates. The major practical problem here is that ex ante real interest rates are not directly observable. Cumby and Mishkin (1986) suggest an econometric methodology to tackle this problem. The ex post or realised real interest rate is:

$$R_{mt} = i_{mt} - \pi_{mt} \qquad [A2]$$

where R_{mt} and i_{mt} are the realised real and nominal returns on the m period bond held from t to t+m and π_{mt} is the realised inflation rate from t to t+m. The ex ante real rate is defined as:

$$E(R_{mt}) = i_{mt} - E(\pi_{mt})$$

Combining the definitions of the ex ante and ex post rates gives:

$$\left.\begin{array}{c} R_{mt} = E(R_{mt}) + u_{mt} \\ \text{where} \\ u_{mt} = E(\pi_{mt}) - \pi_{mt} \end{array}\right\} \qquad [A3]$$

Substituting for the ex post real rates (defined in equation [A3] to get rid of the unobservable ex ante rates in equation [A1] yields:

$$R_{mt} = \alpha + \gamma R^{*}_{mt} + [u_{mt} - \gamma u^{*}_{mt} + e_{mt}] \qquad [A4]$$

u^{*}_{mt} is correlated with R^{*}_{mt} because R^{*}_{mt} is not realised until t+m and is thus obviously correlated with inflation forecast errors occurring in the interim between t and t+m. The composite error term is thus also correlated with R_{mt}. The use of an instrumental variable set (X_t) that is a subset of the information set available at time t will yield consistent parameter estimates since such instruments are, by definition, independent of subsequently realised forecast errors. In the present context, consistency also requires that the chosen instruments be uncorrelated with the error term in equation [A1].

With the current problem of overlapping data, however, an instrument set with the above characteristics will not result in consistent estimates of parameter standard errors. The Cumby, Huizinga and Obstfeld (1983) estimation procedure tackles this problem. Not only does it provide consistent estimates of the covariance matrix of the parameter estimates when the error term is serially correlated or conditionally heteroskedastic, but also produces more efficient estimates than the McCallum (1976) procedure.

Following Cumby and Mishkin (1986), a constant term, a time trend, the current nominal interest rate, i_{mt}, three lagged values of inflation are seen as suitable candidates for X_t. Unlike Cumby and Mishkin, however, we also find that one-period lagged values of money and output growth do add significantly to explanatory power for some countries. The sample residual autocorrelations from these regressions (not reported) are almost exactly the same as those reported by Cumby and Mishkin with no significant autocorrelations occurring at lags greater than 2, except at the seasonal frequency which may be spurious. This provides some indication that enough relevant information is included in X_t and that the fitted values which represent ex ante real rates will be reliable.

DATA APPENDIX

All data are taken from OECD National Accounts, Main Economic Indicators and Economic Outlook databases.

For the Cointegration Results

- Real long-term interest rates refer to long-term rates minus a centred 3-year moving average of inflation. Inflation refers to the GDP deflator for each country. Long-term rates are the 10-year government bond rate for the United States; central government bonds for Japan; and public sector bonds for Germany and the United Kingdom; and public and semi-public sector bonds for France.

- Real exchange rates refer to the nominal bilateral spot rate between the two countries deflated by the ratio of their respective GDP deflators.

- The cumulated current account term refers to the cumulation of the current account of country A in local currency as a percentage of nominal GDP in local currency minus the same concept for country B.

For the Real Interest Parity Tests

- Short-term real interest rates are the three month nominal rate for period t to t+1 less the realised inflation rate over this period. Short rates refer to the 3-month Treasury bill rate for the United States, Italy, the United Kingdom and Canada; the 3-month Treasury paper rate for the Netherlands; the Gensaki rate for Japan; the PIBOR for France; the FIBOR for Germany; and the 3-month Eurodeposits for Switzerland. The inflation rate refers to CPI inflation.

- Instrumental variables used in addition to some of the above were US and German real GDP, the United States money supply M2 and Germany money supply M3.

For the Interest Rate Charts

- Onshore and offshore rates refer to 3-month domestic deposits versus 3-month Eurodeposits.

- Covered interest parity measures use 3-month interest rates (above), spot exchange rates and forward rates.

For the Savings Investment Correlations

- Investment refers to total private investment as a share of GDP/GNP. Total savings and government savings are also used in the regression.

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