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# Increasing Financial Market Integration, Real Exchange Rates and Macroeconomic Adjustment

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Money and Finance Division

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This paper is one of four in this Working Paper Series, focusing on financial liberalisation, along with those of Kupiec, Miller and Weller, and Driscoll. It examines the extent to which international financial markets have become more integrated over the past decade. The finding that financial markets are almost fully integrated, in contrast to goods markets which are not, has important implications for real interest rate differentials, real exchange rate behaviour and external adjustment. In particular, the reduced importance of external imbalance and the increased role of real interest rates in real exchange rate determination can be associated with more prolonged misalignments.

Le présent document constitue l'une de quatre études de cette Série consacrée à la libéralisation financière, avec celles de Kupiec, de Miller et Weller, et de Driscoll. Il examine les progrès réalisés dans le processus d'intégration des marchés internationaux de capitaux au cours des dix dernières années. Le constat selon lequel les marchés financiers sont devenus très fortement intégrés, contrairement aux marchés de biens qui ne le sont pas, a d'importantes conséquences sur la formation des différentiels de taux d'intérêt réels, l'évolution des taux de change réels et l'ajustement extérieur. En particulier, l'importance réduite des déséquilibres externes et le rôle accrû joué par les taux d'intérêt réels dans la détermination des taux de change réels peuvent être associés à des phénomènes d'ajustements retardés.

# INCREASING FINANCIAL MARKET INTEGRATION, REAL EXCHANGE RATES AND MACROECONOMIC ADJUSTMENT

by

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# I. INTRODUCTION AND SUMMARY

It is generally recognised that world financial market integration has proceeded rapidly in the past decade, far exceeding that for 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 countries. 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.

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. To the extent that these developments have led to greater financial integration, arbitrage should drive the risk adjusted nominal rate of return on financial assets denominated in different currencies and/or issued in different countries into uniformity. This proposition is directly testable by examining interest rate parity concepts, adjusted where appropriate for expected exchange rate depreciation. The first objective of the paper then, is to review the extent to which such measures suggest that major industrial countries and some smaller economies have eliminated barriers to cross border flows.

The second objective is to assess the implications of identified breakdowns in barriers to cross border capital flows for macroeconomics. In the extreme case of financial autarky, only a zero current account balance is sustainable, except for short-run periods when official reserves can be built up or run down. The real exchange rate adjusts to ensure a zero current balance and the rate of interest ensures that domestic savings equals investment. As liberalisation begins to relax international liquidity constraints, capital becomes more mobile and the concept of a sustainable current account balance is significantly altered. While controls still exist, the terms and conditions by which a country can access international capital markets will reflect both the nature of international impediments to the free movement of capital and the decisions of international lenders regarding the creditworthiness of domestic borrowers. Liquidity constraints are likely to bind prior to prospective solvency constraints in this intermediate situation. While savings and investment imbalances may emerge, there are still strong constraints limiting the extent to which this occurs. Thus in the 1970s and early 1980s the magnitude of current accounts was more likely to have been limited by the restrictive supply of internationally loanable funds than by default risk.

As capital controls are completely removed, creditworthiness considerations alone replace official restrictions as the key limitation on market access. These are mainly governed by the extent to which a country builds up foreign debts in comparison to its capacity to repay them. As the country's stock of debt rises (its cumulated current account deficit) so does the cost of borrowing, ultimately very steeply. Deficits that are matched by profitable investment will be rated more favourably than those which correspond to excess consumption, because the former promise a reversal of the cumulated current account deficit. Nevertheless, the process of international financial liberalisation can be thought about as increasing market tolerance to larger external imbalances and cumulated indebtedness, as impediments to capital mobility are removed and as markets become broader and deeper.

These developments have many advantages that should not give rise to concerns for policymakers. 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 (particularly small 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 to all others.

There are, however, two important senses in which concerns may arise for policy, both relating to factors influencing real exchange rates. It is relatively straightforward to show that two basic theoretical influences on real exchange rates are:

i) real interest rate differentials, which lead to predictable divergences between spot and expected equilibrium rates; and

ii) current equilibrium rates themselves, which are driven by cumulated external balance positions.

These are often referred to as "fundamentals".

The first important issue concerns the extent to which real exchange rates are in practice related to these fundamental influences. Capital controls giving rise to political risk, inefficient expectations cycles and time varying risk premia may give rise to substantial unexplained movements in exchange rates. While the removal of capital controls may remove one source of variability, the complete flexibility of cross border flows and large portfolio shifts involved in sustained savings investment imbalances may be associated with increased variability as a consequence of bandwagon behaviour, noise trading, etc. The relative importance of these effects in comparison to the influence of fundamentals in explaining real exchange rate behaviour is an important aspect of the case for coordinated monetary policy and intervention strategies to stabilise rates. If deviations from fundamentals are large and persistent, the case for such policies is stronger than when unexplained residuals are small and shortlived.

The second important issue concerns the extent to which the relative importance of cumulated current balances and real interest differentials change as a direct consequence of increased international financial integration. Under financial autarky the requirement for a zero external imbalance implies that the real exchange rate adjusts quickly to movements in cumulated current account balances, while real interest differentials (which clear national savings and investment) have a zero impact. Increased tolerance to cumulated current account balances as capital controls are removed reduces -- but does not eliminate -- this influence. On the other hand, real interest rates no longer have to ensure national savings equal investment, and differentials between countries play a more important role in allocating capital between countries, and hence increase their impact on real exchange rates.

The reduced importance of external imbalances and the increased role of real interest rates in real exchange rate determination can be associated with more prolonged misalignments. For example, excessively large fiscal deficits associated with government current spending reduce national savings and force real interest rates (at least incipiently) to rise. With liberalised financial markets capital flows associated with higher real interest rates are likely to have a stronger effect on the real exchange rate. This, in turn, generates external imbalances that have a reduced impact on real exchange rates. Cumulated current account balances are, therefore, less self-correcting through induced exchange rate movements than in the past.

These considerations suggest that the need to co-ordinate policies between countries to avoid prolonged real exchange rate misalignments (unsustainable external balance developments and ultimately sharp corrections in relative prices) is increased by the process of globalisation of international capital markets. This includes fiscal policy and policy-induced distortions to private savings through the tax system, financial regulations, etc. There is some need, however, to be careful in the extent to which monetary policy is co-ordinated to avoid perceived exchange rate "misalignments". Attempting to offset real exchange rate appreciation due to reduced savings or increased investment by monetary easing would result only in a lower nominal exchange rate while the real exchange rate would appreciate through higher inflation. On the other hand, if inefficient expectations episodes and time varying risk premia are policy-regime dependent, gains to real exchange rate stability may be achieved without inflation costs in EMS-type arrangements, provided savings and investment (fundamentals) shocks are relatively unimportant. Similar comments apply to co-ordinated intervention strategies.

Section II of the paper examines various concepts of interest rate parity and attempts to review the extent to which world financial markets have moved toward greater integration. The extent to which saving investment correlations have broken down, and whether consumption paths have become more optimal over time through greater access to international capital markets, are also discussed. Section III examines evidence on the extent to which the relative importance of real interest rates and cumulated external imbalances as determinants of real exchange rates has shifted in the wake of international financial market integration. Finally, in Section IV, some concluding remarks are made.

## II. 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 substantially eliminated in the major OECD countries. This has facilitated the integration of international financial markets. Financial innovation, spurred by tremendous advances in telecommunications technology, has also 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 array of financial instruments than are likely to be available on domestic financial markets. The level of cross-country integration has also been further facilitated by the 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 have been suggested for quantifying the level of international financial market integration. The different measures suggested (see Appendix 1) do not typically give the same answers. There are a few reasons for this. Some measures are more narrowly based than others in the sense that the array and maturity of the assets implicitly included is restricted. Also, some tests are based on nominal, while others are based on real, magnitudes. Therefore, to obtain a more comprehensive perspective on the degree of the overall level of international financial integration and how this is changing over time, a sensible procedure is to assess the evidence for and against all the measures presented in Appendix 1. These tests are all closely related to one another and one can move from one to another by adding or relaxing, in most cases, a single assumption. Thus, to the extent that different tests (or measures) do not give the same result for a particular country and time period, it may be possible to focus on the assumption whose relaxation is responsible. The following five measures, in descending order of specificity, are proposed: a) closed interest parity and covered interest parity; b) uncovered interest parity; c) real interest parity; and d) a recently proposed test based on the correlation of domestic saving and investment. The extent of international financial market integration as reflected by the first four measures relies on the co-movement of domestic and foreign prices (i.e. interest rates). The final measure, on the other hand, relies on the co-movement of domestic quantities (i.e. investment and national saving ratios).

A. <u>Closed and covered interest parity</u>

In theory any type of disturbance, monetary or real, can create an <u>ex ante</u> international interest rate discrepancy. Divergent monetary and fiscal policies, as well as shocks to the supply side of the economy and technological innovations, can cause yields on comparable assets to move in opposite directions, or to move in the same direction but by varying magnitudes. The extent to which such incipient differences emerge and endure depends on the strength of the international transmission mechanism of such disturbances. This, in turn, depends largely on three main factors, namely, the mobility of capital, the nature of the exchange rate regime in force and the degree of substitutability of assets internationally. Any of these factors could be of more or less importance depending upon the nature of the market in question. Collectively, their importance is likely to grow as we move from the first to the fifth definition of financial market integration suggested above.

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 purest in that, for it to be valid, and in comparison with the other definitions, it requires the least number of conditions to be fulfilled. The only requirement is that the political or (single) country risk premium be zero. However, it is also the most narrowly 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 to which the rates used in the test refer are integrated. In other words, national markets may be partially integrated with world markets so that some assets are priced internationally while others, non-traded assets by definition, are priced predominantly at the national level.

The only reason for deviations from closed interest parity is the existence of a political risk premium. This is to be interpreted very widely here as representing not only existing capital controls and different asset tax arrangements in different political jurisdictions, but also to the prospect that existing barriers and taxes will change in the future (2). 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 (3). Chart 1 displays the differential between the three-month onshore (interbank) - offshore (Eurodeposit interbank) rates for seven OECD countries over periods for which data were available and Table 1 compares average disparities over different sub-periods (4). 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 all these cases the elimination of the differential dates from the moment when capital controls were finally removed (5).

Since the United States was the first of those countries to eliminate capital controls in the early 1970s, it is surprising that differentials have occasionally been quite large since then. The interest differential has, however, been subject to a trend decline throughout the 1980s but still remains fractionally negative (i.e. in favour of offshore deposits). The pattern for the interest rate differential for Switzerland is, in some respects, quite similar to that for the United States. Volatility in the differential has been greatly reduced since roughly 1982 but still remains high relative to that for Japan, Germany, France, the United Kingdom and the Netherlands. Also unlike these countries, the differential is not centred on zero and does not seem to be converging on zero (6). The only large positive interest differentials to emerge are those for Germany, and to a lesser extent the Netherlands, in the early 1970s, and Japan in the late 1970s. A higher interest rate locally than offshore indicates barriers preventing capital inflows. France and Germany provide an interesting contrast in this respect. Except for the period over which convergence is achieved, the French differential is almost invariably negative, at times substantially so, indicating that controls were preventing capital flight. For Germany the differential is predominantly, and sometimes substantially, positive, indicating that controls were preventing capital inflows.

A clear-cut message emerges visually from Chart 1. Financial markets can be said to be virtually fully integrated by the closed interest parity criterion. Comparative econometric tests of interest parity for the pre- and post-capital controls periods to prove the point further seems almost superfluous.

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 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 (as shown in Chart 1) (7). Covered disparities between U.S. and other countries' three-month treasury bill rates are graphed in Chart 2. 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 has been greatly reduced for most, though not all, currencies.

B. Uncovered interest parity

Abstracting from broad political risk, yield differentials between financial instruments denominated in different currencies incorporate market forecasts of the relevant exchange rate over the future time horizon corresponding to the maturity of the asset. In addition, since market participants know that this exchange rate is unlikely to be predictable with much accuracy they will, if risk-averse, expect to be compensated for this uncertainty if they are to be induced to buy the foreign-currency denominated asset. Political risk aside, these are the two major factors which drive a wedge between domestic currency nominal interest rates on comparable assets. Time-series plots of uncovered nominal interest rate differentials on comparable assets display no tendency to converge over time. They have, if anything, widened since the fixed exchange rate period of the 1960s (see Kasman and Pigott, 1988). Their failure to converge cannot be attributable to political barriers, as is evident from the tabular and graphical analysis of dramatic reductions in closed and covered interest rate disparities over time (see Charts 1 and 2 and Table 1). Therefore, the failure of uncovered interest differentials on comparable assets denominated in different currencies to converge over time must be largely due to currency considerations.

Ignoring political factors and assuming risk neutral transactors uncovered interest parity states that the domestic nominal interest rate equals the foreign nominal rate on a comparable asset plus the expected change in the exchange rate over the period to 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 (8). The null hypothesis of uncovered interest parity is unanimously rejected virtually without exception. The agnostic inference following from this is that either expectations are not rational, a time-varying risk premium exists or both conditions prevail. Indeed the rejection of the null hypothesis is also consistent with a host of other phenomena such as bubbles, bandwagon effects and peso effects.

The failure of uncovered interest parity to hold, therefore, may not provide a clear insight into the degree of international financial market integration. The latter, however, may be conducive to greater variability of nominal and real exchange rates through inefficient expectations episodes or time varying risk premia. This issue is taken up to some extent in Section III below, in the context of influences on real exchange rates, and evidence concerning uncovered interest parity is surveyed in Appendix 2.

C. 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. For this reason it is arguable 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 be equal, or to move to equality rapidly after a disturbance. This requires both uncovered interest parity and *ex ante* purchasing power parity to be valid (see Appendix 3 for an algebraic treatment). If the real rate of interest in an economy is caused by, and moves *pari passu* with, the real rate in the rest of the world, domestic monetary policy would be unable to drive a wedge between them and hence could not influence the levels at which national and foreign savings are equated to investment, nor the *ex post* real exchange rate at which this occurs. This possibility highlights the importance of investigating the extent to which real rates in different countries are forced to move in harmony by international arbitrage.

Ex ante real interest rate estimates

The statistical method employed to estimate *ex ante* real interest rate is explained in Appendix 3 of the paper. The estimates are displayed graphically in Chart 3. The rates are those for three month treasury bills in all countries (9). It is immediately apparent from Chart 3 that the United States rate underwent a major structural break approximately at the end of the 1970s. The pattern of the estimates over time are largely in accordance with those reported by Cumby and Mishkin (1986), who find that the three month domestic money market rate was either slightly negative or close to zero for most of the 1970s, but strongly positive from about the start of the 1980s until mid-1983 (when their sample ends). This structural break coincided with a policy move by the Federal Reserve away from interest rate to non-borrowed reserves targeting in October 1979. These higher real rates in the 1980s have been attributed to many factors. Those which are most often cited are expansionary fiscal policy combined with contractionary monetary policy, improved profitable investment opportunities, reduced saving propensities and an increasingly uncertain economic environment resulting in higher risk premia being built into nominal and real interest rates. Real interest rates were also abnormally low in the 1970s, as the first oil shock lowered investment demand and increased saving as resources were transferred from relatively high consuming OECD countries to OPEC (see Hendershott and Peek (1989)). The estimated real rate for the United States also displays much greater variability for the 1980s compared to that for the period 1975 to 1979. The maximum real rate estimate for the United States is 6 per cent, which was attained twice during the 1982-1983 period. This maximum estimate falls a good bit short of the maximum (almost 10 per cent) reported by Cumby and Mishkin, who used equivalent maturity domestic money market rates.

Japan also experienced an upward shift in the real short-term rate of about fifty basis points in 1982. While the broad trend in the Japanese rate is similar to that for the United States, there appears to be considerable scope for short-term independent variation. Before 1986 U.S. and German real rates move independently of each other. Subsequently these two rates seem to co-vary much more closely, however. Both the German and French rates fell very substantially in the second half of 1981 and, although the German rate has hovered around an annual rate of 4 per cent since then, the French rate was subject to a persistent upward trend during the rest of the 1980s reaching almost 8 per cent by the end of the 1980s. The Italian real rate also increased, though more slowly, through the 1980s to reach roughly the same level as the French rate in early 1990. The U.K. rate was quite volatile between 1974 and the end of the 1970s. From approximately 1984 onwards the rate has fluctuated around an average of about 1 1/2 per cent.

Between 1974 and the early 1980s the pattern of movement between the U.S. and Canadian rates was very close, with the Canadian rate, nevertheless, being almost always in excess of the U.S. rate, sometimes by a margin of almost 100 basis points. Thereafter the long-run linkage between these rates remains strong but short-run changes are not so closely synchronised. The rate for the Netherlands became substantially positive around 1978, earlier than for other countries, and in the 1980s its pattern of behaviour is also different.

<u>Tests of real interest parity</u>

Results of econometric tests for the co-movement of real rates with those of the United States are reported in Table 2 and with those of Germany (for EMS countries) in Table 3. 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 $\gamma$ coefficients. The equations for rates <u>vis-à-vis</u> the United States were estimated for three time periods. The first period (August 1974 to October 1979) and the second period (November 1987 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 were a reliable measure of the degree of international financial market integration, then one would expect to observe a stronger regression relationship and higher values of $\gamma$ in the second compared to the first period.

The hypothesis of no linkage between real rates in the United States and those in other major OECD countries in the first sub-period is rejected for all countries except Germany (10). The hypothesis that rates were fully linked cannot be rejected for Italy, the United Kingdom, the Netherlands and Switzerland. The estimated $\gamma$ is significantly greater than one for Canada and significantly less than one, although significantly different from zero, for Japan and France. The same equations estimated for the 1980s sees the $\gamma$s fall in value in all instances and, in some cases, dramatically. 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 Germany. Estimating this same relationship from January 1986 to the end of the sample period at February 1990 indicates a strengthening of the relationship for Japan, Germany (which becomes significantly positive at 0.595), the United Kingdom (fractionally increased), Canada and Switzerland (where $\gamma$ is now not significantly different from one). On the other hand, however, $\gamma$ for France falls from 0.424 to zero, while that for the Netherlands and Italy fail to show any improvement.

The existence of the EMS and closer monetary policy co-operation between European countries might suggest closer linkages between European rates than between U.S. and European rates. Tests are carried out and are reported in Table 3 using Germany as the base country. 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 (third period). This last period was chosen somewhat arbitrarily on the basis of an inspection of the graphs in Chart 3. The results are mixed. In conformity with those in Table 2 the weakest results are again for the second period. With the exception of the Netherlands, the strongest links are between Germany and the two countries in the sample who are not members of the exchange rate mechanism of the EMS, namely the United Kingdom and Switzerland.

The hypothesis that German and Swiss rates are fully linked ($\gamma$=1) cannot be rejected for any of the three periods (11). The hypothesis that $\gamma$=1 cannot be rejected for the United Kingdom, the Netherlands or Switzerland for period three. For the first period $\gamma$=1 only for Switzerland and is significantly in excess of one for the United Kingdom and the Netherlands. For France and Italy there is no evidence of increased linkage over time by this measure.

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 consisent and substantial progress. This is particularly true if the comparison is between the 1970s and all of the 1980s, but less so if the comparison is with the latter half of the 1980s. This finding applies equally to Europe, where the degree of integration in the first half of the 1980s is reduced compared to that which existed in the 1970s. The level of integration of the 1970s was only re-established in the latter half of the 1980s (see Caramazza _et al_. (1986) for a similar conclusion) (12). These results contrast strongly with the evidence on progress in the liberalisation of capital movements in the OECD area, which has been quite spectacular in the 1980s. It also contrasts with evidence presented above of dramatic reductions in closed and substantial reductions in covered interest disparities, which for most large OECD countries now fluctuate randomly within a very narrow band close to zero. The unavoidable conclusion from this conflicting evidence is that the degree to which real interest parity holds has little to do with the level of international financial market integration. The evidence is, however, consistent with some influence of the monetary policy regime on the degree to which real interest parity holds.

Real interest parity has been rejected in the bulk of empirical tests. Its failure has been attributed by some (Dornbusch (1976) and Mussa (1982) for example) to sticky prices causing deviations from purchasing power parity which can, in principle, endure for a long time. Others (Roll (1979), Frenkel (1981), Adler and Lehman (1983), Darby (1981), Mishkin (1984)) infer that deviations from purchasing power parity 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 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. Yet others (Branson (1979) and Girton and Henderson (1977)) account for real interest disparities by deviations from uncovered nominal interest parity. In sum, even if uncovered interest parity were valid (and here the evidence is virtually unanimously negative), real interest parity will hold only if ex ante purchasing power parity holds, or, in other words, if the relative price of national outputs follows a martingale process.

One of the more sophisticated recent tests (Cumby and Mishkin (1986) who's test is employed above) 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 dependence in real interest rate movements across countries, there remains considerable scope for independent national stabilisation policies. However, this conclusion has to be tempered by the consideration that past independent movements in national real interest rates may be more a manifestation of relative commodity price movements arising from real shocks to the economy, and less a symptom of the independent exercise of national monetary and fiscal policies.

The bulk of econometric work tests only for a contemporaneous relationship between real interest rates across countries. Doing so, using high frequency point-in-time monthly data (as in Cumby and Mishkin, and in the tests performed herein, for example) may therefore be quite restrictive since there may be a tendency for national real rates to converge over time. This is likely to be the case if real interest disparities are caused exclusively by prolonged, but nonetheless temporary, deviations from purchasing power parity on account of price sluggishness. Modjtahedi (1987) used a methodology that allowed for dynamics in real interest rate adjustment across countries. Although he found significant contemporaneous correlation between ex ante real rates, these seemed to be mutually independent in the long run. More specifically, he finds that an unanticipated rise in the U.S. real rate causes foreign nominal interest rates and inflation rates to respond in the same direction, and by the same amount, leaving foreign real rates largely unchanged. The increase in the U.S. real rate is seen as increasing foreign nominal rates through conventional portfolio channels and foreign inflation through currency depreciation, yielding a net result of, at best, unchanged foreign real rates.

## D. The correlation of domestic saving and investment rates

The final definition of the degree of international capital mobility was initially proposed by Feldstein and Horioka (1980). The intuition behind this measure is apparently simple. A high correlation between national saving and investment implies that domestic investment is being crowded out by a shortage of home saving. 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. Foreign savings are thus not internationally mobile. This is essentially the result reported by Feldstein and Horioka.

More precisely, they 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. In a recent update of this work, 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 falling, the coefficient for the 1980 period in particular is much higher than one might reasonably expect in a context of world-wide 24-hour-a-day financial markets mobilising the world's savings pool, and directing it to the areas where the most attractive investment opportunities are to be found irrespective of political boundaries.

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, the latter's original findings seem to be reasonably well sustained (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 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. Frankel, in a recent (1989) review of the research on the domestic savings-investment relationship, summarises by saying that "the evidence if anything showed the coefficient rising over time rather than falling" (15).

This conclusion is consistent with the evidence provided herein that virtually all countries examined moved further from real interest parity in the 1980s than was the case in the 1970s. Caramazza et al. (1986) arrive at a similar conclusion. If the strength of the regression relationship between saving and investment rates were a valid measure of the degree of capital mobility, one might reasonably expect to find a weakening regression relationship as the sample period is updated from the early 1970s to the present, reflecting the effects of international financial market deregulation and innovation.

In sum, if there is no arbitrage mechanism tying the domestic to the exogenous foreign real interest rate, then there is no reason to expect national saving and investment rates to move independently of each other even in the currently prevailing context of negligible deviations from closed or covered interest parity.

Recall that the two building blocks of real interest parity are uncovered nominal interest parity and ex ante purchasing power parity. The professional consensus is that there are large deviations from the former. The latter has been subject to more detailed scrutiny in recent years. It is unanimously accepted that purchasing power parity does not hold in the short run. The debate is consequently about whether deviations from purchasing power parity are corrected in the long run or not at all. This is equivalent to the issue of whether the real exchange rate follows a random walk, or whether it returns over time to some fixed value, i.e., the long-run equilibrium real exchange rate. Using unit root tests (16), different researchers have found different results. Roll (1979), Adler and Lehmann (1983), Huizinga (1987), Meese and Rogoff (1985), for example, were unable to reject the random walk model for the real exchange rate. Cumby and Obstfeld (1984) rejected the random walk model for the U.S.-Canadian real exchange rate using monthly data. Frankel (1989), using 119 years of data on the sterling/dollar real exchange rate, discovered a statistically significant tendency for the real exchange rate to regress to purchasing power parity, but at a very slow rate of 16 per cent per year (17). The undisputed failure of short-term purchasing power parity to hold can, by itself, easily account for the failure of real interest parity for short-term maturity assets as in the tests reported above. Indeed, more generally, real interest parity based on instruments of any arbitrary maturity will not hold unless the relative price of non-traded goods is expected to remain constant over the maturity of the assets on which the test is based.

Murphy (1986) draws attention to the important role played by non-traded goods from a different angle. He demonstrates that the correlation of changes in saving and investment following an unanticipated productivity disturbance depends on the relative capital-labour factor intensifies in the traded and non-traded goods sectors. For a positive productivity shock in either sector, saving and investment will tend to move together (apart) when the non-traded goods sector is capital (labour) intensive. In this model a variety of relationships between national saving and investment can occur in a context of perfect capital mobility. Engel and Kletzer (1989) also demonstrate a result similar to that of Murphy. In their model investment and consumption dynamics are related because current domestic demand and output of non-tradeables must be equal and the latter, in turn, depends on the level of the capital stock. Hence the co-movement of national savings and investment (18). Wong (1990) also demonstrates a positive correlation between saving and investment in a dependent economy world facing perfect capital mobility, but without relying on assumptions about different factor intensities between the traded and non-traded sectors (19).

These results of Murphy, Engel and Kletzer and Wong are again unfavourable to Feldstein's and his collaborator's interpretation of the saving-investment relationship as reflecting 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 purchasing power parity for traded goods is fully established within the duration of the typical business cycle. The key assumption is therefore an implicit one about commodity markets rather than financial markets. Indeed it is a relatively simple exercise to demonstrate that in a world without non-traded goods, perfect capital mobility implies that savings and investment are uncorrelated and that real interest parity holds.

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 some 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.

## III. CAPITAL MARKET INTEGRATION, REAL EXCHANGE RATES, REAL INTEREST RATES AND EXTERNAL IMBALANCE

Provided the right measures of international financial integration are employed -- those which do not confuse financial and goods market integration -- the preceding section demonstrated that international capital flows have become increasingly more mobile in the 1980s. In this section some macroeconomic consequences of this process are explored by examining the implications for interrelationships between real exchange rates, external imbalances and real interest rates. Two issues are of interest:

i) the extent to which unexplained variations in the real exchange rate due to changes in fundamentals or to time varying exchange risk premia or market inefficiencies (bubbles, noise trading, peso problems, etc.) -- the relative importance of which may have changed as a consequence of financial liberalisation; and

ii) the extent to which international financial market integration has altered the relative importance of real interest differentials and cumulated current account balances as fundamental influences on real exchange rates.

### A. Background

The distinction between fundamental influences on the real exchange rate (i.e. those expected on the basis of standard theories) and unexplained residuals can best be addressed with cointegration techniques.

If the real exchange rate is assumed to adjust towards its flexible price equilibrium value and if uncovered interest parity holds, it is relatively straightforward to show that the real bilateral exchange rate depends on:

-- the expected current equilibrium real exchange rate;

-- the real interest rate differential; and

-- the speed with which the real exchange rate is expected to adjust towards its equilibrium value (20).

The current equilibrium real exchange rate, in turn, is that consistent with balance of payments equilibrium. That is, given trade elasticities and the speed with which portfolio holders desire to adjust towards long-run sustainable levels of net foreign assets, this is the real exchange rate where the associated external imbalances are financed (21). In forward-looking markets this current equilibrium real exchange rate also influences market expectations about future rates.

These models (often referred to as Dornbusch-Frankel or Hooper and Morton models) relate the bilateral real exchange rate to the real interest rate differential, the cumulated current account balance of one country versus that of the other, and a constant term capturing the long-run equilibrium real exchange rate. Meese and Rogoff (1985), in following up their earlier paper on the out-of-sample forecasting properties of standard exchange rate models, extended their analysis to this type of real exchange rate equation. They found the theoretically anticipated sign in most cases, but a lack of statistical significance and hence explanatory power when using the equations for forecasting. They further investigated the associations between real exchange rates and real interest differentials by testing for co-integration between these variables. Their tests over the period 1974 to 1984 (using monthly data) suggested that these variables were not co-integrated, 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 (22).

Reasons often cited for the failure of a broad range of exchange rate models are (23):

-- estimation problems associated with imposing inappropriate constraints, peso problems in the data which give rise to unusual expectational episodes and simultaneity problems;

-- mis-specification of the models because of non-linearities in the data generating mechanism (24), or omitted variables; and

-- mis-specifications resulting from the failure of uncovered interest parity (an important building block for most of these models) to hold, because of time varying exchange risk premia, political risk associated with barriers to cross border flows of capital, or because expectations are not rational.

The co-integration techniques used by Meese and Rogoff, because they are independent of any particular structural hypothesis, permit many of the problems in the first two sets of issues to be avoided. However, most previous work in this area attempts to test whether the real exchange rate is co-integrated with real interest differentials, or other variables, separately, i.e. with only one explanatory variable (25). If both the real interest differential and cumulated current account balances are integrated processes of order one, and if both influence the real exchange rate independently, as theory would suggest, then omission of either from the co-integrating regression may lead to false conclusions about the null hypothesis. By including both real interest rates and balance of payments factors in the co-integrating regression, it is possible to minimise the risk of accepting the null hypothesis of no co-integration incorrectly because important fundamental variables are omitted, while still remaining agnostic about specification issues.

The finding of co-integration or its absence gives important insights into the issues flagged earlier. The behaviour of the residuals in the co-integrating regression will cause the hypothesis of no co-integration to be accepted if links with fundamentals are tenuous and country premia, time-varying risk premia and inefficient expectations cycles dominate. How these residuals behave over time as capital controls are reduced is of interest, as is any change in the relative importance of real interest differentials and cumulated current account balances in the co-integrating regression.

B. Empirical implementation

In the light of the above discussion, the co-integrating regression used here includes the long-term real interest differential -- which has had most success in obtaining significant and correctly signed estimates (26) -- and divergences between cumulated current account balances, which introduce forward-looking expectations about real exchange rates associated with balance of payments sustainability in the longer run. Inclusion of both variables, by reducing the risk of a key omitted variable, implies that unexplained variability of the real exchange rate is more likely to be associated with country risk premia (capital controls), time varying exchange risk premia, or inefficient expectational episodes not based on forward-looking balance of payments factors. By attempting to allow for the presence or absence of capital controls and political risk (lack of financial integration), some appreciation of the relative importance of these factors and how they might have changed over time is obtained.

Allowance for changes in the degree of international financial integration is made in two ways:

i) Most capital controls associated with divergences from closed and covered interest parity (see section II) are associated with the 1970s for most major currencies such as the dollar, the yen, the Deutschemark and sterling. In the case of the French franc such divergences were still important to the mid-1980s. Co-integration and error correction tests may be conducted for the full sample period, and for periods when such divergences were important (27).

ii) Deviations from covered interest parity (a measure of the country premium) may be allowed for directly in the co-integrating regression.

These issues are explored by testing the following four null hypotheses:

Hypothesis 1: that the real exchange rate is not co-integrated with real interest differentials and cumulated current account balances over the full sample period (ignoring country risk).

Hypothesis 2: that the real exchange rate is not co-integrated with fundamentals in the 1970s when capital controls and political risk factors were high.

Hypothesis 3: that the real exchange rate is not co-integrated with fundamentals over the 1980s or periods when capital controls and political risk factors in most countries were low.

Hypothesis 4: that the real exchange rate is not co-integrated with fundamentals, after allowance for deviations from covered interest parity as a proxy for changes in country risk premia, over any sample period.

The alternative hypothesis in each case is that the real exchange rate is co-integrated with fundamentals.

The currencies tested involve five major countries, the United States, Japan and Germany, the United Kingdom (given its importance as a major financial centre) and France (as representative of an EMS country). For the three major countries the bilateral rates of the yen (Y/\$) and the Deutschemark (DM/\$) against the dollar are considered. Since balance of payments equilibrium considerations underlie the inclusion of cumulated current account terms, the pound sterling (£/DM) and the French franc (FF/DM) bilateral exchange rates with the Deutschemark are considered (28). Quarterly data is used over the sample period 1971Q3 to 1989Q4 (unless otherwise specified), and this is also broken into two sub-periods for each country, reflecting an assessment of when covered interest disparities became an order of magnitude smaller in the sample period.

The co-integrating regression and ADF test equation are set out in Appendix 4. Depending on the significance of the constant term and the time trend in the latter, co-integration is assessed by the significance of the parameter on the lagged error term from the co-integrating regression. Critical values for the t-statistics are presented in Phillips and Ouliaris (1988). Since the ADF test is only valid asymptotically, it is also useful to cross check the results with other tests. In particular, it is useful to check whether the data generating process has an error correction form -- co-integration and error correction being asymptotically equivalent concepts. Results for the co-integrating regression, the ADF and the error correction tests are set out in full in Appendix 4. A summary of these results is provided in Table 4.

C. Results

Results for the full sample (when no allowance is made for deviations from covered interest parity) -- hypothesis 1 -- are shown in the first column of Table 4. In all cases the real interest differential and the cumulated current account balances are of the correct sign in the co-integrating regression, and most are significant at the 5 per cent level according to a standard t-test (except the current account term for the £/DM rate). The ADF statistic suggests that the null hypothesis is rejected at the 5 per cent level for the Y/\$ rate and the FF/DM rate, and at the 10 per cent level for the £/DM rate. It was not possible to reject the null hypothesis at the 15 per cent level for the DM/\$ rate. However, the error correction test rejects the null hypothesis that the data generating process does not have an error correction form in all four cases.

Results for the 1970s -- hypothesis 2 -- suggest a somewhat different picture. The real interest differential and the cumulated current account term again have the correct sign and in nearly all cases are significant at the 5 per cent level (excepting the real interest rate term for the £/DM rate). However, the size of the coefficient on the cumulated current account term is an order of magnitude larger than for the full sample. The ADF statistic accepts the null hypothesis of no co-integration for the DM/\$ real exchange rate, while rejecting it at the 5 per cent level for the Y/\$ rate and the FF/DM rate, and at the 15 per cent level for the £/DM rate. The error correction tests confirm that the data generation process has an error correction form in all cases (reversing the ADF finding for the DM/\$ rate).

Results for the 1980s -- hypothesis 3 -- show a significant change in the relative importance of the real interest differential and the cumulated current balance term. In all cases the coefficient on the former is higher in the 1980s, while that on the latter is markedly smaller. The ADF statistic rejects the null hypothesis of no co-integration for the Y/$ and DM/$ real exchange rates at the 10 per cent level, while this rejection is achieved at the 15 per cent level for the £/DM rate. (The data are too short to interpret the second half of the 1980s for the FF/DM rate.) The error correction coefficient suggests that the data generating process has an error correction form in all cases at the 5 per cent level.

Finally, results where some allowance is made for deviations from covered interest parity in the co-integrating regression -- hypothesis 4 -- are shown in the last three colums of Table 4. In principle, this disparity could be deducted directly from the real interest differential term, if covered disparities referred to contracts of a maturity equal to that of the long-term interest rates. Since no such markets exist, three month covered disparities are included separately in the co-integrating regression as a proxy for quarters in which political risks may have been subject to change (the estimates of this term which are typically significant and of the expected sign (not reported)). These results are consistent with the importance of changes in capital controls for the DM/$ and £/DM rates. The inclusion of this term often, though not always, increases the signfiicance of the ADF and error correction coefficient -- i.e. increases the confidence with which the null hypothesis can be rejected -- over the full sample period and over the 1970s, but not over the 1980s. For the 1970s, when capital controls were more important, inclusion of this term reduces the standard errors of the equation substantially, while the Durbin Watson statistics rise. Sufficient data were not available to carry out these tests for the Y/$ rate. Inclusion of the term makes little difference to the FF/DM results, possibly because of the participation of both currencies in fixed exchange rate arrangements -- political risks are not reflected in differences between spot and forward exchange rates except immediately prior to realignments.

Two characteristics of the findings are of particular interest for considering the impact of international financial integration on real exchange rate dynamics. First, in contrast to other studies, support is found for the proposition that real exchange rates are cointegrated with fundamentals. This finding appears to derive from the inclusion of more than one explanatory variable -- particularly the real interest differential and cumulated current account balances -- in the co-integrating regression. Deviations of the real exchange rate from fundamentals have a clear tendency to revert back. The unexplained residuals may, nevertheless, be large and/or persistent.

Second, the full sample results -- which give a better estimate of the cointegrating vector -- consistently show a much smaller coefficient on the cumulated current account term and a higher coefficient for the real interest terms compared to the shorter sample results for the 1970s. When more than one explanatory variable is used in the co-integrating regression, the co-integrating vector need not be unique. Indeed, the robustness of the ADF statistic to stationary measurement error allows the co-integrating vector to consist of random (covariance stationary) variables -- it need not be constant for the entire sample period (29). As these changes in parameter values appear to be significant according to a conventional Chow test, it seems likely that the co-integrating vector has changed between the two regimes of capital controls and full integration of financial markets. Reasons why this finding is so universal amongst countries that have liberalised international financial markets -- i.e. the possible nature of the stationary measurement error across different capital control regimes -- is of interest in considering possible changes in the international adjustment process in the 1980s.

Each of these two issues is discussed in turn.

D. Fundamentals and unexplained residuals

Chart 5 shows the residuals from the co-integrating regression based on the real interest differential and cumulated current account terms for all four currencies. The shorter lines, where relevant, refer to the residuals for the co-integrating regression which includes deviations from covered interest parity, as a proxy for changes in political risk, and which is estimated over the 1970s only. They are an alternative estimate of the residuals for the period in which financial integration was more limited.

A number of interesting phenomena can be observed from the charts. In discussing these it is helpful to separate the case of the Y/$, DM/$ and £/DM rates from the FF/DM rate. This is because France has maintained capital controls for much longer than the other countries and its exchange rate with the DM has been affected by the "snake" and EMS arrangements in the 1970s and 1980s, respectively. This is of interest in its own right, and is taken up separately below.

The dollar, yen, Deutschemark and sterling

A first observation is that there are systematic swings in the unexplained residuals of the co-integrating regression which can be of considerable orders of magnitude for the Y/$, DM/$ and £/DM real exchange rates. Thus in the first half of 1985, the period in which Krugman (1985) first identified a significant overvaluation of the dollar:

-- the Y/$ residuals rise to around 20 per cent; and

-- the DM/$ residuals rise to around 24 per cent,

suggesting a considerable appreciation in the dollar not attributable to real interest differentials or cumulated current account balances. These episodes are not unique. Thus the strength of both the yen and the Deutschemark against the dollar in 1980 and 1988, and their weakness in 1989, substantially exceed that which can be exaplained by fundamentals. Similar comments apply to sterling:

-- the £/DM residuals fall to around 34 per cent in 1981 and to 14 per cent in 1989 suggesting unexplained real strength of sterling against the Deutschemark; and

-- they rise to around 22 per cent in early 1987 suggesting unexplained weakness.

Second, consistent with the ADF and error correction results, the residuals follow a typical first order autoregressive process. While inefficient expectations episodes or time-varying risk premia may drive exchange rates away from fundamentals, there is always a tendency to revert back. Diverging bubbles, for example, always have a tendency according to the cointegration results to collapse back towards fundamentals. This raises the interesting policy issue of whether fluctuations away from fundamentals need be of concern if they always correct themselves in the end. In this context, it is worth examining the error correction coefficients in Table 4 which give some idea of the mean lag for the reversion process. For the full sample, these lie within a range of -0.08 to -0.22, or roughly 6 to 13 quarters for most of the adjustment to take place. A visual inspection of the chart also suggests the presence of large and persistent deviations from fundamentals, particularly in the 1980s. These may be associated with important misalignments of the relative prices on which business decisions are taken.

Third, the size and persistence of the residuals is typically smaller in the 1970s when integration of international capital markets was more limited. This is particularly so if the co-integrating regression for the shorter sample which allows for changes in political risk is considered. Both the amplitude and persistence of the residuals for the shorter broken line (where presented) are, respectively, smaller and shorter. These visual impressions are confirmed more formally by the results in Table 4. The error correction coefficients are typically larger when estimated for the 1970s, and imply a mean lag of only three or four quarters. If the co-integrating regression includes the deviations from covered interest parity term, this lag shortens to around 1 1/2 quarters for the DM/\$ and £/DM rates.

This suggests that the large swings in real exchange rates in the 1970s were more readily explainable in terms of swings in observed fundamentals and/or political risks. In the 1980s similar very large swings in real exchange rates cannot be explained in terms of swings in country premia -- which to all intents and purposes have been eliminated. While real exchange rates remain co-integrated with fundamentals, other factors (inefficient expectations episodes, time-varying exchange risk etc.) appear to have become more important. This is consistent with the overwhelming evidence rejecting uncovered interest parity for sample periods including the 1980s, which is surveyed in Appendix 2. Recent evidence (e.g. Frankel and Froot (1989)), tends to suggest that inefficient expectations episodes dominate time-varying risk premia as explanations of this phenomenon.

<u>The FF/DM rate: smaller deviations from equilibrium within the band</u>

In the case of the FF/DM rate there are marked differences in comparison to the results for the other currencies. First, the amplitude of the cycle of the residuals is typically smaller -- as is also reflected in the smaller standard errors for the full sample co-integrating regression results reported in Table 4. Second, the persistence of the residuals is much shorter -- as is also reflected in the much higher error correction coefficient (compared to the other currencies over this period) of -0.34, implying a mean lag of only 3 quarters. Third, the chart gives a clear visual impression that the amplitude of the cycle in the residuals has damped over time.

These striking results appear to have less to do with capital controls than with France and Germany's participation within the EMS. The residuals from the co-integrating regression appear to have become smaller even after 1983, when closed and covered interest parity measures presented in Section II suggest that country risk associated with capital controls became relatively small. This is consistent with the notion that inefficient expectations cycles and time-varying exchange risk premia may be exchange rate regime dependent. In particular, it is consistent with the view that a credible target zone for the nominal exchange rate exerts a stabilising influence on real exchange rate movements (see Krugman, 1986). The EMS target band arrangement appears to have been particularly effective in reducing unexplained variance and large misalignments in the real exchange rate.

E. The relative importance of fundamentals in integrated international capital markets

The results presented in Table 4 suggest that more liberal international capital markets have been associated with a decline in the importance of cumulated current account balances and an increase in the importance of real interest rates as influences on real exchange rates. This finding has implications for the process of external adjustment in the world economy.

While the arguments are set out more formally in Appendix 4, the intuitive idea behind this reasoning can be understood by considering the limiting case of financial autarky, where capital is completely immobile. In this world the only sustainable current account balance is zero. Temporary imbalances may be endured to the extent that official reserves can be built up or run down, but otherwise liquidity constraints are quickly binding. The real exchange rate adjusts to ensure that external balance holds at all times, while the real interest rate ensures that domestic savings equals domestic investment. Any ex ante tendency for the cumulated current account balance to rise must generate an appreciation of the equilibrium real exchange rate and vice versa. Consistent behaviour of expectations would see agents expecting only very short-lived divergences between spot and current equilibirum real exchange rates.

In this world real interest differentials have zero impact on the real exchange rate, and the impact of cumulated current account balances is dominant. As capital controls are removed and markets become more integrated this situation changes. With fully integrated markets country premia disappear, and covered interest arbitrage implies zero exchange risk. Borrowers need to meet a long-run solvency constraint (see Appendix 4), but there is no binding liquidity constraint prior to this. Since portfolio holders are prepared to allow cumulated current accounts imbalances to diverge from long-run sustainable levels to finance savings investment imbalances, the speed of adjustment to long-run external balance is reduced. There is no need for the exchange rate to adjust to maintain external balance at all points in time. Thus a rise in the cumulated current account will have a smaller impact on the current equilibrium real exchange rate. At the same time, real interest rates do not have to ensure that national savings equals investment, and real interest differentials come to play a more important role in influencing the direction of capital flows (and hence the real exchange rate).

The results reported in Table 4 for the 1970s appear consistent with an intermediate regime of relatively but not completely, immobile capital. There is a small role for real interest differentials for most currencies, though not for the £/DM rate, and the cumulated current account term has a relatively large coefficient. As capital controls are removed and markets become more integrated, the relative importance of the cumulated current account and the real interest differential changes in exactly the manner expected by the above reasoning. This change cannot continue to the point where current balance terms are zero, however, because solvency constraints become binding at some point.

This finding has important implications for the nature of external adjustment and the need for international policy coordination. Since real interest rates have a greater impact on real exchange rates in financially integrated markets, either increased investment opportunities or reduced savings behaviour can lead to real appreciation (and vice versa). This, in turn, will be associated with a deterioration in external balance, the feedback of which to real exchange "corrections" is weakened. External imbalances, therefore, may become larger and more persistent. In general terms this should not be of interest to policymakers, in the sense that it simply reflects the balance of investment opportunities and the preferences of consumers (savers), and therefore represents welfare-enhancing portfolio capital flows.

There is a sense, however, in which such developments may be of concern. If imbalances reflect investments in profitable projects that promise a future reversal of the cumulated current account deficit, it is unlikely that solvency constraints will ever become binding. If, on the other hand, they reflect inappropriately low levels of saving:

- either excessive government dissaving reflected in high budget deficits; or

- private savings because of myopia, or tax distortions and financial regulations that discriminate between consumption and saving;

solvency constraints are more likely to become binding as cumulated current account balances continue to grow. This could see important discontinuities in the importance of the cumulated current account as an influence on real exchange rates, from which would follow possibly substantial changes in the latter. Since real exchange rates are an important relative price upon which investment decisions are based in both deficit and surplus countries, prolonged imbalances that do not reflect profitable investment could ultimately be costly.

## IV. CONCLUDING REMARKS

The evidence presented in Section II is consistent with increasing integration of world financial markets throughout the 1980s. Given the lack of integration in goods markets, however, there is no reason for this to be associated with real interest parity, at least in the short run. The process of integration has, at the same time:

- increased the importance of real interest differentials as an influence on the real exchange rate, and reduced the impact of cumulated current account balances; and

-- been associated with substantial and more persistent movements in real exchange rates which, while always reverting back towards the level based on fundamentals, cannot be fully explained by them.

With regard to the first of these, a case can be made for co-ordinating fiscal policies, financial regulations and taxation arrangements to avoid unwanted shifts in savings and investment patterns which influence the real exchange rate via their impact on real interest rates. This does not require the authorities to take a view on the appropriate real exchange rate -- provided criteria exist by which appropriate fiscal and regulatory policies can be formulated. The real exchange rate could then be left to the market, if unexplained movements in the exchange rate could be judged relatively unimportant. The evidence here, however, was not reassuring.

If unexplained residuals are large, a case can also be made for co-ordinating monetary policy and intervention strategies to avoid inefficient expectations episodes. This, however, does require the authorities to take a view on the appropriate level of the real exchange rate, i.e. that based on fundamentals. The problem here is one of signal extraction, i.e. identifying episodes of inefficient expectations at work when they are actually happening. Identifying these in retrospect when the state of fundamentals is known with greater certainty is difficult enough. Recommending policy intervention to burst a putative bubble is more problematic, given the difficulty of identifying explained and unexplained behaviour in a timely fashion. Thus if the real exchange rate were appreciating because of reduced national savings or higher investment, the attempt to stabilise the real exchange rate through easier monetary policy in the mistaken belief that it was due to a bubble would be inflationary.

Success with such co-ordination may, however, depend on the comprehensiveness of the approach. Thus a target band arrangement anchored by low-inflation monetary policy in a currency union may be more successful than sporadic attempts at co-ordination. Thus the experience of France within the EMS suggests that co-ordination through targeting the exchange rate does reduce inefficient expectational cycles, while inflation over the 1980s was substantially reduced -- although the question of whether this might somehow lead to inferior fundamentals was not addressed. Whether such arrangements would be applicable to a broader range of countries, however, will depend on the likely importance of savings and investment shocks. These, as already noted, can generate inappropriate (inflationary) monetary policy responses under an exchange rate target band arrangement. Differential real shocks between countries (which may have been relatively small between France and Germany in the second half of the 1980s) weaken the case for target bands -- depending of course on the size of the shocks and the width of the bands. This, of course, underlines the case for co-ordinating fiscal and other policies that may be a source of such problems.

## NOTES

1. See Bryant (1989).

2. 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.

3. Inhibited 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.

4. The duration of the time periods displayed in the graphs coincides broadly with the periods for which the relevant Euromarket existed.

5. Given a sufficiently strong incentive, methods can be devised for circumventing exchange control arrangements particularly in the context of rapid financial innovation. Hence some convergence of domestic and foreign interest rates may occur even with exchange controls in force (see, for example, Browne and McNelis, 1990).

6. Banks may not encounter the same costs onshore and offshore. One source of differential costs is differences in reserve requirements. Caramazza *et al*. calculate an effective cost differential for the United States *vis-à-vis* the Eurocurrency market, where reserve requirements are generally lower, to be 0.52 per cent on average for the period June 1973 to June 1985.

7. 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 those limited number of countries for which Eurodeposits are issued in its 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.

8. 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.

9. Standard errors have yet to be fitted to these estimates. 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.

10. For reasons explained in footnote (9) the sample division for Japan and Italy is different than that for the other countries investigated. It is respectively May 1978 to May 1984 and November 1979 to January 1985.

11. This contrasts with the results of Cumby and Mishkin who found, in the same sample of countries with the same base country but using domestic money market rates rather than treasury bill rates, that Switzerland had the lowest, albeit still a significant value, for the January 1973 to December 1983 period.

12. Real interest parity based on long maturity financial instruments might convey a different picture. The measurement of long-term real interest rates is problematical and testing real interest parity based on such rates would no doubt be equally problematical. Invoking results reported in Popper (1987), who used currency swap rates to test for long-term nominal interest rate parity, Frankel (1989) concludes that the magnitude of these long-term international differentials compares favourably with the magnitude of short-term differentials which are now very small. He concludes that Feldstein and Horioka are wrong in their conjecture that there is a term-structure wedge separating national capital markets and that the relevant distinction is between real versus nominal interest rates rather than between long versus short-term rates.

13. Note, however, that some authors have 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 adressed, but is found not to be responsible for the high correlations reported (see Frankel, 1989).

15. Frankel's own empirical results, after adding on three years of record current account deficits in the United States between 1985 and 1987, suggest a zero degree of saving retention.

16. If the real exchange rate is stationary, random disturbances have only a transitory effect on it, and it eventually returns to its long-run equilibrium. If it is non-stationary then there is no such tendency. Unit root tests due to Dickey and Fuller are typically used to discriminate between these two cases.

17. Some of the tests that failed to reject the random walk model for the real exchange rate were carried out on monthly data. The greater degrees of freedom afforded by monthly data tends to reduce the standard error of the autoregressive coefficient ($\beta$) in:

$$er_{t+1} - \bar{er}_{t+1} = \beta\,[er_t - \bar{er}_t]$$

where er is the long-run equilibrium real exchange rate (proxied as a sample mean or a time trend). Using monthly data, the true value of $\beta$ will clearly be higher than with lower frequency data. The power of the test that $\beta$ is significantly different from, say, 0.95 using monthly data may consequently be no greater than the power of the test that $\beta$ is significantly different from, say, 0.75 using quarterly data. This raises doubts about the standard tests' ability to discriminate between random walk and non-random walk models in the absence of very long historical time series. Hakkio (1986) shows, in fact, that when the real exchange rate differs only slightly from a random walk standard tests are biased in favour of accepting the random walk hypothesis.

18. To be more precise, the mechanism works as follows. An increase in savings leads to a reduction in the consumption of and, given either no non-traded goods inventories or a perishable non-traded consumption good, the production of the non-traded good. This releases factors of production to the traded goods sector of the economy. However, since the non-traded sector is assumed to be labour intensive, it releases proportionately more labour than capital. This results in a potentially higher marginal product of capital in the traded goods sector, raising the desired current level of the capital stock and subsequently actual investment. Hence, a positive correlation between national savings and investment will be observed. The events described in this scenario are no doubt quite time consuming and this correlation might not show up in a time series test using relatively high frequency quarterly data but would emerge from the data averaged over the typical business cycle. Since many tests of the saving-investment relationship (including the original Feldstein-Horioka one) use cyclically-adjusted saving and investment variables, the high values for the estimated coefficient in the relationship may be capturing this effect rather than that of capital mobility.

19. Wong's model is a two good (traded and non-traded), two period, two factors of production model. The labour factor of production is sector specific but capital is freely mobile between the two sectors of the economy and also across countries. It is assumed that it takes one period for investment in physical capital to become operational. Both goods are perishable implying that the non-traded sector must clear each period. Now imagine a fall in the rate of time preference. Savings increase and the consumption of both goods falls in the first period relative to the second period. This clearly implies that the relative price of the non-traded good increases in the second period relative to the first (given that the price of the non-traded good is exogenously determined in world markets). This prospect stimulates investment in the non-traded goods sector. This increased saving in the first period increases consumption expenditure in the second period and, given the model assumptions, investment in the non-traded goods sector increases. Shocks to savings can therefore induce movements in investment in the same direction in a world of perfect capital mobility.

20. This is set out in Appendix 4.

21. These models are often referred to as Dornbusch-Frankel and Hooper and Morton models. See for example, Frankel (1979, 1985), Dornbusch (1976), and Hooper and Morton (1982).

22. See, for example, Shafer and Loopesko (1983), Sachs (1985), Isard (1988), Meese (1990) and Coughlin and Koedijk (1990).

23. See Meese (1990).

24. See Dooley and Shafer (1976).

25. Meese and Rogoff (1985), Coughlin and Koedijk (1990). At least for the earlier study this was because the relevant Monte Carlo studies to determine significance levels for the test when the co-integrating regression contains more than one explanatory variable had not been conducted. This is now no longer the case.

26. 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 equilibirum, so that choice of a similarly long-term interest rate (which is the average of expected future short rates) is appropiate. 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 econonmetric 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.

27. In the previous section closed interest parity relationships suggest that fluctuations became significantly smaller with a move towards a zero mean in about 1974 for the United States and Germany, 1980 for Japan, 1979 for the United Kingdom and 1983 for France. Break points are chosen at 1979Q1 for the £/DM rate, 1984Q1 for the FF/DM rate. Given the shortness of the sample period with a 1974 break for the DM/$ rate, a 1980Q1 break point was chosen arbitrarily. This is directly comparable with the break point for the Y/$ rate.

28. In the context of their membership of the EEC, their major trade relationships are intra European rather than with the United States.

29. See Phillips and Durlauf (1986) and Ouliaris (1990).

# TABLES AND CHARTS

Table 1

**NARROWING OF CLOSED INTEREST RATE DISPARITIES**
(measured in basis points)

| | Early period | | | Later period | | |
|---|---|---|---|---|---|---|
| | Mean | Standard deviation | Coefficient of variation | Mean | Standard deviation | Coefficient of variation |
| United States | 82 | 60 | 73 | 49 | 30 | 61 |
| Japan | 63 | 90 | 143 | 5 | 4 | 80 |
| Germany | 98 | 150 | 153 | 15 | 10 | 67 |
| France | 205 | 230 | 112 | 14 | 10 | 71 |
| United Kingdom | 103 | 110 | 107 | 3 | 5 | 167 |
| Switzerland | 112 | 110 | 98 | 64 | 20 | 31 |
| Netherlands | 27 | 28 | 104 | 3 | 2 | 67 |

Notes: The "early period" and "later period" intervals are not the same for each country. They are as follows:

United States: July 1963 - December 1979 and January 1980 - January 1990
Japan: June 1978 - June 1984 and July 1984 - January 1990
Germany: July 1963 - December 1981 and January 1982 - January 1990
France: January 1973 - April 1987 and May 1987 - January 1990
United Kingdom: January 1975 - June 1981 and July 1981 - January 1990
Switzerland: June 1963 - December 1981 and January 1982 - January 1990
Netherlands: January 1962 - December 1983 and January 1984 - January 1990.

Table 2

**REAL INTEREST RATE LINKAGES WITH THE UNITED STATES: THREE-MONTH TREASURY BILL RATES AND CONSUMER PRICES**

(Absolute t values in parentheses)
(The data are monthly)

| | FIRST PERIOD | | SECOND PERIOD | | THIRD PERIOD | |
|---|---|---|---|---|---|---|
| | $\alpha$ | $\gamma$ | $\alpha$ | $\gamma$ | $\alpha$ | $\gamma$ |
| 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 KINGDOM | -0.54 | 1.920 | 0.425 | 0.730 | 0.824 | 0.757 |
| | (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: The linkage between bilateral ex ante real rates is examined using the following equation:

$$E\,(r_{mt}) = \alpha + \gamma\, E(r^{*}_{mt}) + e_{mt}$$

where $E(r_{mt})$ and $E(r^{*}_{mt})$ are the expected or ex ante domestic and foreign real rates on assets of maturity m at time t. $e_{mt}$ is a random error term. Replacing those ex ante rates by their ex post equivalents yields:

$$r_{mt} = \alpha + \gamma\, r^{*}_{mt} + [u_{mt} - \gamma\, u^{*}_{mt} + e_{mt}]$$

where $u_{mt}$ and $u^{*}_{mt}$ are expectational errors. The estimation of this last equation gives rise to special econometric difficulties which are explained in a technical appendix to Blundell-Wignall and Browne (1990). 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 3

**REAL INTEREST RATE LINKAGES WITH GERMANY**
**THREE MONTH TREASURY BILL RATES AND CONSUMER PRICES**

(Absolute t values in parentheses)

| | FIRST PERIOD | | SECOND PERIOD | | THIRD PERIOD | |
|---|---|---|---|---|---|---|
| | $\alpha$ | $\gamma$ | $\alpha$ | $\gamma$ | $\alpha$ | $\gamma$ |
| 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: The linkage between bilateral ex ante real rates is examined using the following equation:

$$E\,(r_{mt}) = \alpha + \gamma\, E(r^{*}_{mt}) + e_{mt}$$

where $E(r_{mt})$ and $E(r_{mt})$ are the expected or ex ante domestic and foreign real rates on assets of maturity m at time t. $e_{mt}$ is a random error term. Replacing those ex ante rates by their ex post equivalents yields:

$$r_{mt} = \alpha + \gamma\, r^{*}_{mt} + [U_{mt} - U^{*}_{mt} + e_{mt}]$$

where $U_{mt}$ and $U_{mt}$ are expectational errors. The estimation of this last equation gives rise to special econometric difficulties which are explained in a technical appendix available on request. 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.

Table 4

COINTEGRATION AND ERROR CORRECTION REGRESSIONS
FOR BILATERAL REAL EXCHANGE RATES

| | Full sample | 1970s | 1980s |
|---|---|---|---|
| | (Yen/dollar real exchange rate) | | |
| Real interest differential | -0.03 | -0.04 | -0.05 |
| | (-3.7) | (-3.3) | (-4.8) |
| Cumulative current account | -0.35 | -1.29 | -0.38 |
| | (-11.5) | (-4.6) | (-11.3) |
| Standard error of estimates | 0.106 | 0.093 | 0.099 |
| Durbin-Watson | 0.407 | 0.506 | 0.519 |
| ADF statistics | -3.7*** | -3.4*** | -3.0** |
| Error correction coefficient | -0.22 | -0.34 | -0.35 |
| | (-4.0)*** | (-2.1)*** | (-4.8)*** |
| | (Deutschemark/dollar real exchange rate) | | |
| Real interest differential | -0.06 | -0.02 | -0.11 |
| | (-9.4) | (-3.0) | (-10.5) |
| Cumulative current account | -0.21 | -1.35 | -0.12 |
| | (-5.4) | (-12.5) | (-3.6) |
| Standard error of estimates | 0.121 | 0.058 | 0.092 |
| Durbin-Watson | 0.256 | 0.692 | 0.897 |
| ADF statistic | -2.2 | -2.5 | -3.1** |
| Error correction coefficient | -0.18 | -0.38 | -0.40 |
| | (-3.7)*** | (-2.4)*** | (-4.5)*** |
| | (Pound sterling/Deutschemark real exchange rate) | | |
| Real interest differential | -0.03 | -0.00 | -0.01 |
| | (-6.3) | (-0.1) | (-1.2) |
| Cumulative current account | -0.09 | -0.35 | -0.17 |
| | (-1.5) | (-4.4) | (-2.6) |
| Standard error of estimates | 0.130 | 0.080 | 0.106 |
| Durbin-Watson | 0.249 | 0.319 | 0.264 |
| ADF statistic | -2.9** | -2.7* | -2.7* |
| Error correction coefficient | -0.08 | -0.26 | -0.22 |
| | (-1.8)** | (-2.5)*** | (-3.3)*** |
| | (French franc/Deutschemark real exchange rate) | | |
| Real interest differential | -0.01 | -0.01 | |
| | (-3.8) | (-2.7) | |
| Cumulative current account | -0.08 | -0.21 | |
| | (-2.7) | (-2.0) | |
| Standard error of estimates | 0.043 | 0.050 | n.a. |
| Durbin-Watson | 0.329 | 0.332 | |
| ADF statistic | -4.9*** | -3.7*** | |
| Error correction coefficient | -0.34 | -0.37 | |
| | (-4.9)*** | (-4.0)*** | |

Note: Real interest differential and cumulated current account balances refer to coefficients in the co-integrating regression of the log of the real exchange rate against a constant and the long-term real interest rate differential and the differential between the cumulated current account balances as a share of GDP. Significance levels for the ADF statistic are:

| Number of explanatory variables | Significance level 5% | 10% | 15% |
|---|---|---|---|
| n = 2 | -3.26 | -2.98 | -2.79 |
| n = 3 | -3.73 | -3.44 | -3.26 |

Source: Phillips and Ouliaris (1988).

3 asterisks indicates significance at the 5 per cent level, 2 asterisks indicates significance at the 10 per cent level, and 1 asterisk indicates significance at the 15 per cent level. The error correction coefficient is based on a standard t test.

Specification and testing for co-integration and error correction are set out in Appendix 3 to Blundell-Wignall and Browne (1990). Sample periods are: Y/$, 1971Q2-1990Q1; DM/$, 1971Q2-1989Q4; £/DM, 1971Q2-1989Q4; FF/DM 1973Q2-1989Q4. Break points are 1980Q1 for Y/$ and DM/$ rates, 1979Q1 for £/DM rate and 1984Q1 for FF/DM rate. Given this latter break point there are not enough observations available to do a cointegration test for the period following the break point.

Chart 1

3-MONTH INTEREST RATES DIFFERENTIALS
-- on-shore deposits minus off-shore deposits --

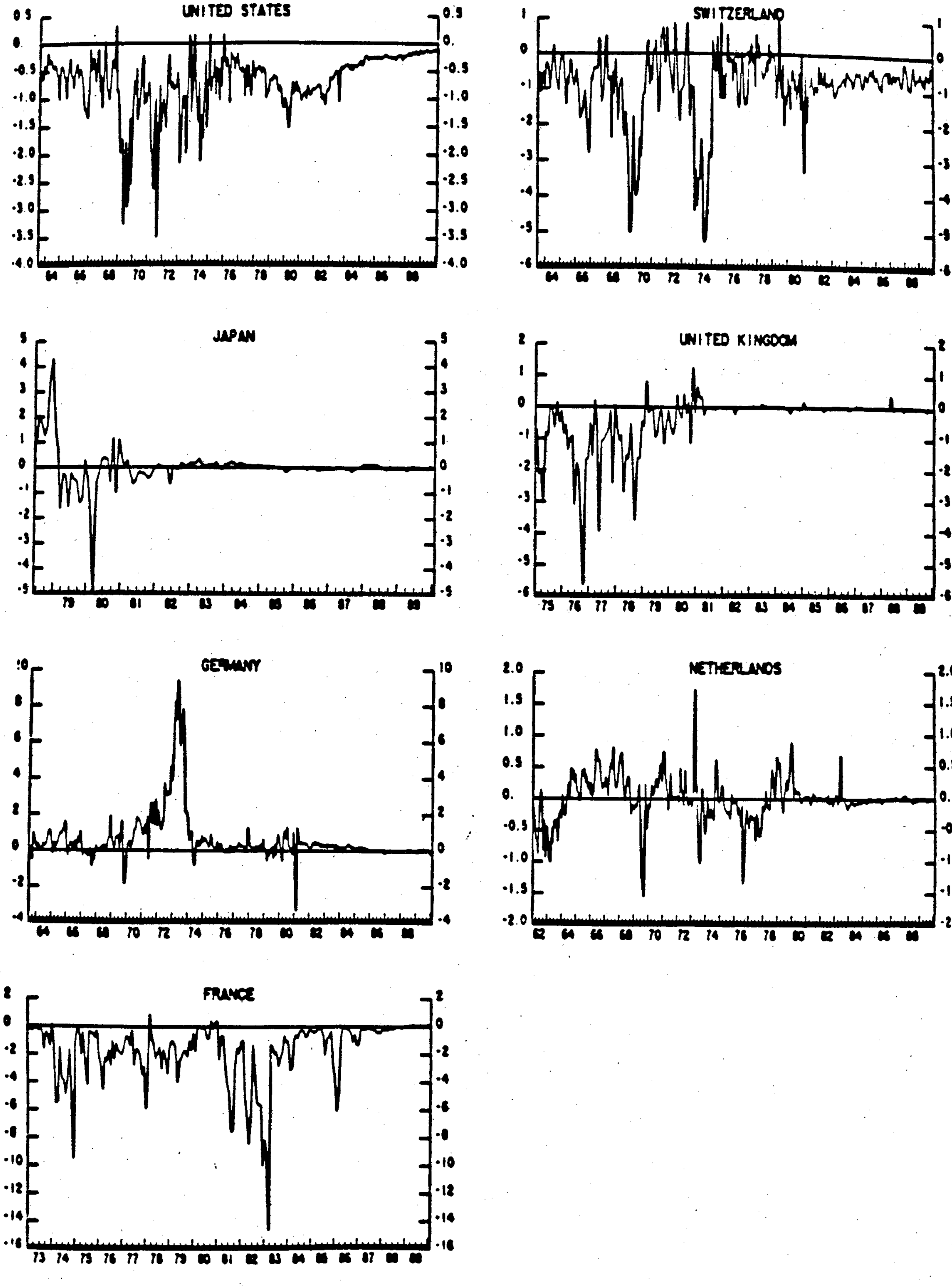


Chart 2

COVERED INTEREST DISPARITIES USING TREASURY BILL RATES

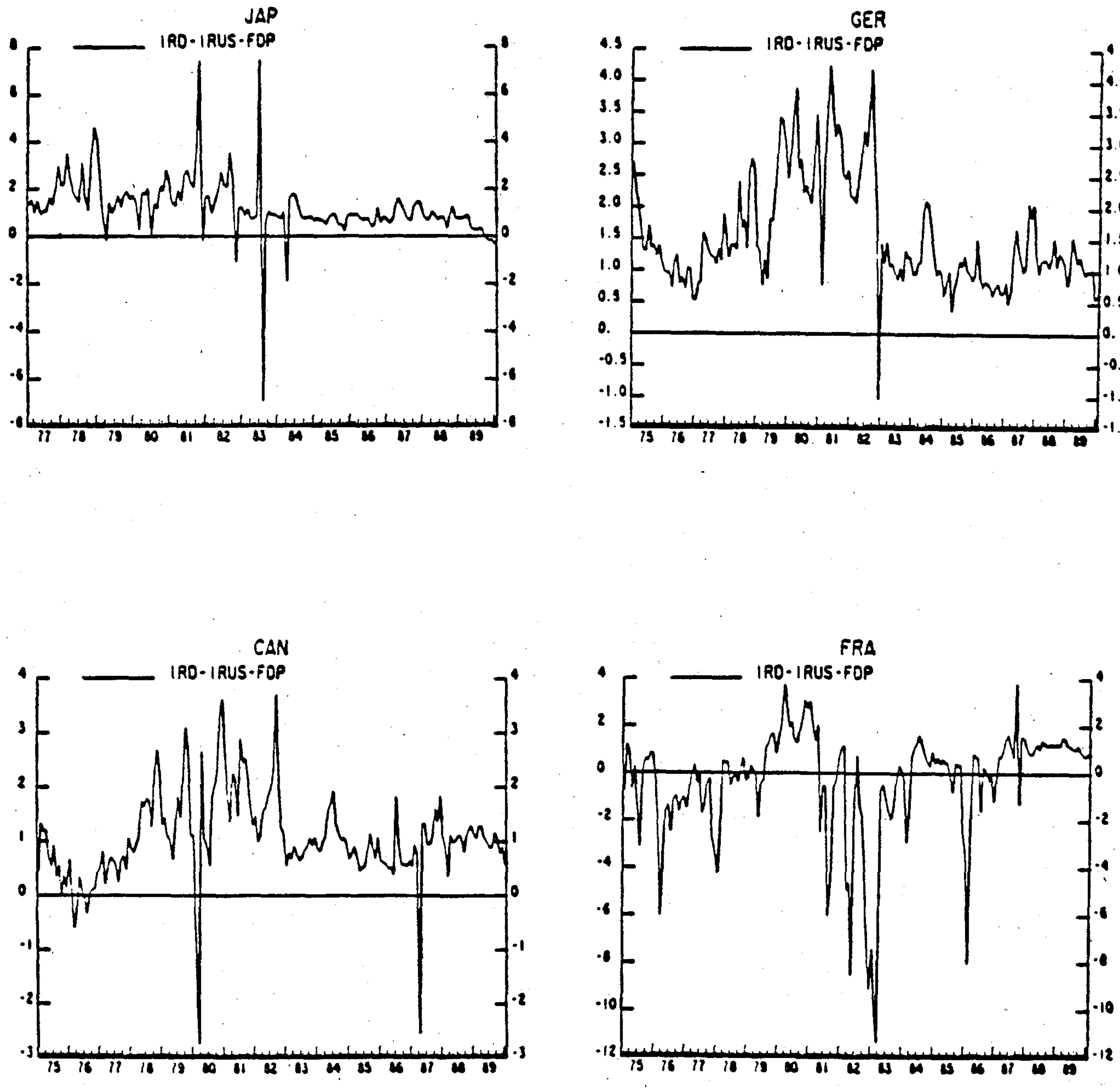


Chart 2 (cont.)

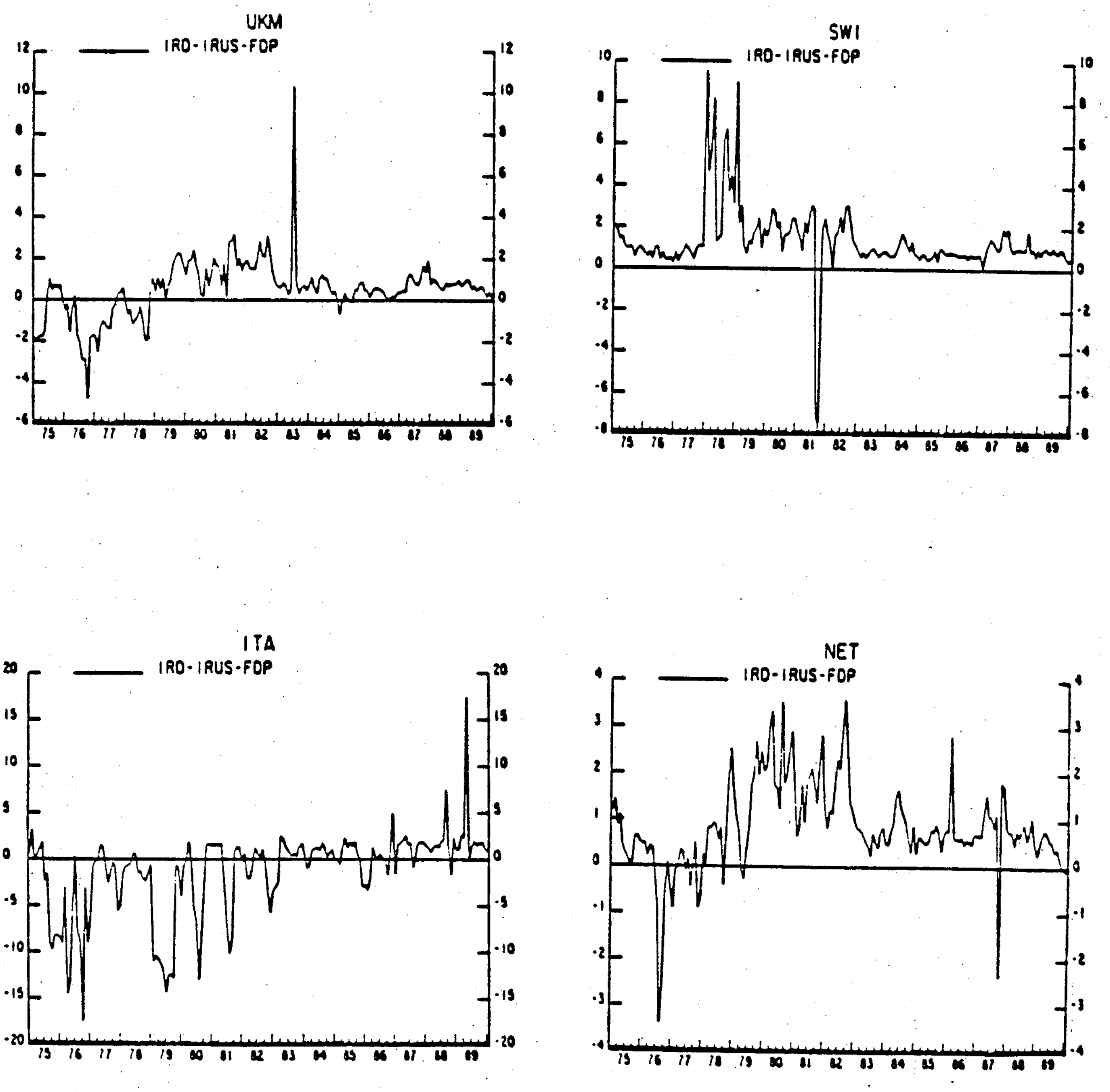

UKM
IRD-IRUS-FDP
SWI
IRD-IRUS-FDP
ITA
IRD-IRUS-FDP
NET
IRD-IRUS-FDP

Chart 3

EX ANTE REAL RATE ESTIMATES

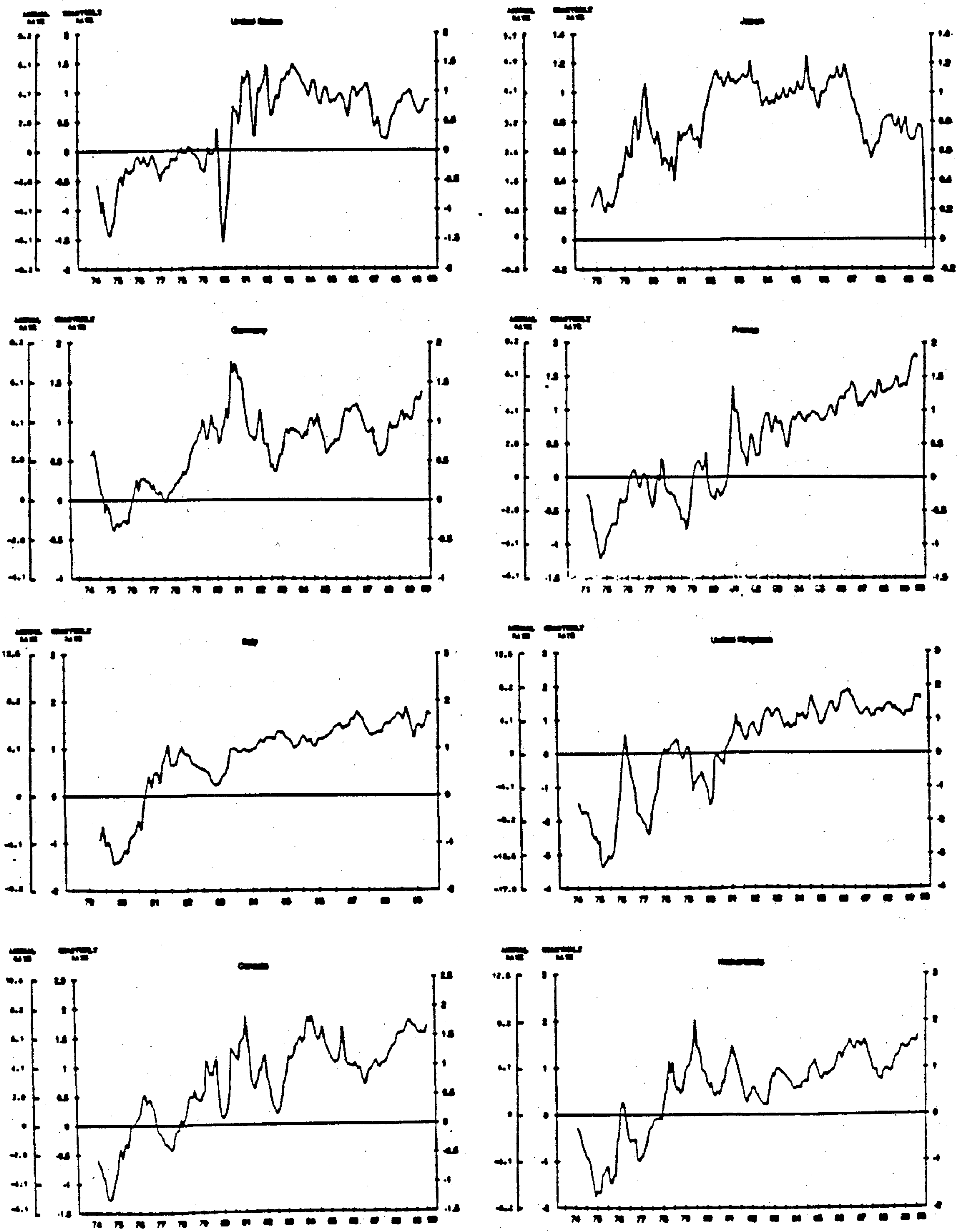
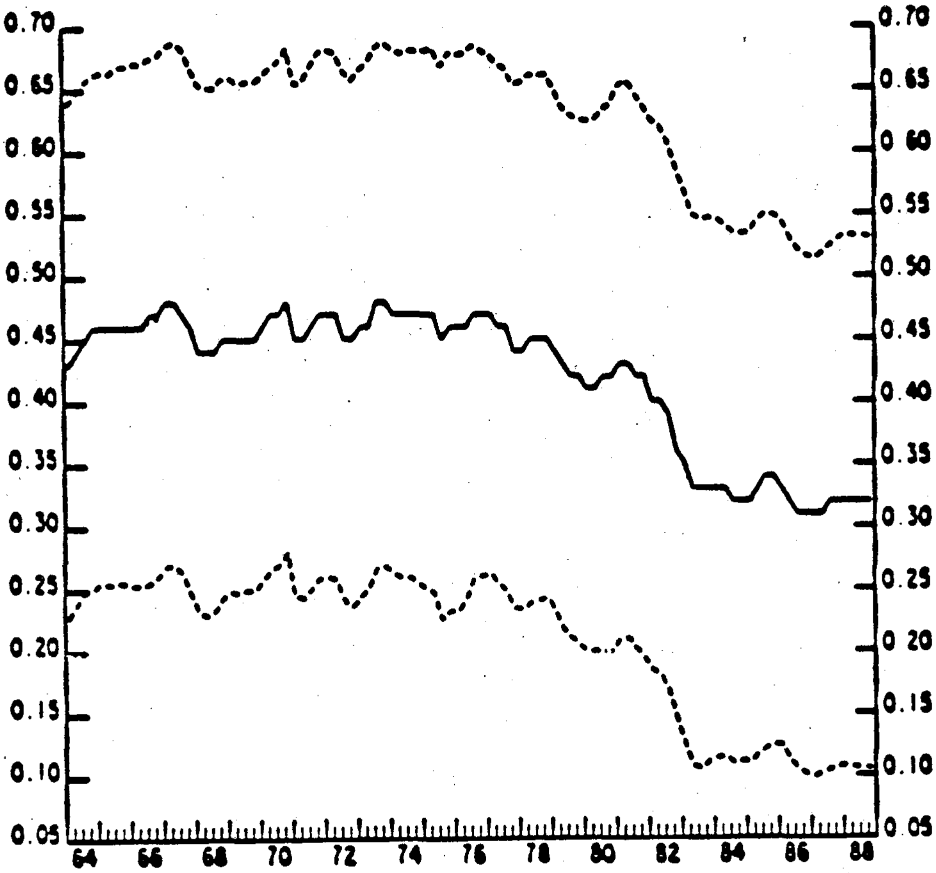


Chart 4

ESTIMATED SAVINGS: INVESTMENT CORRELATIONS: POOLED DATA

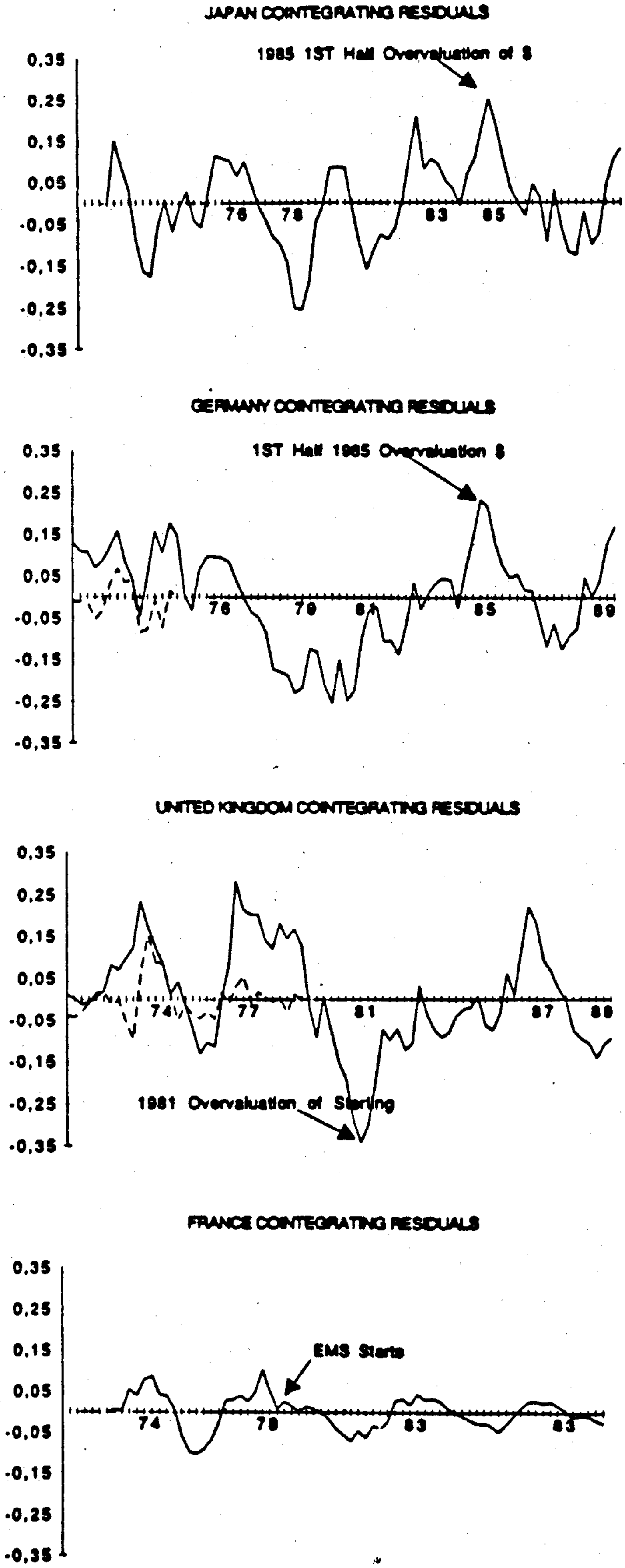



Note: The solid line refers to the time-varying parameter estimate of $\Phi$ in the equation:

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

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, $I^G$ 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 $\Phi$. 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 $\Phi$, $\hat{\Phi}_t$, obtained by adding that quarter's values of the relevant variables for all the countries and deleting those for quarter t-4. The discontinued lines represent two standard error estimates for the $\hat{\Phi}_t$.

Chart 5


JAPAN COINTEGRATING RESIDUALS
1985 1ST Half Overvaluation of $
0,35
0,25
0,15
0,05
-0,05
-0,15
-0,25
-0,35
76
78
83
85
GERMANY COINTEGRATING RESIDUALS
1ST Half 1985 Overvaluation $
0,35
0,25
0,15
0,05
-0,05
-0,15
-0,25
-0,35
76
79
81
85
89
UNITED KINGDOM COINTEGRATING RESIDUALS
0,35
0,25
0,15
0,05
-0,05
-0,15
-0,25
-0,35
74
77
81
87
89
1981 Overvaluation of Sterling
FRANCE COINTEGRATING RESIDUALS
EMS Starts
0,35
0,25
0,15
0,05
-0,05
-0,15
-0,25
-0,35
74
78
83
83

# APPENDIX 1

## COMPETING MEASURES OF INTERNATIONAL FINANCIAL MARKET INTEGRATION

Table A1 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 form in which it is presented in the table. If it is assumed that the relevant assets are issued in the same country but denominated in different currencies (i.e. prp = 0), that investors are risk neutral (i.e. erp = 0), and that covered interest parity (cip) holds ($i - i^* = fdp$) then tests of UIP amount to tests of foreign exchange market efficiency (i.e. $\Delta s = \alpha_5 + \beta_5 fdp + \Sigma$, and the perfect capital mobility null hypothesis becomes $\alpha_5 = 0$ and $\beta_5 = 1$). 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 A.1

ALTERNATIVE SUGGESTED MEASURES OF FINANCIAL MARKET INTEGRATION

| Measure | Context | Test equation(s) | Definitions | Perfect Capital Mobility Null Hypothesis |
|---|---|---|---|---|
| 1<br>Closed interest parity | a) Same currency<br>b) Different country (i.e. "onshore"-"offshore") | $i = \alpha_1 + \beta_{11} i^* + \beta_{12}(prp)$ | i = Domestic interest rate<br>i* = Foreign interest rate<br>prp = Political risk premium | $\alpha_1 = 0$<br>$\beta_{11} = 1$<br>$\beta_{12} = 0$ |
| 2<br>Covered interest parity (CIP) | a) Different currency<br>b) Same or different country<br>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 | $\alpha_2 = 0$<br>$\beta_{21} = \beta_{22} = 1$<br>$\beta_{23} = 0$ [Required if different country] |
| 3<br>Uncovered interest parity (UIP) | a) Different currency<br>b) Same or different country<br>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<br>$E(\Delta S)$ = Expected change in the spot exchange rate | $\alpha_3 = 0$<br>$\beta_{31} = \beta_{32} = 1$<br>$\beta_{33} = 0$ [Required if different country]<br>$\beta_{34} = 0$ [Risk neutrality] |
| 4<br>Real interest parity | a) Different currency<br>b) Same or different country<br>c) Different commodity bundles<br>d) Investors taking open positions in foreign exchange markets and reckoning in terms of the purchasing power in their currency of residence | $r = \alpha_4 + \beta_{41} r^* + \beta_{42} E(\Delta RS) + \beta_{43}(prp) + \beta_{44}(rerp)$ | r = Domestic real interest rate<br>r* = Foreign real interest rate<br>$E(\Delta RS)$ = Expected change in the real exchange rate<br>rerp = Real exchange rate risk premium | $\alpha_4 = 0$<br>$\beta_{41} = 1$<br>$\beta_{43} = 0$ [Required if different country]<br>$\beta_{44} = 0$ [Risk neutrality]<br>$\beta_{42} = 0$ [Because $E(\Delta RS) = 0$] |
| 5<br>Independence of domestic saving and investment ratios | See Section 5 of paper for further discussion | $(I/Y) = \alpha_s + \beta_{51}(NS/Y)$<br>$(I/Y) = a - br + u_1$ | I = Investment<br>NS = National saving<br>Y = GNP<br>$U_1$ = Other factors affecting domestic investment other than r. | All conditions required for 4 i.e. r=r* and, in addition,<br>r* exogenous,<br>$\rho(u_1, NS/Y) = 0$, and, No non-traded goods |

## APPENDIX 2

## COINTEGRATION AND FOREIGN EXCHANGE MARKET EFFICIENCY

The rejection of uncovered interest parity and efficiency in the exchange market are quite universal. Bilson (1981) and Boothe and Longworth (1986) find that the future change in the spot rate is negatively, although not often significatively, related to the forward premuim. Foreign exchange market efficiency requires a positive relationship. Using a different approach based on identifying periods of unexploited profit opportunities, Dooley and Shaffer (1988) found such periods to exist. Furthermore, these opportunities seemed to persist in time. Others, e.g. Bilson (198.) and Booth (198.) have found similar evidence of unexploited profit opportunities. Hodrick and Srivastava (1984) concluded, however, that episodes of apparent profitable currency speculation did involve the assumption of significant risk.

Statistical issues involved in testing for foreign exchange market efficiency have recently received greater attention and, in some cases, have overturned previous results. Econometric techniques for dealing with overlapping observations (see Hansen and Hodrick, 1980, and Cumby et al., 1983) have led to rejections of market efficiency in situations in which OLS accepted efficiency using the same data. Another major statistical and more intractable problem arises from the fact that market participants may be assigning probabilities to future events which have not occurred with sufficient frequency, or have not occurred at all, in the data sample examined. In other words, the sample statistics may be poor measures of the underlying ex ante subjective probability disturbance governing agents' behaviour and thus inferences based on these may be biased.

While there is general agreement that forward rates have little, if any, power to forecast future spot rates, there is much less of a consensus about the source of this failure. Frankel (1982) and Demowitz and Hakkio fail to find evidence of significant time-varying risk premia. Hsieh (1982), Hansen and Hodrick (1983) and Hodrick and Srivastava (1984) all find evidence supporting the risk premium hypothesis. Fama (1984) finds, conditional on rational expectations, that most of the variations in forward rates is variation in risk premia and, in keeping with the findings of several others, the premium and expected future spot rate components of forward rates are negatively correlated. Several, though not mutually exclusive, explanations of these findings have been proposed.

One possibility is that the assessment of the expected change in the spot rate is consistently perverse relative to the true expected change. As has been indicated already peso effects could account for these results. A third possibility that has been suggested is that government foreign exchange market intervention can cause the observed data to display a "market inefficiency". Governments may, for example, tend to support their currencies with greater determination the greater are the market forces, such as purchasing power disparities, indicating depreciation. Finally, the expected real components of nominal interest rates can vary somewhat independently across countries due to purely domestic influences. This could happen if random variations in the real exchange rate induce market participants to prefer to borrow and lend in domestic currency.

Since a forward contract is an agreement to exchange the future pay-offs on foreign investments in nominal terms, prospective uncertainty about the future purchasing power of these pay-offs will induce risk-averse investors to demand that a risk premium be incorporated in the forward exchange rate. Thus, if the expected patterns for the price levels in two countries is different, bonds will be priced to reflect these differences and thus the forward price of foreign exchange will not equal the currently expected spot price. *Ex ante* real interest rates on comparable assets across currencies are not equal (see Section II in the main text). On the basis of this factor alone it is perhaps not surprising that the foreign exchange market efficiency hypothesis is rejected. Korajczyk (1985), using the framework of the international asset pricing model approach (see Stultz, 1981 and Lucas 1982, for example), notes that the part of the deviation between the forward and corresponding future spot exchange rates which is forecastable should be identically equal to the risk premia reflected in real interest rate differentials on default free nominal bonds. However, based on this model he was unable to reject the hypothesis that only risk premia cause the observed discrepancy between forward and future spot rates. More recently Levine (1989) suggests that anticipated real exchange rate movements help explain the Korajczyk findings. Using the covered interest parity relationship, an expression for the real exchange rate as deviations from purchasing power parity, plus Fisher equations for the domestic and foreign real interest rates, he shows that the risk premium is equal to the *ex ante* real interest rate disparity plus the anticipated change in the real exchange rate conditional on all information available at the moment expectations are formulated. According to the efficient purchasing power parity theory the last term should be zero. However, Levine infers from his empirical tests that forward exchange rates incorporate anticipated real exchange rate changes.

Tests of the foreign exchange market efficiency hypothesis are plagued by the joint null hypothesis (i.e. risk neutrality and rationally forward expectations) nature of these tests. These are inconclusive because market expectations are not directly observed. Frankel and Froot (1985) use survey data on expectations in an attempt to resolve this problem directly. On the basis of the assumption that survey expectations are true expectations these corroborated Fama's (1984) finding that exchange risk premiums have been very large (1). They report premium estimates varying between 3.53 per cent (for the U.K. pound) and 10.04 per cent (for the French franc) at annual rates using the Economist survey for the 1981-1985 period. Estimates for roughly the same period using the Amex surveys varied from -1.25 (for the Swiss franc) to 5.61 (for the French franc). If these estimates are reliable, then the unbiasedness of the forward rate and uncovered interest parity cannot be easily sustained. In a more recent paper the same authors Froot and Frankel (1989), using survey data from the same sources, reverse their earlier conclusions and claim that the bulk of the bias in the forward rate is accounted for by systematic expectational errors. None of the bias, in fact, related a risk premium in their analysis.

These results are only as good as the survey data on which they are based. Survey data, however, are known to be vulnerable to many potential shortcomings. The incentives survey respondents have for revealing their true expectations can be questioned. Presumably the market participants true expectation of the future spot rate is the "output" of an expensive production process involving data collection, model formulation and model testing. It may be unreasonable to expect him to reveal the output of this research endeavour without some reward. But there is no such reward. In sum, rationally motivated behaviour may involve market participants concealing their true expectations, particularly when these relate to prices in auction markets in which they are seeking to make a profit from the supposed exclusive possession of the information on which these expectations are being based. Surveys also typically evoke responses only with respect to the expected price but not with respect to the expected volume of transactions. Thus the aggregate survey expectation must necessarily be some unweighted average of replies. The future actual market exchange rate is, however, clearly a weighted average where the weights depend upon the volume of transactions of market participants.

Furthermore, suppose that in the Froot and Frankel (1989) experiment, all survey respondents (or a sizeable proportion of these) say that their expectation of the future spot rate is the relevant forward rate. This would render their test completely vacuous. Thus rather than supporting the Froot-Frankel result as to the non-correlation of the risk premium and the forward discount, the fact that they find that the different surveys tend to corroborate each other in indicating the absence of a risk premium could be interpreted, quite simply, as being due to the fact that respondants (lacking a pecuniary inducement to reveal their true expectations) are giving the forward rate as their expectation of the future spot rate without, of course, saying that this is in fact what they are doing (2).

A necessary condition for foreign exchange market efficiency is that the forward and corresponding future spot rate be cointegrated. In an efficient market these two rates could not drift apart to any significant extent. Two variables that are cointegrated can be shown to follow an error-correction model (Engel and Granger (1987)). Rejection of the error-correction model based on these variables implies rejection of the efficiency hypothesis (see Hakkio and Rush, 1989). Acceptance of the error correction model does not, however, imply acceptance of market efficiency. Given the accumulated evidence against foreign exchange market efficiency, the presumption is that these tests also reject efficiency.

When two variables $X_t$ and $Y_t$ are cointegrated, the following error-correction specification can be written:

$$X_t - X_{t-1} = a[X_{t-1} - d\,Y_{t-1}] + b[Y_t - Y_{t-1}]$$

$$+ \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{m} \beta_i \Delta X_{t-j} + e_t \qquad (2A)$$

where $a \neq 0$ and $b \neq 0$ and $e_t$ is a stationary and possibly autocorrelated error term. d is the cointegrating vector. Let Y be the forward exchange rate ($F_t$) and X the corresponding future spot rate ($S_{t+1}$). Then the error-correction model for these variables can be written as:

$$S_{t-1} - S_t = a[S_t - d\,F_{t-1}] + b[F_t - F_{t-1}]$$

$$+ \sum_{i=0}^{n} \alpha_i \Delta S_{t-i} + \sum_{j=1}^{m} \beta_j \Delta F_{t-j} + e_t$$

Standard tests for foreign exchange market efficiency when the spot and forward rate are thought to be nonstationary are typically carried out using the following specification:

$$S_{t+1} - S_t = a + b[F_t - F_{t-1}] + v_t$$

If indeed the spot and forward rates are cointegrated then this equation is clearly misspecified by the exclusion of the error-correction term $b[S_t - dF_{t-1}]$ and possibly lagged values of $\Delta S_t$ and $\Delta F_t$.

**NOTES**

1. As noted already, one of the stumbling blocks in testing for uncovered interest parity (UIP) is the peso problem. Testing UIP using direct evidence on expectations is clearly not vulnerable to this problem.

2. Another problem with the Froot-Frankel methodology is the following. If respondent's survey expectations are their true expectations, and they act on the basis of these expectations, then they will in effect act to arbitrage away any large discrepancies between their expected future spot exchange rate and the implied forward rate. Thus is particularly true if, indeed, there is no risk premium. This causality runs from their dependent variable $[\Delta S_{t+k}]$ to their independent variable $[fd_t]$ in their test equation. $\beta_2$ will consequently be biased toward zero. For most countries, the authors find $\beta_2$ to be not significantly different from one (supporting the perfect substitutability hypothesis). If simultaneity could be properly accounted for, then one might easily find $\beta_2$ to be significantly in excess of one, i.e. consistent with the existence of a risk premium.

# APPENDIX 3

## REAL INTEREST PARITY

Real interest parity says that, under certain conditions, international asset arbitrage will equalise real interest rates in different countries under either fixed or flexible exchange rate regimes. This can be demonstrated simply. Suppose that domestic and foreign assets are perfect substitutes. Again abstracting from political and currency risks, uncovered interest parity can be stated as follows:

$$i_{mt} = i_{mt}^{*} + E(\Delta S_{mt}) \tag{3A}$$

where $i_{mt}$ is the current domestic currency interest rate with a maturity of length m and $i_{mt}$ is the corresponding foreign currency interest rate. $E(\Delta S_{mt})$ is the expected cumulative change in the bilateral nominal exchange rate over the m periods to maturity of the domestic and foreign bonds. If (relative) ex ante purchasing power parity holds at all times then $E(\Delta S_{mt})$ is the difference between the expected domestic and foreign inflation rates, i.e.

$$E(\Delta S_{mt}) = E(\pi_{mt}) - E(\pi_{mt}^{*}) \tag{3B}$$

where $E(\pi_{mt})$ and $E(\pi_{mt})$ are the expected domestic and foreign inflation rates from period t to t+m. Equations (3A) and (3B) together yield the real (ex ante) interest parity condition:

$$\left.\begin{array}{l} i_{mt} - E(\pi_{mt}) = i_{mt}^{*} - E(\pi_{mt}^{*}) \\ \text{or} \\ E(r_{mt}) = E(r_{mt}^{*}) \end{array}\right\} \tag{3C}$$

Thus, to obtain the real (uncovered) interest rate parity condition, all that is required is to add the ex ante purchasing power parity condition to the uncovered interest parity condition.

An obvious next step is to look at empirical support for the real interest parity relationship in (3C). The major practical problem here is that ex ante real interest 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

$$r_{mt} = i_{mt} - \pi_{mt} \tag{3D}$$

where $r_{mt}$ and $\pi_{mt}$ are the realised real return on the m period bond held from t to t+m and $\pi_{mt}$ is the realised inflation rate from t to t+m. Combining the definitions of the ex ante and ex post rates gives:

$$\left.\begin{array}{l} r_{mt} = E(r_{mt}) + u_{mt} \\ \text{where} \\ u_{mt} = E(\pi_{mt}) - \pi_{mt} \end{array}\right\} \tag{3E}$$

Invoking rational expectations for future inflation, then

$$E[u_{mt}/\phi_t] = 0$$

where $\phi_t$ is the set of all available information at time t. Cumby and Mishkin propose, as a choice for an estimate of the <u>ex ante</u> real rate, the best linear prediction of $E(r_{mt})$ given $X_t$. $X_t$ is a vector of variables which is the subset of the information set $\phi_t$ which is observed and which is correlated with $E(r_{mt})$, i.e., the projection equation for $E(r_{mt})$ is:

$$E(r_{mt}) = X_t\beta + v_{mt} \tag{3F}$$

where $v_{mt}$ is the projection equation error. Substituting (3F) into (3E) yields:

$$\left.\begin{aligned} r_{mt} &= X_t\beta + v_{mt} + u_{mt} \\ &= X_t\beta + w_{mt} \end{aligned}\right\} \tag{3G}$$

The estimated <u>ex ante</u> real rates are the fitted values from equation (3G) i.e.

$$\hat{r}_{mt} = X_t\hat{\beta} \tag{3H}$$

Rational expectations implies that $u_{mt}$, reflecting inflation forecast errors, is orthogonal to $X_t$ and, by construction, $v_{mt}$ is also independent of $X_t$. Thus equation (3G) can be estimated by OLS. An overlapping data problem arises in the present context, however, because the interest rates examined are three month rates but the observation interval is monthly. This implies that the error term in equation (3G) follows an MA(2) process. For the most part the vector $X_t$ consists of the same variables employed by Cumby and Mishkin, i.e. the contemporaneous corresponding maturity nominal rate, three lagged values of inflation and one-period lagged values of money and output growth plus a time trend. The estimation is performed using an estimation procedure suggested by Cumby, Huizinga and Obstfeld (1983). The estimated equations are not reported but are available from authors. The estimated <u>ex ante</u> real rates are presented in Chart 3.

The linkage between bilateral <u>ex ante</u> real rates is examined using the following equation:

$$E(r_{mt}) = \alpha + \gamma\, E(r^*_{mt}) + e_{mt} \tag{3I}$$

The hypothesis that foreign and domestic <u>ex ante</u> 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. Substituting for the <u>ex post</u> real rates (defined in equation (3E) to get rid of the unobservable <u>ex ante</u> rates in equation (3I) yields:

$$r_{mt} = \alpha + \gamma r^*_{mt} + [u_{mt} - \gamma u^*_{mt} + e_{mt}],\tag{3J}$$

$u^*_{mt}$ 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 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 (A29).

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 CHO 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 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 results of those regressions are reported in Table 2. 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 ocurring at lags greater than 2 except at the seasonal frequency which may be spurious. This suggest that $v_{mt}$ (the projection equations error) is small relative to $u_{mt}$ (the inflation forecast error) and "provides some indication that enough relevant information is included in $X_t$" and that the fitted values which represent <u>ex ante</u> real rates will be reliable.

## APPENDIX 4

## REAL EXCHANGE RATE FUNDAMENTALS AND COINTEGRATION TESTS

### A. Theory

The effects of financial liberalisation can be thought about in terms of balance of payments equilibrium. The current account is given by:

$$b(t) + r^{*} a(t) = \dot{a}(t) \qquad (4A)$$

where b is the balance of trade; a is the stock of net foreign assets and $r^{*}$ is an average constant rate of return on net foreign assets. The trade balance is assumed to be determined by:

$$b(t) = \gamma (q(t) - \bar{q}) + \bar{b} \; ; \gamma > 0 \qquad (4B)$$

where $q(t) = s(t) + p^{*}(t) - p(t)$ is the logarithm of the real exchange rate; s(t) is the logarithm of the nominal exchange rate (domestic currency per unit of foriegn currency); and p(t) is the logarithm of the price level; an asterisk denotes a foreign variable and a bar denotes a steady-state variable. The capital account is given by:

$$c(t) = \eta (\bar{a} - a(t)) + \alpha (R^{*}(t) - R(t)) \; ; \eta, \alpha > 0 \qquad (4C)$$

where an e superscript denotes an expected value.

The degree of capital market integration is captured by the parameters $\eta$ and $\alpha$. The smaller the parameter $\eta$ the greater the tolerance of the market towards risk (political or exchange), and vice versa. The parameter $\alpha$ reflects the responsiveness of capital flows to expected differences in return differentials (inversely related to the variance in expected returns). The removal of capital controls is expected to increase tolerance towards risk (reduce $\eta$). Setting the capital account equal to the current account yields an expression for real interest differential in terms of the current account:

$$R(t) - R^{*}(t) = \frac{\eta}{\alpha} (\bar{a} - a(t)) - \frac{\gamma}{\alpha} (q(t) - \bar{q}) - \frac{\bar{b}}{\alpha} - \frac{r^{*}}{\alpha} a(t) \qquad (4D)$$

Which suggests the real interest rate will exceed the foreign rate according to a risk premium, the first term, and the extent to which domestic investment exceeds savings i.e. the curent account is in deficit. If capital is perfectly mobile there is no divergence from the real foreign rate. In the case of financial antarky $\alpha = 0$ and the real interest differential is undefined in terms of balance of payments considerations. It is determined separately in each country to equate savings to investment.

The real exchange rate is determined within the asset market approach, which begins from the uncovered interest parity condition allowing for risk:

$$\dot{s}^{e}(t) = r(t) - r^{*}(t) - \frac{\eta}{\alpha} (\bar{a} - a(t)) \tag{4E}$$

where r is the nominal interest rate and the last term is the risk premium. this implies:

$$\dot{q}^{e}(t) = R(t) - R^{*}(t) - \frac{\eta}{\alpha} (\bar{a} - a(t)) \tag{4F}$$

The removal of capital controls, which reduces $\eta$ and increases $\alpha$ reduces the influence of the risk premium term. To see the role of both the risk premium and real interest rates on the real exchange rate it is necessary to define the expectations formation process.

Equations (4F) and (4A) constitute a pair of forward looking differential equations. Rational expectations are assumed to hold and the system is written as:

$$\begin{bmatrix} \dot{q}(t) \\ \\ \dot{a}(t) \end{bmatrix} = \begin{bmatrix} & \frac{\eta}{\alpha} \\ & \\ \gamma & r^{*} \end{bmatrix} \begin{bmatrix} q(t) \\ \\ a(t) \end{bmatrix} \tag{4G}$$

The characteristic equation is given by:

$$\lambda^{2} - r^{*}\lambda - \frac{\gamma\eta}{\alpha}$$

and the solution for $\lambda$ is given by:

$$\lambda = 1/2 \; [r^{*} \pm | r^{*2} + \frac{4\gamma\eta}{\alpha} |^{1/2}] \tag{4H}$$

which has the saddle point property, given the sign restriction on parameters and the steady-state foreign interest rate. Choosing the negative value of $\lambda$, the solution for (4G) is given by:

$$\dot{q}(t) = \lambda \; (q(t) - \bar{q}) \tag{4I}$$

$$\dot{a}(t) = \lambda \; (a(t) - \bar{a})$$

Substituting the expression for expected real depreciation in (4I) into (4F) and rearranging yields the expression for the real exchange rate:

$$q(t) = \frac{1}{\lambda}\,(R(t) - R^{*}(t)) - \frac{\eta}{\alpha\lambda}\,(a(t) - \bar{a}) + \bar{q} \tag{4J}$$

As liberalisation and globalisation of markets reduces $\eta$ and increases $\alpha$ the following predictions arise:

i) that the influence of cumulated current account balances on the real exchange rate diminishes. Note that even though $\lambda$ becomes less negative, this must be dominated by the fall in $\eta/\alpha$ given the definition of $\lambda$ in (4J);

ii) that $\lambda$ becomes less negative, the impact of the real interest differential on the real exchange rate increases; and

iii) the speed with which the real exchange rate is expected to return to fundamental equilibrium is reduced -- i.e. longer misalignments are expected to arise.

Thus if domestic savings investment imbalances cause the real interest rate to diverge from the foreign rate this will have a greater impact on the real exchange rate. The appreciation of the real exchange rate will cause the current account to deteriorate via the elasticities condition. At the same time the reduced role of the cumulated current account implies less "corrective" action is set into motion by which the real exchange rate would adjust to reduce external imbalances. Thus an increase in the fiscal deficit which pushed up domestic real interest rates and caused the real exchange rate to appreciate is likely to be associated with more persistent external imbalances in liberalised financial markets.

B. Cointegration tests

Equation (4J) is the basis of "fundamentals" used in the cointegrating regression. Alternative theoretical derivations of this basic framework can be found in Frenkel and Mussa (1985), Fukao (1989). Empirical tests based on the notion that the most robust relationship in empirical exchange rate models is between the real exchange rate, the real interest differential and balance of payments factors is found in a variety of studies (1).

Since the real world consists of a large number of countries, the equilibrium bilateral real exchange rate derived from the balance of payments approach is captured empirically by the inclusion of a constant term and $(a(t) - a^{*}(t))$ as in Meese and Rogoff (1983,1985), Meese (1990) and Coughlin and Kees Koedijk (1990) (2). Inflation expectations are approximated by a centred 3-year moving average (3).

The four hypotheses identified in the text are tests of the null hypothesis of no cointegration against the alternative that the real exchange rate is cointegrated with the real interest differential and the equilibrium rate deriving from balance of payments factors. The cointegrating regression based on equation (4J) is given by:

$$q(t) = const + \alpha\ [a(t) - a^*(t)] - \beta\ [R(t) - R^*(t)] + \xi(t) \qquad (4K)$$

where $\xi(t)$ is the vector of residuals from the cointegrating regression. As before each of the variables was pre-tested to confirm that they are integrated processes of order one. The Augmented Dickey Fuller (ADF) test is then implemented to test whether the real exchange rate is cointegrated with its fundamental determinants. Depending on the significance of the constant term and time trend, cointegration is assessed by the significance of the parameter on the lagged level of the error term from equation (4J) in the ADF regression. Critical values for the t-statistics are presented in Engle and Yoo (1987). Since this test is only valid asymptotically, it is also useful when dealing with the shorter sample periods to test whether the data generating process in equation (4K) is also an error correction process -- an equivalent concept to cointegration. Results for these tests and the implicit structure of the ADF and error correction estimating equations are not presented here but are available from the authors.

## NOTES

1. See for example Frankel (1979, 1985), Hooper and Morton (1982), Shafer and Loopesko (1983), Meese and Rogoff (1985), Sachs (1985) and Isard (1988), Fukao (1989).

2. Thus if the equilibrium real exchange rate for the yen against the rest of the world rises, all bilateral equilibrium rates rise. This applies also to the equilibrium real rate for the dollar. The equilibrium bilateral rate between the yen and the dollar is a net outcome of these fundamental balance of payments influences.

3. As in Danker and Hooper (1989). Ten year inflation expectations are unlikely to have much meaning in practice -- witness that most official forecasts of inflation have an eighteen month to two year horizon at most. Attempts to use econometrically generated ten year forecasts of inflation have never found empirical support in empirical work on real exchange rates as, for example, Shafer and Loopesko find. The current quarterly formulation assumes that 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.

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