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Has International Financial Integration Increased?

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Abstract: This paper compares the behavior of real interest rate differentials across the major countries under the Bretton Woods regime and the regime of floating exchanges that replaced it. The primary object is to investigate both the extent of market integration and how it may have changed through time. For all fifteen possible country pairs real interest differentials are mean reverting, and in two-thirds of these cases indistinguishable from zero statistically. Additional evidence points to a narrowing of differentials under floating rates over time and an increase in speeds of convergence.

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Real interest rate equalization is the broadest and arguably most theoretically appealing of the various measures of financial integration. In this paper, we examine the behavior of cross-country real interest rate differentials for the United States and five other major industrial countries vis-à-vis one another during the last decade and a half of the Bretton Woods period and under the current regime of floating rates that replaced it. Our object primary object is to investigate both the extent of financial market integration *per se* and whether and how it may have changed through time.

We focus on three issues specifically: whether real interest rate differentials, if not literally zero, are at least small in absolute value and hence consistent with financial integration in the presence of cross-country differences in risk; whether they are mean reverting, and hence indicative of long-run equilibrium; and whether and how their behavior has differed across exchange-rate regimes. As a first step in this investigation we examine separately the time-series behavior of the individual countries' real interest rates and their nominal rate and inflation components.

We find after allowing for a structural break in 1980 that real interest rates in the five Six countries are stationary. We find further that cross-country differentials are invariant to the change in regime. Fluctuations in differentials occur periodically over the sample period, but while somewhat persistent, in the end prove transitory. For all fifteen possible country pairs real interest rate differentials are mean reverting, and in two-thirds of these cases indistinguishable from zero statistically. Additional evidence points to a narrowing of differentials through time and an increase in speeds of convergence.

Has international financial integration therefore increased? Some of this evidence suggests that it has; almost none suggests the opposite. Viewed from an absolute standpoint, moreover, the degree of integration appears to be not drastically different from what one finds comparing the behaviors of spreads between the nominal rates yielded by different domestic financial instruments. If the markets for these instruments can be considered well integrated, as they commonly are believed to be, then the implication is obvious -- so also international markets.

I. Theoretical Considerations

To measure financial integration we adopt the criterion of real interest parity. To see what this entails, consider the following equation in which the differential between the *ex ante* real yields on domestic and foreign bonds, $\rho_t - \rho_t^F$, has been decomposed into two components, the deviation from uncovered interest parity $[(R_t - R_t^F) - \dot{s}_t^*]$, and the deviation from anticipated purchasing power parity, $[\dot{s}_t^* - (\pi_t^* - \pi_t^{*F})$:

Define R

$$\rho_t - \rho_t^F = [(R_t - R_t^F) - \dot{s}_t^*] + [\dot{s}_t^* - (\pi_t^* - \pi_t^{*F})], \tag{1}$$

where the π_t^*s are rates of inflation anticipated at time t to prevail over the life of the bond, $\dot{s}_t^*$ is the similarly defined anticipated rate of change of the nominal exchange rate, and the superscript F denotes the foreign country.

For *ex ante* real interest rates in the two countries to be equal, therefore, deviations from both UIP and anticipated PPP both have to be zero -- the law of one price in an *ex ante* sense has to hold in both bond markets and goods markets. In the absence of perfect foresight, the distinctions between actual and anticipated inflation and hence between *ex ante* and *ex post* real yields become relevant. For *ex post* yields to be equal, an additional condition has to be met: The differential between economic agents' errors in predicting inflation in the two countries also has to be zero.

To see why, first write the *ex post* real yields r and r^F in terms of their *ex ante* counterparts and the inflation prediction errors ϵ and ϵ^F:

$$r_t = \rho_t + \epsilon_t\,, \tag{2a}$$

and

$$r_t^F = \rho_t^F + \epsilon_t^F \tag{2b}$$

Then after rearranging terms in (2a) and (2b), substitute for ρ and ρ^F in (1). The result is

$$r_t - r_t^F = [(R_t - R_t^F) - \dot{s}_t^*] + [\dot{s}_t^* - (\pi_t^* - \pi_t^{*F})] + \overline{\epsilon}_t^*\,, \tag{3}$$

where $\overline{\epsilon}_t = \epsilon_t - \epsilon_t^F$. Clearly, this last term -- the error in predicting the inflation differential -- also matters. If it is non-zero, *ex post* real rates will differ even if *ex ante* rates are equal. The prediction error associated with the exchange rate change, of course, cancels out.

In the empirical work that follows, we use *ex post* measures of real interest rates throughout. Under the assumptions of rational expectations, prediction errors will be mean zero in large samples. We therefore place more confidence in inferences with regard to the long-run behavior of real interest differentials rather than their shorter term movements.

An additional reason for doing so is the possible effects of shocks on interest differentials. Although the evidence on this question has been mixed, a considerable number of recent studies suggest that monetary shocks have significant effects on real interest rates over the shorter run.[1] Given differences in the magnitudes and timing of such shocks among countries these effects are likely to spill over into real interest differentials as well as the levels of rates within the various countries. Thus, for example, a monetary tightening in the United States that goes unmatched by similar policy changes abroad would lead to short-term increases in U.S. real interest rates and decreases in U.S. versus foreign real interest differentials. Real shocks -- waves of innovation, productivity shocks, fiscal policy changes and the like -- also might be expected to have short-term real-rate effects.

I.A. Previous Evidence on Real-Interest Equality

Much of the existing empirical evidence has been inconsistent with complete financial integration and with full equality of real interest rates among countries.[2] In direct tests of real-interest rate equality, based on regressions such as

$$r_t = a + b\, r_t^F + \eta_t \,, \tag{4}$$

researchers generally have rejected the hypothesis that (a b) = (0 1). These studies, now close to a decade and a half old, include Cumby and Mishkin (1986), Mark (1985), Merrick and Saunders (1986) and Mishkin (1984a,b).

Indirect evidence derived from studies of UIP, in general, has told a similar story. Underlying these studies is an expanded version of equation (1), in which the deviation from *ex ante* UIP is decomposed into two components: the deviation from covered interest rate parity, $(R_t - R_t^F) - fd_t$, where fd_t is the forward premium; and the difference between the forward premium and the anticipated change in the nominal exchange rate:

$$\rho_t - \rho_t^F = [(R_t - R_t^F) - fd_t] + [fd_t - \dot{s}_t^*] + [\dot{s}_t^* - (\pi_t^* - \pi_t^{*F})], \tag{5}$$

Since the bulk of the evidence shows covered interest parity holding for major currencies in recent decades, researchers have focused their attention on the second and third right-hand-side terms in equation (5), and particularly the second.[3] For the current float, the period investigated in these studies, the results have been largely negative. Using quarterly and monthly data and forecast horizons of one to twelve months, researchers generally have found significant differentials between fd and $\dot{s}^*$.[4] They have interpreted these differentials variously as risk premia, reflections of rational learning in the presence of regime changes, and irrational behavior on the part of traders.[5] Whatever the underlying cause, these differentials imply non-zero differentials between real interest rates internationally.[6]

Of particular concern has been the effect of exchange-rate variability on real-interest differentials. The uncertainty generated by frequent and substantial changes in real exchange rates, some observers argue, has adversely affected the functioning of capital markets. Although international arbitrage continues to take place, it is hampered by the heightened uncertainty. The flow of capital from one country to another therefore is decreased which in turn results in widened cross-country real interest differential (see, e.g., McKinnon, 1990) [7].

Lothian (1996), examining annual data on real interest rate differentials over the long period 1791-1992, however, fails to find such effects. His evidence shows largely similar (but non-zero) cross-country real interest differentials under the classical gold standard of 1875-1914, the Bretton Woods regime and the current float. Several other recent studies of real interest equalization for the floating rate period alone also present results somewhat more favorable to the real interest equalization. These include Goodwin and Grennes (1994), Gagnon and Unreth (1995), Johnson (1992), and Kugler and Neusser (1993). All find at least a long-run tendency toward stable real interest differentials, if not outright real-interest equality.

II. Empirical Results

The interest-rate data used in the empirical analysis are quarterly short-term domestic money-market interest rates for six countries (Canada, France, Germany, Japan, the United Kingdom, and the United States) over the period 1957 Q1 to 1995 Q2.[8] These countries were chosen on the basis of data availability and because of their prominent positions in the world economy. The price-level data used in constructing real interest rates are for consumer price indexes or other similar cost-of-living indexes. The source for these data was the CD-ROM version of the International Monetary Fund's International Financial Statistics.

II.A. Overview of the Data

Figures 1 and 2 provide a summary view of how real interest rates in the six countries have behaved over the sample period. Shown in Figure 1 is a time-series plot of the quarterly six-country average real rate, and plus and minus one standard deviation upper and lower bounds about that average. Figure 2 displays two measures of the cross-country divergence in real interest rates – the quarterly cross-country standard deviation used to derive the bounds in Figure 1, and the quarterly mean absolute deviation of real interest rates from their cross-country averages.

Two features of Figure 1 stand out. The first is the importance of two jump-like movements in the three series, the abrupt decline that occurs around 1973 and the even more dramatic increase that takes begins in or around early 1980. The second is the fact that these movements appear to take place in most of the countries. Though a small bit of evidence, this commonalty of movements is certainly consistent with the view that these countries are part of an integrated world market.

Also evident in this chart, but perhaps better illustrated by Figure 2, are the often substantial quarterly cross-country divergences in real interest rates that occur in particular quarters. But as Figure 2 also demonstrates, persistently wide real-interest differentials are not a general phenomenon. Instead they appear to be confined to several clearly defined periods. In the end, differentials on average narrow and appear to return to a stable value. This appears to be true moreover throughout the sample period, under both fixed and floating exchange rates. Below we examine further these features of the data.

II.B. Results of Unit Root Tests

To investigate the time-series behavior of real interest rates and their nominal rate and inflation components, we conducted a series of unit root tests on the levels and first differences of the three series. Tables 1 and 2 present the results of the Augmented Dickey Fuller (ADF) and Phillips-Perron tests that we performed.

Perhaps not surprisingly, given the pattern of movements of real interest rates visible in Figure 1, the results of these tests were somewhat ambiguous. In both the ADF and Phillips-Perron tests we were unable to reject the hypothesis that the levels of nominal interest rates contained unit roots in all but one instance. The one exception was Japanese nominal interest rates in the ADF tests (though not the Phillips-Perron tests). At the same time we always were able to reject the unit root null for the differences of the nominal rates. We conclude that nominal rates can be treated as I(1). For inflation, in contrast, the two sets of tests yielded totally conflicting results. In the ADF tests for the levels of inflation, we never could reject the unit root hypothesis, while in the Phillips-Perron tests we always could. Viewed separately, the first set of results suggests that inflation rates are I(1); the second that they are I(0).

This disparity between the two sets of test results raises obvious questions about the processes followed by real interest rates. If inflation and nominal interest rates are indeed both I(1), as suggested by the ADF tests, real interest rates could still be stationary, provided that nominal rates and inflation are cointegrated. If the orders of integration of the two series differ, however, as the Phillips-Perron tests suggest they do, then real interest rates in these countries necessarily would be non-stationary as Rose (1988) had earlier argued for the United States. Tests performed on the real interest rates themselves failed to resolve this issue. In the ADF tests, we could not reject the unit root hypothesis in any instance for the levels of real interest rates, while in the Phillips-Perron tests we always could.

II.C. Testing for Structural Breaks

If real interest rates are in fact non-stationary it is still possible that cross-country differentials are stationary since real rates in the various countries might very well be cointegrated. Alternatively the results of the unit root tests may themselves be spurious. Unit root tests are of notoriously low power in small samples. In the presence of structural breaks, this is à fortiori true, as Perron (1989) has shown, and for real interest rates this is liable to be a particularly troubling problem. In their examinations of U.S. real interest rate data, Mishkin (1986) and Bonser-Neal (1990) report such breaks occurring in both 1973 and 1980. For the series studied here, moreover, this also appears to be the case as indicated in Figure 1.

To investigate this issue econometrically, we use Zivot and Andrews' (1992) modification of Perron's procedure. Zivot and Andrews argue that potential breakpoints, should be treated as endogenous. Failure to do so will bias the unit root tests towards rejecting the unit root null too frequently. They therefore developed a data dependent algorithm to determine possible break points and thus transformed Perron's conditional unit root test into an unconditional test. Monte Carlo simulations of their modifications of Perron's models showed that the appropriate critical values were larger (in an absolute sense) than those used by Perron.

They investigated three models: a shift in the mean of the process (Model A), a shift in the rate of growth of the process (Model B), and a shift in both the mean and the rate of growth of the process (Model C). The null hypothesis for all three models was:

$$y_t = \mu + y_{t-1} + e_t \tag{6}$$

that is, that the series $\{y_t\}$ is integrated of order 1 without an exogenous structural break. Their alternative hypothesis is that it can be represented by various trend-stationary processes with a once only breakpoint occurring at an unknown time in each. The aim of the Zivot and Andrews procedure is to sequentially test the candidates for this breakpoint and select the one that gives the most weight to the trend-stationary alternative. That is, the breakpoint λ is chosen as the minimum t-value for the hypothesis $\alpha^i = 1$ for i = (A,B,C) in sequential tests of the following augmented regressions:

Model A:

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\lambda}) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \Sigma_{j=1}^{k} \hat{c}_j^A \Delta y_{t-j} + \hat{e}_t \tag{7a}$$

Model B

$$y_t = \hat{\mu}^B + \hat{\beta}^B t + DT_t^*(\hat{\lambda}) + \hat{\alpha}^B y_{t-1} + \Sigma_{j=1}^{k} \hat{c}_j^B \Delta y_{t-j} + \hat{e}_t \tag{7b}$$

Model C

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{\lambda}) + \hat{\beta}^C t + DT_t^*(\hat{\lambda}) + \hat{\alpha}^C y_{t-1} + \Sigma_{j=1}^{k} \hat{c}_j^C \Delta y_{t-j} + \hat{e}_t \tag{7c}$$

where $DU_t(\hat{\lambda}) = 1$ if $t > T\lambda$ and 0 otherwise; $DT_t^*(\hat{\lambda}) = t - T\lambda$ if $t > T\lambda$ and 0 otherwise and where $\lambda = Tb/T$, the proportion of the total number of observations T up until the breakpoint Tb.

In testing the unit root hypothesis, the smallest t-values for the hypothesis $\alpha^i = 1$ in each instance are compared with the set of critical values estimated by Zivot and Andrews. Because their testing methodology is not conditional on the prior selection of the breakpoint (all points are considered potential candidates) their critical values are larger (in an absolute sense) than those of Perron. Consequently it is more difficult to reject the null hypothesis of a unit root.[9]

Table 3 presents the results of the Zivot and Andrews tests for models A, B and C. Model A appears to produce fairly consistent results across all countries in that it points to a structural break at roughly the first quarter of 1980 and results in rejection of the null hypothesis of a unit root in all instances. These results therefore suggest that the implication of the ADF and Phillips-Perron tests of non-stationarity of the various countries' real interest rates is incorrect. We therefore proceeded on the basis that real interest rates were stationary across all countries and examined possible dynamics of the real rate differential incorporating the structural break in 1980 Q1.[10]

The economic interpretation of this break, however, remains somewhat unsettled. Some researchers have attributed the shift in the U.S. to the adoption of new Federal Reserve policy that occurred in late 1979 and became more apparent in 1980. Why operating procedures per se should have such an effect is not specified. An alternative line of reasoning, which we find more theoretically appealing, focuses instead on the learning process in which financial market participants were forced to engage during this period (see Evans and Wachtel, 1993; Evans and Lewis, 1995) as a result of the shift to a lower inflation regime. *Ex post* real interest rates stayed persistently high, according to this argument, because market participants only gradually learned that a new lower inflation regime was in place. The anticipated rate of inflation therefore lagged the actual.

II.D Results for Real Rate Differentials

Although real interest rates may not be equal across countries at all points in time, they nevertheless may revert to common long term means. We examined this question first by testing the joint hypothesis from the SUR approach that all of the constant terms -- the long-term means -- were equal in each period. The Wald chi-squared statistic rejected the joint test at the 5% level of significance. So also did tests of equality between means for each period separately. These results implied that deviations between long term means may persist for prolonged periods. Nevertheless one would expect that for some pairs of countries the situation might be different. For example one might expect the long-term means for Canada and the United States to be similar, because of the strong economic and financial ties between the two countries. A similar argument might be made for France and Germany under the ERM. To address this question we estimated equation (14) for all possible pairs of countries.

$$\Delta rd_{ijt} = \alpha_1 + \alpha_2 D80 + \nu_1 rd_{ijt-1} + \nu_2 D80\, rd_{ijt-1} + e_t \tag{8}$$

where rd_{ijt} is the difference between the real interest rates in countries i and j, and D80 is a dummy variable that takes the value of 1 after 1980 Q1 and is 0 otherwise.

The constant term in this regression α_1 is an estimator of the difference between the pre-1980 means in the two countries, and should not be significantly different from zero if the two countries' means are the same in that period. The sum of α_1 and coefficient of the dummy variable α_2 is a similar estimator for the post-1980 period. If α_2 is not significantly different from zero the inference to be made is that the average real interest rate differentials are the same in both periods.

Table 4 presents summary results of these pair-wise comparisons inclusive of the structural break.[11] The first point to note is that in only five of the fifteen cases is the constant term α_1, the estimator of the first period mean, significantly different from zero. Three of these cases, however, involve comparisons of t-bill rates and rates on other money market instruments, and hence may be simply a reflection of the greater risk attached to the latter. Interestingly in the five comparisons of U.S. and foreign-country rates α_1 is never significant. Nor does the picture change very much after 1980. In six of the comparisons, α_2 is significant, but in three of these cases it implies a *smaller* average real rate differential post-1980.

Of further interest are the patterns of adjustment implied by the estimated γs. In Table 4, γ_1 is always significantly different from zero, thus implying mean reversion for all of the country pairs. Most of these coefficients fall between -.50 and -.70, which translates into half lives of adjustment of roughly two to three months. We also find some evidence of a between-period change in adjustment speeds in a number of cases in the form of γ_2s significantly different from zero. In five of the six with significant coefficients, the estimated speed of adjustment increases, and in each instance noticeably so -- with γ_1 and γ_2 summing to close to minus one implying nearly complete adjustment within the quarter.

Combined, these results suggest that there are long-run values, in a number of instances subject to shift, toward which real rate differentials tend. They suggest further that these adjustments if anything have become more rapid through time. A question considered below is whether the observed long-run differentials might reasonably be due to differences in the risk characteristics of the particular countries' bonds.

II.E. Behavior Across Regimes

As noted earlier, a major concern has been the possibly adverse effects of floating exchange rates on international financial integration. To investigate this issue we ran a series of regressions similar to those reported in Table 4, but in this instance used a dummy variable for the floating-rate period to allow intercepts and slopes to vary across regimes:

$$\Delta rd_{ijt} = \alpha_1 + \alpha_2 \, D73 + \nu_1 \, rd_{ijt-1} + \nu_2 \, D73 \, rd_{ijt-1} + e_t, \tag{9}$$

where the dummy D73 here took the value 1 beginning in 1973 Q1 and was 0 otherwise.

These results are reported in Table 5. If the float did cause real interest differentials to widen, as often alleged, we would expect to see coefficients for α_2 that are significantly different from zero and that when summed algebraically with α_1 are greater in absolute value than α_1 alone, thus implying a larger mean differential post-1980 Q1. This is the case in only three instances. We find α_2 significantly different from zero in six of the fifteen comparisons, but in three of these the estimated values are such that a *narrower*, rather than a wider, differential is implied. If we ignore statistical significance and simply compare the magnitudes of α_1 and $\alpha_1 + \alpha_2$, the picture is qualitatively the same. Nine of fifteen comparisons point to narrower differentials; only six to wider. The float *per se* does not appear to have mattered in the way that has been claimed.

There is, however, some inter-country pattern in the differences pre- and post-1973. Two countries, France and Japan, generally exhibit narrower differentials under the float, Japanese real interest rates falling relative to those of other countries and French rising. Canada and the U.K. in several instances show widened differentials, both countries' real rates rising relative to those of the other four countries in our sample. Without stretching the point, one could interpret the French and Japanese findings as caused by the substantial financial liberalization that took place in both countries in the latter portion of the sample period. The Canadian and U.K. results quite possibly can be attributed to the prolonged tight monetary policy that both countries pursued in the early 1990s to curb the higher than major-country average rates of inflation that they were experiencing.

II.F. Cross-Country vs. Within-Country Rate Interest Rate Differentials

The results we have reported do not say anything about the degree of integration in an absolute sense. To do that we need some standard of comparison. One possible benchmark is the behavior of interest-rate spreads within a particular country's financial market, since such markets can reasonably be expected to be well integrated. Behavior of cross-country interest differentials that closely mimicked the behavior of within-country interest differentials would thus provide evidence of international integration.

We have made several such comparisons using the U.S. market as a benchmark. The first, which is reported in the top two lines of Table 6, uses the differential between nominal three-month Libor and 91-day Treasury bill rates; the second, which is reported in the next two lines of that table, uses the differential between nominal 90-day prime commercial paper and 91-day treasury bill rates.[12] These regressions took the form:

$$\Delta rd_{ijt} = \alpha_1 + \nu_1\, rd_{ijt-1} + e_t\,, \tag{10}$$

where the subscripts i and j now refer to different instruments rather than to countries.

Two features of the regressions deserve comment. The first is that the constants, which again are estimators of long-run mean differentials, are significantly different from zero in both instances. For Libor versus the t-bill, the value is .28, while for commercial paper versus the bill it is .22. Both differentials are interpretable as risk premia, with the difference between the two most likely a reflection of the somewhat greater risk associated with bank liabilities. The second feature of interest is the adjustment process. Both spreads are mean-reverting with estimated half lives of adjustment of roughly two to three quarters (i.e. coefficients of -.20 and -.29 on the lagged levels of the respective differentials). Many, if not most, of the real interest differentials observed among countries are not drastically out of line with those for the U.S. Judged by this criterion international markets therefore actually appear rather well integrated. Estimated speeds of adjustment also actually appear faster across countries. This however, could be due to measurement error in the inflation-rate adjustments used in the international comparisons, so we place less stock in this result.

III. Conclusions

The evidence presented above points to considerable long-run financial integration across the six major industrial countries examined in this study. This is true both for the later years of Bretton Woods and to an even greater extent for the current float. The volatility of nominal exchange rates that has characterized the floating-rate regime therefore appears not to have mattered. After we allow for a structural break, real interest rate differentials between pairs of countries appear mean reverting, and in two-thirds of the cases, not significantly different from zero. The evidence also indicates that the speed of convergence has increased over time, and that the degree of integration between international markets does not appear much different than that found for interest rates for markets in the U. S.

Over short but still lengthy periods real interest differentials, have, however, fluctuated greatly and at times been exceedingly wide. Our findings suggest, that this behavior has been due to two sets of factors. The first is the existence of capital, controls and other such governmentally imposed impediments to capital flows. France and Japan are examples here. The other is as a transient response to shocks, policy and otherwise, and not as has been previously thought, indicative of deficient market integration. An important question that remains to be answered are the specific types of shocks that has caused the movements.

NOTES

1. See Lastrapes (1998 forthcoming) for multi-country evidence on this subject and the studies cited therein.

2. See the review of this literature in Mussa and Goldstein (1993).

3. In the early years of the current float PPP also seemed to be contradicted by the evidence. Most of the studies reaching that conclusion, however, were based on analysis of floating exchange rates in the decade or so following their introduction. More recent studies using long historical time series (e.g. Lothian and Taylor, 1996) almost universally show exchange rates to be mean reverting. More recent studies for the float alone also suggest the same thing (see Frankel and Rose, 1995; and Lothian, 1997).

4. Frankel (1992, p. 200) in reviewing the evidence describes these currency premia as "substantial and variable" and "responsible for approximately the entirety of [the] real interest differentials vis-à-vis the United States." In addition, see Engel (forthcoming), and Hodrick (1987) for overviews of this literature.

5. The risk premium explanation has been most prevalent. Frankel and Froot (1987, 1990) present evidence of irrationality on the part of traders. Evans and Lewis (forthcoming), however, show that this latter explanation and rational learning in the face of change in the inflation regime are observationally equivalent. Lothian and Simaan (1995) show that despite the often substantial departures from UIP over the shorter run, the relation holds rather well over longer periods.

6. Additional evidence on financial integration is provided by three related areas of research: the analysis of the cross-country relations between investment and savings begun by Feldstein and Horioka (1980); the analysis of international consumption risk sharing (e.g. Lewis, 1993); and the study of international portfolio allocation -- the home-bias literature (e.g. Tesar and Werner, 1995). All in one way or another also have produced evidence of incomplete international financial links.

7. For a further discussion of this hypothesis in Mussa and Goldstein (1993).

8. For the United States, the United Kingdom and Canada the data are treasury bill rates; for France, Germany and Japan they are call money rates.

9. We should note that the Zivot and Andrews procedure did not aim at testing for structural change per se, but rather was designed to test for a unit root in the presence of an unknown structural break.

10. For additional evidence supporting the stationarity of real interest rates see Neusser (1991), and Jackson and Lothian (1993)

11. For the comparisons of foreign rates with U.S. rates we also estimated the equation using SUR to correct for serial correlation and heteroskedasticity between countries. These estimates were only slightly different from the pair-wise estimates of Table 4 for the U.S. Hence we do not report these results.

12. The sample periods used in this first draft were 1957 Q1 to 1995 Q1 for CP vs. t-bill and 1972 Q1 to 1995 Q1 for Libor vs. t-bill. All rates were expressed on a 360-day money market yield basis.

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Table 1

Unit Root Tests on Levels of Nominal Interest Rates, Inflation and Real Interest Rates

Country	Variable	ADF	Lag	PP
Canada				
	nominal	-2.03	7	-2.33
	inflation	-2.02	9	-4.22*
	real	-2.36	8	-5.83*
France				
	nominal	-2.48	5	-2.49
	inflation	-1.84	5	-5.26*
	real	-2.86	5	-7.65*
Germany				
	nominal	-2.70	9	-2.77
	inflation	-2.76	12	-8.14*
	real	-2.62	12	-8.99*
Japan				
	nominal	-3.99*	5	-3.26
	inflation	-2.18	12	-7.34*
	real	-2.16	12	-7.99*
U.K.				
	nominal	-1.82	9	-2.44
	inflation	-1.74	12	-6.21*
	real	-1.91	12	-8.22*
U.S.				
	nominal	-1-85	7	-2.17
	inflation	-2.19	3	-3.66*
	real	-2.45	2	-4.88*

Note: Critical value of the ADF and Phillips-Perron test at 5% level is 3.4, T=153.

Table 2

Unit Root Tests on First Differences of Nominal Interest Rates, Inflation and Real Interest Rates

Country	Variable	ADF	Lag	PP
Canada	nominal	-4.34*	8	-9.69*
	inflation	-4.08*	8	-17.75*
	real	-3.83*	11	-16.55*
France				
	nominal	-5.11*	6	-9.48*
	inflation	-7.17*	5	-14.78*
	real	-6.30*	6	-14.55*
Germany				
	nominal	-3.74*	11	-9.09*
	inflation	-3.07	12	-15.00*
	real	-5.54*	12	-14.38*
Japan				
	nominal	-5.38*	2	-11.76*
	inflation	-4-16*	12	-22.0*
	real	-4.79*	12	-22.5*
U.K.				
	nominal	-4.41*	11	-10.76*
	inflation	-4.13*	12	-20.87*
	real	-3.87*	12	-21.78"
U.S.				
	nominal	-4.55*	7	-10.02*
	inflation	-4.20*	12	-14.84*
	real	-3-48*	12	-15.17*

Note: Critical value of the ADF and Phillips-Perron test at 5% level is 3.4, T=153.

Table 3

Zivot and Andrews Unit Root Tests Inclusive of a Structural Break

	Model A		Model B		Model C	
Country	**break point** **t value**	**lag**	**break point** **t value**	**lag**	**break point** **t value**	**lag**
Canada	1980 Q2 -7.17*	0	1973 Q2 -6.89*	0	1978 Q2 -7.93 *	0
France	1980 Q2 -8.09*	0	1980 Q2 -7.65*	0	1980 Q4 -8.14*	0
Germany	1979 Q2 -6.55*	4	1975 Q2 -5.58*	5	1979 Q2 -5.81*	9
Japan	1980 Q2 -10.25*	0	1973 Q1 -10.29*	0	1974 Q3 -11.34*	0
U.K.	1980 Q1 -4.67*	4	1974 Q1 -2.90	3	1980 Q2 -11.02*	3
U.S.	1980 Q1 -6.88*	5	1973 Q1 -3.05	5	1980 Q1 -7.07*	5

Note: Critical values of models A, B and C at the 5% level are -4.80, -4.42 and -5.09 respectively.

Table 4

Modeling Cross Country Real Interest Rate Differentials with a Break in 1980

$$\Delta rd_{ijt} = \alpha_1 + \alpha_2 \, D80 + \nu_1 \, rd_{ijt-1} + \nu_2 \, D80 \, rd_{ijt-1} + e_t$$

Countries	α_1	α_2	ν_1	ν_2	R^2
USCA	-.31 (-1.24)	-.84 (-1.94)	-.50 (-4.75)	-.25 (-.34)	.26
USFR	.43 (1.29)	-1.08 (-1.88)	-.66 (-7.56)	.37 (2.52)	.29
USGE	-.49 (-1.61)	.14 (.29)	-.61 (-6.81)	.21 (1.31)	.27
USJA	-.75 (-1.64)	.18 (.26)	-.59 (-7.10)	-.53 (-2.78)	.37
USUK	.66 (1.40)	-2.26 (-2.94)	-.79 (-7.81)	-.25 (-1.48)	.44
UKCA	-1.11 (-2.13)	.50 (.61)	-.80 (-7.92)	-.27 (-1.63)	.45
UKFR	-.11 (-.22)	-.37 (1.78)	-.65 -(7.46)	-.50 (2.53)	.38
UKGE	-1.00 (-2.13)	1.78 (2.47)	-.60 (-6.46)	-.60 (-3.59)	.43
UKJA	-1.38 (-2.48)	2.47 (2.60)	-.65 (-7.86)	-.20 (-.85)	.33
CAFR	.77 (2.06)	-.71 (-1.26)	-.64 (7.52)	.05 (.28)	.31
CAGE	-.15 (-.45)	.98 (1.66)	-.63 (-7.07)	.05 (.29)	.30
CAJA	-.49 (-.99)	2.35 (2.82)	-.70 (-7.89)	-.44 (-2.26)	.40
FRGE	-1.10 (-2.93)	1.67 (2.86)	-.76 (-8.78)	.27 (1.43)	.35
FRJA	-.90 (-1.59)	2.13 (2.32)	-.46 (-6.01)	-.34 (-1.63)	.25
GEJA	-.23 (-.49)	.76 (1.03)	-.55 (-6.61)	-.88 (-4.20)	.38

Note: rd_{ijt} is the difference between the real interest rates in countries i and j, and D80 is a dummy variable that takes the value of 1 after 1980 Q1 and is 0 otherwise.

Table 5

Modeling Cross-Country Real Interest Differentials with a Break in 1973

$$\Delta rd_{ijt} = \alpha_1 + \alpha_2\, D73 + \nu_1\, rd_{ijt-1} + \nu_2\, D73\, rd_{ijt-1} + e_t$$

Countries	α_1	α_2	γ_1	γ_2	R^2
USCA	-.12 (-.44)	-.78 (-2.00)	-.68 (-4.70)	-.20 (-1.22)	.26
USFR	.78 (1.89)	-1.31 (-2.33)	-.68 (-7.28)	.33 (2.37)	.29
USGE	-.05 (-.15)	-.78 (1.63)	-.73 (-6.07)	.25 (1.63)	.30
USJA	-1.09 (-1.85)	.88 (1.19)	-.58 (-5.34)	-.25 (-1.60)	.35
USUK	.03 (.04)	-.19 (-.25)	-.95 (-5.47)	.17 (.86)	.40
UKCA	-.25 (-.40)	-1.21 (-1.53)	-.99 (-5.80)	.10 (.49)	.45
UKFR	.82 (1.29)	-1.89 (-2.24)	-.74 (-6.34)	-.08 (-.49)	.38
UKGE	.025 (.04)	-.93 (-1.26)	-.90 (-5.13)	.18 (.94)	.37
UKJA	-1.39 (-1.98)	1.33 (1.52)	-.71 (-5.35)	.10 (.65)	.31
CAFR	.98 (2.10)	-.79 (-1.32)	-.73 (7.54)	.24 (1.60)	.32
CAGE	.22 (.55)	-.03 (-.05)	-.83 (-6.63)	.34 (2.23)	.30
CAJA	-1.26 (-2.01)	2.78 (3.41)	-.73 (-6.31)	-.22 (-1.42)	.42
FRGE	-.78 (-1.70)	.80 (1.34)	-.73 (-7.32)	.20 (1.29)	.32
FRJA	-1.34 (-1.86)	2.19 (2.37)	-.46 (-5.05)	-.21 (-1.41)	.26
GEJA	-1.26 (-1.98)	2.17 (2.68)	-.64 (-5.27)	-.11 (-.70)	.34

Note: rd_{ijt} is the difference between the real interest rates in countries i and j, and D73 is a dummy variable that takes the value of 1 after 1973 Q1 and is 0 otherwise.

Table 6

Modeling U.S. Nominal Interest Differentials

$$\Delta rd_{ijt} = \alpha_1 + \nu_1 \, rd_{ijt-1} + e_t$$

Rates	α_1	γ_1	SEE	R^2
LIBOR vs. t-bill .277	-.196 (3.07)	.533 (-3.64)		.098
Commercial paper vs. t-bill	.224 (4.33)	-.309 (-5.23)	.354	.154

Note: All interest rates were for 3-month instruments and were expressed on a 360-day money market yield basis.

Fig 1. Six-Country Average of Ex Post Real Interest Rates

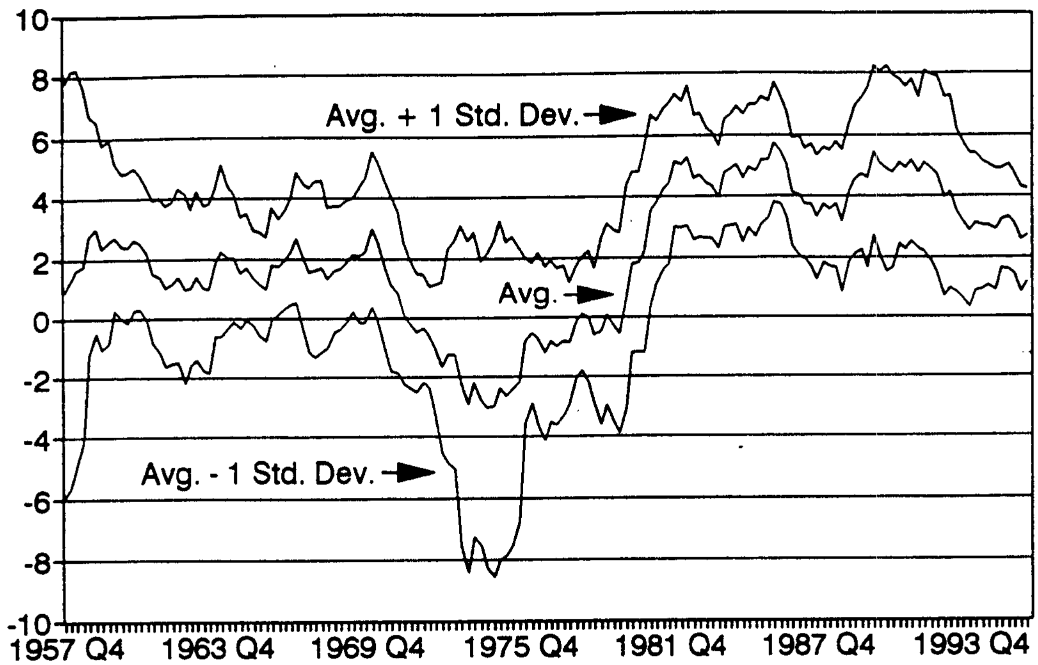

Fig. 2. Dispersion of Real Interest Rates across the Six Countries