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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 its changes over time. For all fifteen possible country pairs real interest differentials are mean reverting, and in two-thirds of these cases indistinguishable from zero statistically. For all country pairs on average and for most such pairs individually, moreover, the estimated differentials are not appreciably different in absolute value than the differentials that we estimate for various money-market rates within the United States. Additional evidence points to a narrowing of differentials under floating rates over time and an increase in speeds of convergence.

> The rate of interest plays a central role in two great branches of economic science,—the theory of prices, and the theory of distribution. The role of the rate of interest in the theory of prices applies to the determination of the prices of wealth, property, and services.
>
> Irving Fisher (1907, p. 225).

In an integrated world economy, real rates of interest on physical assets will tend to converge. So too will real rates of interest on financial assets like bonds, which are much more directly observable. Real interest rate equalization is, therefore, 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. We 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 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 these cross-country 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.

1. Theory and previous evidence

To measure financial integration we adopt the criterion of real interest parity. We define this in Fisherian fashion as:

$$\rho_t - \rho_t^F = \left[R_t - R_t^F\right] - \left(\pi_t^* - \pi_t^{*F}\right), \quad (1)$$

where the ρs are the real rates of interest, the Rs are nominal interest rates and the $\pi_t^* s$ are rates of inflation anticipated at time t to prevail over the life of the bond.[1]

The economic rationale for real interest equalization, also follows directly from Fisher's analysis (see in particular, Fisher, 1907, pp. 279–280). The real rate of interest in Fisher's framework is the real rate of return on physical assets—in his terminology the "commodity rate of interest." It and the real rate of interest on financial assets are linked via an arbitrage relationship. Using this framework, we can view the cross-country differential in real interest rates on bonds as made up of two components, the cross-country differential in real interest rates on physical assets and the (two) within-country differentials between real interest rates on physical assets and on bonds:

$$\rho_t - \rho_t^F = \left[\bar{\rho}_t - \bar{\rho}_t^F\right] + \left[(\rho_t - \bar{\rho}_t) - \left(\rho_t^F - \bar{\rho}_t^F\right)\right], \tag{2}$$

where a $\bar{\rho}_t$ and $\bar{\rho}_t^F$ are the real interest rates on physical assets in the two countries. The first term on the right-hand side reflects the degree of arbitrage across countries; the second, the degree of financial intermediation within the two countries. Viewed from this perspective, the equalization of real interest rates on financial assets therefore depends not only on arbitrage among countries but between markets for financial assets and goods within countries.[2]

In the empirical work that follows, we use *ex post* measures of real interest rates throughout. Since under rational expectations these errors will be mean zero in large samples, we place more confidence in inferences with regard to the long-run behavior of real interest differentials than their short-run movements. An additional reason for emphasizing the long run is the possible effect 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.[3] 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 increases 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 that differ across countries.

Much of the earlier empirical evidence has appeared to be inconsistent with complete financial integration and full equality of real interest rates among countries.[4] In direct tests of real-interest rate equality, based on regressions such as

$$r_t = a + br_t^F + \eta_t, \tag{3}$$

researchers generally have rejected the hypothesis that $(a\ b) = (0\ 1)$. These studies, most of which are now well over a decade old, include Cumby and Mishkin (1986), Mark (1985), Merrick and Saunders (1986) and, more recently, Marston (1995).

Indirect evidence derived from studies of purchasing power parity and covered and uncovered interest parity, has told a similar story. To understand the relevance of such evidence to the issue of real interest rate equality, consider the following alternative decomposition of the real interest differential:

$$\rho_t - \rho_t^F = \left[\left(R_t - R_t^F\right) - fd_t\right] + \left[fd_t - ds_t^*\right] + \left[ds_t^* - \left(\pi_t^* - \pi_t^{*F}\right)\right], \tag{4}$$

where fb_t is the forward premium, ds_t^* is the anticipated change in the log nominal exchange rate, and where $[(R_t - R_t^F) - fb_t]$ is, therefore, the deviation from covered interest rate parity, $[fb_t - ds_t^*]$ the exchange-rate forecast error and $[ds_t^* - (\pi_t^* - \pi_t^{*F})]$ the deviation from anticipated purchasing power parity (in rate-of-change form). The sum of the first two right-hand-side terms, in turn, is the deviation from uncovered interest rate parity.

With well-functioning and otherwise efficient money and foreign-exchange markets, arbitrage will insure that covered interest parity holds exactly. In the presence of capital controls or other similar governmental interferences in these markets this will not be the case, which is why Frankel and MacArthur (1988) refer to the deviation from covered interest parity as the "political premium." For the 1982–87 sample period that they use these premia are small and statistically insignificant for the major industrial countries. France is the one exception.[5]

Since other studies generally report similar findings, researchers have focused greater attention on the second and third right-hand-side terms in Equation (4), particularly the second.[6] Here 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 $\hat{s}^*$.[7] 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.[8] Whatever the underlying cause, these differentials taken by themselves imply non-zero differentials between real interest rates internationally.[9]

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 have argued, 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 according to this argument is decreased which, in turn, results in widened cross-country real interest differentials (see, e.g., McKinnon, 1990).[10]

Lothian (2000), examining annual data on real interest rate differentials over the long period 1791–1992, however, has failed 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), Kugler and Neusser (1993) and Mancuso, Goodwin, and Grennes (2001). All find at least a long-run tendency toward stable real interest differentials, if not outright real-interest equality. Kang and Fratianni (1993) in a study of major-country equity markets also present evidence of increased integration during the course of the 1980s.

2. 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 2000 Q2. We chose these countries because of their prominent positions in the world economy and because of the availability of relatively long data series for these countries. Unfortunately data for treasury bill rates are only available for the full period for Canada, the United Kingdom and the United States. For France, Germany and Japan we therefore used call money rates. The price-level data used in constructing real interest rates were for consumer price indexes or other similar cost-of-living indexes. The source for all of these data was the CD-ROM version of the International Monetary Fund's *International Financial Statistics*.

2.1. 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. Shown in Figure 2 is a separate plot of the quarterly cross-country standard deviations used to derive the bounds in Figure 1.

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 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

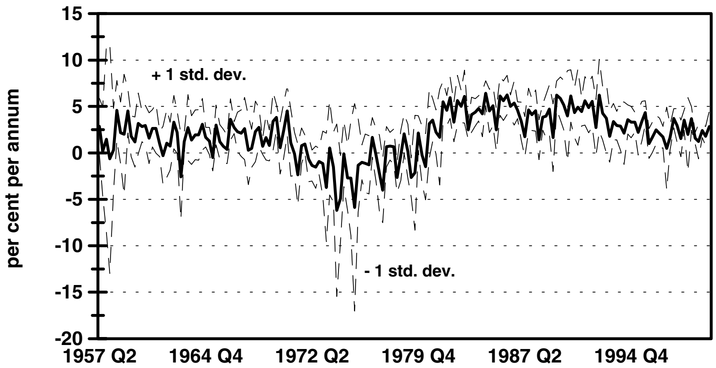

Figure 1. Cross-country average of real interest rates.

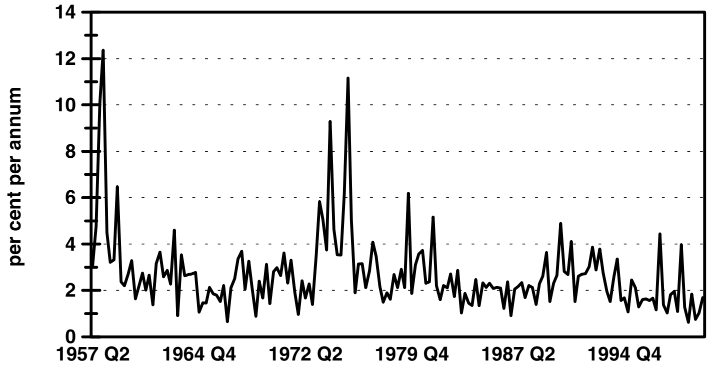

Figure 2. Cross-country standard deviation of real interest rates.

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.

2.2. Results of unit root tests

To investigate the time-series behavior of real interest rates and their nominal rate and inflation components further, we first conducted a series of standard Augmented Dickey Fuller (ADF) and Phillips-Perron unit root tests on the levels and first differences of the three series to try to determine the order of integration of the series. We present these results in Tables 1 and 2. Perhaps not surprisingly, given the pattern of movements of real interest rates visible in Figure 1, the results of these tests were somewhat ambiguous. This could be due either to low test power or to the possible effects of structural breaks. Accordingly, after briefly discussing these initial test results, we go on to employ a superior technique that endogenously allows for such breaks.

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).

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, $T = 153$.

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.

2.3. 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

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, $T = 153$.

samples. In the presence of structural breaks, this is *a fortiori* true, as Perron (1989, 1990) has shown, and for real interest rates this is liable to be a particularly troubling problem. In her examination of U.S. real interest rate data, Bonser-Neal (1990) reports such breaks occurring in both 1973 and 1980. Garcia and Perron (1996) present later evidence consistent with those findings. For the series studied here, the same thing appears to be true as a glance at Figure 1 indicates.

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 toward 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:

$$y_t = \mu + y_{t-1} + e_t, \tag{5}$$

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:

$$y_t = \mu^A + \Theta^A DU_t(\lambda) + \beta^A t + \alpha^A y_{t-1} + \sum_{j=1}^{k} c_j^A \Delta y_{t-j} + \epsilon_t, \tag{6a}$$

Model B

$$y_t = \mu^B + \beta^B t + \gamma^B DT_t^*(\lambda) + \alpha^B y_{t-1} + \sum_{j=1}^{k} c_j^B \Delta y_{t-j} + \epsilon_t, \tag{6b}$$

Model C

$$y_t = \mu^C + \Theta^C DU_t(\lambda) + \beta^C t + \gamma^C DT_t^*(\lambda) + \alpha^C y_{t-1} + \sum_{j=1}^{k} c_j^c \Delta y_{t-j} + \epsilon_t, \tag{6c}$$

where $DU_t(\lambda) = 1$ if $t > T\lambda$ and 0 otherwise; $DT_t^*(\lambda) = t - T\lambda$ 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.[11]

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 differentials incorporating the structural break in 1980 Q1.[12] Below we consider an alternative

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	0	1973 Q2	0	1978 Q2	0
	−7.17*		−6.89*		−7.93*	
France	1980 Q2	0	1980 Q2	0	1980 Q4	0
	−8.09*		−7.65*		−8.14*	
Germany	1979 Q2	4	l975 Q2	5	1979 Q2	9
	−6.55*		−5.58*		−5.81*	
Japan	l980 Q2	0	1973 Q1	0	1974 Q3	0
	−10.25*		−10.29*		−11.34*	
U.K.	1980 Q1	4	1974 Q1	3	1980 Q2	3
	−4.67*		−2.90		−11.02*	
U.S.	1980 Q1	5	1973 Q1	5	1980 Q1	5
	−6.88*		−3.05		−7.07*	

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

breakpoint of 1973 Q1 when we examine the possible effect of the change in the exchange-rate regime.[13]

The economic interpretation of the 1980 break remains unsettled. The high U.S. budget deficits of the early 1980s, and the adoption of new Federal Reserve operating procedures that began in and continued over the course of the next three years have both been cited. A variant of the latter hypothesis focuses on the learning process in which financial market participants were forced to engage during this period (see Evans and Wachtel, 1993; Evans and Lewis, 1995a) as a result of the shift to a lower inflation regime. *Ex post* real interest rates were 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.

2.4. *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. One would expect this to be true for closely linked countries in particular, for example Canada and the United States with their strong economic and financial ties and France and Germany under the ERM.

To address this issue we estimated the following equation for all possible country-pairs:

$$\Delta rd_{ijt} = \alpha_1 + \alpha_2 \mathrm{D80} + v_1 rd_{ijt-1} + v_2 \mathrm{D80}\, rd_{ijt-1} + e_t, \quad (7)$$

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 ratio $(\alpha_1/-v_1)$ is an estimator of the long-run differential between the two countries' real interest rates pre-1980 Q1. The ratio $(\alpha_1+\alpha_2)/-(v_1+v_2)$ is a similar estimator for the period thereafter. A value of α_1 that is significantly different from zero therefore implies a significant long-run differential in the first period. Correspondingly, a value of α_2 that is significantly different from zero implies a significant difference between the long-run differentials in the two periods.

Table 4 presents a summary of the results based on Equation (8).[14] Shown in the left part of the table are estimates of the regression coefficients and other summary statistics; shown in the right are the resultant estimates of the long-run average mean real interest differentials in the two periods and the related speeds of adjustment. The first point to note is that in only six of the fifteen cases is α_1 significantly different from zero. Four of these cases, moreover, 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 four of the five comparisons of U.S. and foreign-country rates α_1 is insignificant. Nor does the picture change very much after 1980. In seven of the comparisons, α_2 is significant, but in four of these cases it implies a *smaller* average real rate differential post-1980, and in one only a negligible between-period difference in average differentials.

Of further interest are the patterns of adjustment implied by the estimates of v_1 and v_2. In Table 4, v_1 is always significantly different from zero, thus implying mean reversion for all of the country pairs. Most of the estimated adjustment coefficients fall between roughly .50 and .70, which translates into half lives of roughly two to three quarters. We find evidence of a between-period change in adjustment speeds in the form of v_2 coefficients significantly different from zero in eight cases. In seven of these, the estimated speed of adjustment increases, and in each instance noticeably so—with v_1 and v_2 summing to close to minus one, which in turn implies 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 the differentials in the main have narrowed through time and that adjustment speeds have become more rapid. 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.

2.5. Behavior across exchange-rate 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

Table 4. Modeling cross country real interest rate differentials with a break in 1980 $\Delta rd_{ijt} = \alpha_1 + \alpha_2 \mathrm{D80} + v_1 rd_{ijt-1} + v_2 \mathrm{D80} rd_{ijt-1} + e_t$.

Countries	α_1	α_2	v_1	v_2	R^2/SEE	$\frac{\alpha_1}{-v_1}$	$\frac{(\alpha_1+\alpha_2)}{-(v_1+v_2)}$	$-v_1$	$-(v_1+v_2)$
USCA	−0.299	−0.533	−0.477	−0.060	0.240	−0.626	−1.550	0.477	0.537
	−1.281	−1.434	−4.884	−0.441	2.179				
USFR	0.409	−0.791	−0.653	0.371	0.282	0.627	−1.353	0.653	0.282
	1.254	−1.572	−7.946	2.762	3.098				
USGE	−0.614	0.565	−0.610	0.078	0.282	−1.007	−0.092	0.610	0.532
	−2.078	1.329	−7.082	0.529	2.726				
USJA	−0.748	1.045	−0.598	−0.374	0.357	−1.252	0.305	0.598	0.971
	−1.628	1.571	−7.183	−2.265	4.286				
USUK	0.748	−2.227	−0.782	−0.275	0.442	0.956	−1.401	0.782	1.057
	1.621	−3.215	−8.168	−1.745	4.347				
UKCA	−1.218	0.980	−0.786	−0.323	0.456	−1.550	−0.214	0.786	1.109
	−2.428	1.358	−8.265	−2.051	4.633				
UKFR	−0.221	0.116	−0.641	−0.471	0.385	−0.344	−0.094	0.641	1.112
	−0.433	0.155	−7.819	−2.633	4.884				
UKGE	−1.135	2.678	−0.569	−0.681	0.445	−1.995	1.235	0.569	1.250
	−2.520	4.075	−6.681	−4.426	4.057				
UKJA	−1.451	2.942	−0.652	−0.220	0.340	−2.227	1.710	0.652	0.872
	−2.650	3.534	−8.145	−1.144	4.978				
FRCA	−0.800	0.735	−0.650	0.054	0.313	−1.231	−0.109	0.650	0.596
	−2.167	1.378	−8.170	0.304	3.436				
FRGE	−1.209	1.934	−0.750	0.213	0.353	−1.612	1.350	0.750	0.537
	−3.275	3.423	−9.215	1.198	3.341				
FRJA	−0.874	2.432	−0.463	−0.405	0.270	−1.889	1.795	0.463	0.868
	−1.574	2.837	−6.369	−2.178	5.165				
GECA	0.257	−1.268	−0.647	−0.047	0.318	0.398	−1.456	0.647	0.694
	0.816	−2.505	−7.700	−0.283	3.010				
GEJA	−0.114	0.686	−0.510	−0.739	0.371	−0.223	0.458	0.510	1.249
	−0.246	1.004	−6.759	−4.105	4.437				
CAJA	−0.465	2.563	−0.705	−0.392	0.408	−0.660	1.912	0.705	1.097
	−0.954	3.337	−8.244	−2.266	4.637				

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; t values are beneath the coefficients; critical values at the 5% and 1% levels are 1.96 and 3.35, respectively.

in this instance used a dummy variable for the floating-rate period to allow intercepts and slopes to vary across regimes:

$$\Delta rd_{ijt} = \alpha_1 + \alpha_2 \mathrm{D73} + v_1 rd_{ijt-1} + v_2 \mathrm{D73}\, rd_{ijt-1} + e_t, \tag{8}$$

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

These results are reported in Table 5. If the float did cause real interest differentials to widen, as has been alleged, we would expect to see coefficients for α_2

Table 5. Modeling cross-country real interest differentials with a break in 1973 $\Delta rd_{ijt} = \alpha_1 + \alpha_2 \text{D73} + v_1 rd_{ijt-1} + v_2 \text{D73}\, rd_{ijt-1} + e_t$.

Countries	α_1	α_2	v_1	v_2	R^2/SEE	$\frac{\alpha_1}{-v_1}$	$\frac{(\alpha+\alpha_2)}{-(v_1+v_2)}$	$-v_1$	$-(v_1+v_2)$
USCA	−0.177	−0.524	−0.706	0.244	0.257	−0.252	1.521	0.706	0.461
	−0.639	−1.444	−4.983	1.521	2.154				
USFR	0.890	−1.377	−0.665	0.298	0.285	1.339	1.330	0.665	0.367
	2.202	−2.676	−7.514	2.276	3.093				
USGE	0.023	−0.502	−0.740	0.240	0.293	0.032	0.956	0.740	0.500
	0.068	−1.149	−6.365	1.656	2.704				
USJA	−1.228	1.496	−0.615	−0.189	0.356	−1.997	−0.333	0.615	0.804
	−2.050	2.059	−5.545	−1.274	4.292				
USUK	0.067	−0.280	−0.948	0.152	0.404	0.071	0.268	0.948	0.796
	0.117	−0.393	−5.515	0.791	4.491				
UKCA	−0.337	−0.742	−0.984	0.111	0.438	−0.342	1.236	0.984	0.873
	−0.561	−0.981	−5.851	0.587	4.708				
UKFR	0.895	−1.709	−0.739	−0.059	0.377	1.212	1.020	0.739	0.797
	1.406	−2.145	−6.596	−0.391	4.914				
UKGE	−0.053	−0.388	−0.894	0.245	0.340	−0.060	0.680	0.894	0.649
	−0.095	−0.551	−5.146	1.277	4.424				
UKJA	−1.553	1.914	−0.726	0.119	0.311	−2.139	−0.594	0.726	0.608
	−2.189	2.223	−5.476	0.753	5.087				
FRCA	−1.136	1.027	−0.723	0.204	0.324	−1.571	0.210	0.723	0.520
	−2.517	1.844	−7.976	1.408	3.410				
FRGE	−0.922	1.104	−0.717	0.202	0.315	−1.285	−0.353	0.717	0.516
	−2.051	1.980	−7.594	1.424	3.439				
FRJA	−1.570	2.738	−0.466	−0.254	0.283	−3.370	−1.623	0.466	0.720
	−2.206	3.107	−5.349	−1.797	5.120				
GECA	−0.238	−0.038	−0.831	0.339	0.313	−0.287	0.562	0.831	0.492
	−0.619	−0.079	−6.963	2.303	3.020				
GEJA	−1.349	2.303	−0.656	−0.092	0.346	−2.055	−1.274	0.656	0.749
	−2.139	2.978	−5.540	−0.609	4.525				
CAJA	−1.319	3.065	−0.740	−0.210	0.423	−1.784	−1.838	0.740	0.950
	−2.129	3.924	−6.574	−1.378	4.577				

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; t values are beneath the coefficients; critical values at the 5% and 1% levels are 1.96 and 3.35, respectively.

that are significantly different from zero and that imply larger mean differentials post-1973 Q1. This is the case in only one instance and then just barely. We find α_2 significantly different from zero in eight of the fifteen comparisons, but in six of these cases the estimated values are such that a much *narrower* long-run differential is implied; in the other two the difference is almost imperceptible—less than 10 basis points in both instances, larger in one, as already mentioned, but smaller in the other. If we ignore statistical significance and simply compare the magnitudes of the long-term average differentials, the picture is qualitatively the same. Nine of fifteen comparisons point to narrower average differentials; only six to wider. The float *per se* does not appear to have mattered in the way that has been claimed.

The final point to mention, is the inter-country pattern in the differences pre- and post-1973. Two countries, France and Japan, generally exhibit substantially narrower differentials under the float, Japanese real interest rates falling relative to those of other countries and French real interest rates rising. Canada and the U.K. in several instances show somewhat 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 U.K. results quite possibly can be attributed to the prolonged tight monetary policy that it pursued in the early 1990s to curb its higher than major-country average rate of inflation. Canada for its part did the same in the late 1980s in response to its depreciating U.S. dollar exchange rate.

2.6. 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. money market as our benchmark. The first, which is reported in the top two lines of Table 6, uses the differential between nominal three-month Eurodollar 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.[15] These regressions took the form:

$$\Delta rd_{ijt} = \alpha_1 + v_1 rd_{ijt-1} + e_t, \tag{9}$$

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

Table 6. Modeling U.S. nominal interest differentials $\Delta rd_{ijt} = \alpha_1 + v_1 rd_{ijt-1} + e_t$.

Spread	α_1	v_1	R^2/SEE	$\alpha/-v_1$	v_1
Euro dollar vs. t-bill	0.252	−0.209	0.099	1.204	0.209
	3.395*	−4.106*	0.506		
Commercial paper vs. t-bill	0.238	−0.325	0.158	0.732	0.325
	4.837*	−5.777*	0.356		

Note: All interest rates are for 3-month instruments and expressed as 360-day money market yields; t values are beneath the coefficients; critical values at the 5% and 1% levels are 1.96 and 3.35, respectively. An asterisk denotes significance at the 1% level.

Two features of the regressions deserve comment. The first is the estimates of the long-run average spreads that come out of these regressions. For the Eurodollar versus the t-bill, this is 1.20 $(i.e. \alpha_1/-v_1)$; for commercial paper it is .73. 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 $-.21$ and $-.33$ on the lagged levels of the respective differentials). For the regressions reported in Table 4 the mean absolute values of the long-run average spreads in the two periods are 1.1 and 1.0, respectively, and hence not at all out of line with the two U.S. money-market spreads. Estimated speeds of adjustment actually appear faster across countries. The latter could, however, be attributable to measurement error in the inflation-rate adjustments used in the international comparisons. Judged by these criteria international markets therefore appear rather well integrated.

3. 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 from that found for money-market interest rates in the U.S.

One of the major reasons that such volatility has not mattered, we believe, is the important set of changes in the institutions surrounding international trade and finance that took place over our sample period. These changes were not simply fortuitous. They came, in large part, as a response to the markedly higher volatility of exchange rates and other economic and financial variables that began at the end of the 1960s and that continued for well over a decade thereafter. As theory suggests and the testimony of important financial market participants bears witness, regulatory and other government constraints on markets broke down and new instruments and markets developed as the welfare costs of these regulations and the opportunity costs of not having such markets mounted. Thus capital controls were removed, interest-rate ceilings on deposits circumvented, new financial instruments introduced and new markets started. The end result was to make it possible for market participants to cope with the increased exchange-rate and interest-rate risk that the higher volatility engendered, and hence to offset their potentially deleterious effects.[16]

Over short but still lengthy periods, however, real interest differentials have 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 concerns the specific types of shocks that have caused the movements.

A second set of issues that needs to be explored further has to do with the shifts in real interest rates uncovered at various points in these countries in the 1970s and 1980s. We have treated them as nuisance parameters using dummy variables to control for these shifts. Future work might usefully focus on investigating the nature of these movements, their cause or causes, and whether they are once and for all shifts or have been subsequently reversed.

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Notes

1. For this equation to hold, rates of inflation and the rate of change of the exchange rate have to be defined in terms of logarithmic derivatives. For discrete data it will only hold as a first approximation.
2. Friedman and Schwartz (1982, pp. 513–517) use a framework of this sort in their analysis of the UK and US and relate the nominal interest rate differential on bonds to the two factors identified in Equation (2) and to the differential in the two countries' inflation rates.
3. See Lastrapes (1998) for multi-country evidence on this subject and the studies cited therein.
4. See the reviews of this literature in Mussa and Goldstein (1993) and von Furstenburg (1998).

5. Such premia, however, may have mattered more greatly pre-1982 since capital controls were more prevalent in this earlier period. The removal of controls is, therefore, one reason to expect international capital mobility to have increased over the much longer (1957–2000) sample period that we use.
6. 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 (e.g. Lothian, 1997).
7. 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 (1996) and Hodrick (1987) for overviews of this literature.
8. The risk premium explanation has been most prevalent. Frankel and Froot (1987) present evidence of irrationality on the part of traders. Evans and Lewis (1995b), however, show that this latter explanation and rational learning in the face of change in the inflation regime are observationally equivalent. Lothian and Simaan (1998) show that despite the often substantial departures from UIP over the shorter run, the relation holds quite well over longer periods.
9. 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, 1999); 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.
10. For a further discussion of this hypothesis see Mussa and Goldstein (1993).
11. 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.
12. Further evidence supporting the stationarity of real interest rates is reported by Neusser (1991), and Jackson and Lothian (1993).
13. In an earlier version of this paper we also ran regressions using both breakpoints. These results were not substantially different from those we report here for the 1980 breakpoint alone.
14. 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.
15. The sample periods were 1957 Q1 to 2000 Q1 for CP vs. t-bill and 1972 Q1 to 2000 Q1 for Eurodollar vs. t-bill. All rates were expressed on a 360-day money market yield basis.
16. See Telser (1981) for a theoretical treatment of such institutional change. The example he considers is future markets. Walter Wriston, the former chairman of Citibank and an architect of the financial changes of the late 1970s and early 1980s, provides a practitioners perspective on these developments. In connection with the Euro markets he writes (1986, p.133): "No one designed them, no one authorized them, and no one controlled them. They were fathered by controls, raised by technology, and today are refugees, if you will, from national attempts to allocate credit and capital, for reasons that have little to do with finance or economics." See Lothian (2000) for a more in-depth discussion of these issues.

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