

revised December 13, 1990  
and 6/13/92 for MIT Press collection

## QUANTIFYING INTERNATIONAL CAPITAL MOBILITY IN THE 1980s

Jeffrey A. Frankel

Research Associate, NBER

Professor of Economics  
787 Evans Hall  
University of California  
Berkeley, CA 94720

The original version of this paper was published in National Saving and Economic Performance, D. Bernheim and J. Shoven, eds., University of Chicago Press: Chicago, for the National Bureau of Economic Research, 1991. (A more complete version appeared as NBER Working Paper No. 2856.) A somewhat revised version is to be reprinted in Current Issues in International Trade and International Finance, edited by Dilip Das, Oxford University Press, Oxford, UK. The present version was further revised and is to appear as a chapter in On Exchange Rates, a collection of the author's writings, forthcoming from M.I.T. Press.

Quantifying International Capital Mobility in the 1980s,  
Jeffrey Frankel

Feldstein and Horioka upset conventional wisdom in 1980 when they concluded that changes in countries' rates of national saving had very large effects on their rates of investment, and interpreted this finding as evidence of low capital mobility. Although their regressions have been subjected to a great variety of criticisms, their basic finding seems to hold up. But does is their interpretation of the finding, that it implies imperfect capital mobility, the right one?

Let us begin by asking why we would ever expect a shortfall in one country's national saving not to reduce the overall availability of funds and thereby crowd out investment projects that might otherwise be undertaken in that country. After all, national saving and investment are linked through an identity. (The variable that completes the identity is, of course, the current account balance.)

The aggregation of all forms of "capital" has caused more than the usual amount of confusion in the literature on international capital mobility. Nobody ever claimed that international flows of foreign direct investment were large enough that a typical investment project in the domestic country would at no added cost be undertaken directly by a foreign company when there was a shortfall in domestic saving.<sup>1</sup> Rather, the argument was that the typical American corporation could borrow at the going interest rate in order

to finance its investment projects and, if the degree of capital mobility were sufficiently high, the going interest rate would be tied down to the world interest rate by international flows of portfolio capital. If portfolio capital were a perfect substitute for physical capital, then the difference would be immaterial; but the two types of capital probably are not in fact perfect substitutes.

This paper examines a number of alternative ways of quantifying the degree of international capital mobility. One conclusion is that the barriers to cross-border flows are sufficiently low that, by 1989, financial markets can be said to be virtually completely integrated among the large industrial countries (and among some smaller countries as well). But this is a different proposition from saying that real interest rates are equalized across countries, which is still different from saying that investment projects in a country are unaffected by a shortfall in national saving. We will see that there are several crucial links that can, and probably do, fail to hold.

In many cases, notably the United Kingdom and Japan, and more recently Italy, France, and a number of smaller European countries, the finding of high integration with world financial markets is a relatively new one, attributable to liberalization programs since 1979. Even in the case of

financial markets in the United States, integration with the Euromarkets appears to have been incomplete as recently as 1982.<sup>2</sup> An important conclusion of this paper for the United States is that the current account deficits of the 1980s were large enough, and lasted long enough, to reduce significantly estimates of the correlation between saving and investment. The increased degree of worldwide financial integration in the 1980s is identified as one likely factor that has allowed such large capital flows to take place over the past decade.

But even if U.S. interest rates are now viewed as tied to world interest rates<sup>3</sup>, there are still other weak links in the chain. The implication is that crowding out of domestic investment can still take place.

#### 1. Four Alternative Definitions of International Capital Mobility

By the second half of the 1970s, international economists had come to speak of the world financial system as characterized by perfect capital mobility. In many ways, this was "jumping the gun." It is true that financial integration had been greatly enhanced after 1973 by the removal of capital controls on the part of the United States, Germany, Canada, Switzerland and the Netherlands; by the steady process of technical and institutional innovation, particularly in the Euromarkets; and by the recycling of OPEC

surpluses to developing countries. But almost all developing countries retained extensive restrictions on international capital flows, as did a majority of industrialized countries. Even among the five major countries without capital controls, capital was not perfectly mobile by some definitions.

There are at least four distinct definitions of perfect capital mobility that are in widespread use. (I) The Feldstein-Horioka definition: exogenous changes in national saving (i.e., in either private savings or government budgets) can be easily financed by borrowing from abroad at the going real interest rate, and thus need not crowd out investment in the originating country (except perhaps to the extent that the country is large in world financial markets).

(II) Real interest parity: International capital flows equalize real interest rates across countries. (III)

Uncovered interest parity: Capital flows equalize expected rates of return on countries' bonds, despite exposure to exchange risk. (IV) Closed interest parity: Capital flows

equalize interest rates across countries when contracted in a common currency. These four possible definitions are in ascending order of specificity. Only the last condition is an unalloyed criterion for capital mobility in the sense of the degree of financial market integration across national boundaries. <sup>4</sup>

As we will see, each of the first three conditions, if it is to hold, requires an auxiliary assumption in addition to the condition that follows it. Uncovered interest parity requires not only closed (or covered) interest parity, but also the condition that the exchange risk premium is zero. Real interest parity requires not only uncovered interest parity, but also the condition that expected real depreciation is zero. The Feldstein-Horioka condition requires not only real interest parity, but also a certain condition on the determinants of investment. But even though the relevance to the degree of integration of financial markets decreases as auxiliary conditions are added, the relevance to questions regarding the origin of international payments imbalances increases. We begin our consideration of the various criteria of capital mobility with the Feldstein-Horioka definition.

## 2. Feldstein-Horioka Tests

The Feldstein-Horioka definition requires that the country's real interest rate is tied to the world real interest rate by criterion (II); it is, after all, the real interest rate rather than the nominal on which saving and investment in theory depend. But for criterion (I) to hold, it is also necessary that any and all determinants of a country's rate of investment other than its real interest

rate be uncorrelated with its rate of national saving. Let the investment rate for country  $i$  be given by

$$(1) \quad (I/Y)_i = a_i - br_i + u_i,$$

where  $I_i$  is the level of capital formation,  $Y_i$  is national output,  $r_i$  is the domestic real interest rate, and  $u_i$  represents all other factors, whether quantifiable or not, that determine the rate of investment. Feldstein and Horioka (1980) regressed the investment rate against the national saving rate,

$$(1') \quad (I/Y)_i = A + B(NS/Y)_i + v_i,$$

where  $NS$  is private saving minus the budget deficit. To get the zero coefficient  $B$  that they were looking for requires not only real interest parity:

$$(2) \quad r_i - r^* = 0,$$

(with the world interest rate  $r^*$  exogenous or in any other way uncorrelated with  $(NS/Y)_i$ ), but also a zero correlation between  $u_i$  and  $(NS/Y)_i$ .

### 2.1. The Saving-Investment literature

Feldstein and Horioka's finding that the coefficient  $B$  is in fact closer to 1 than to zero has been reproduced many times. Most authors have not been willing, however, to follow them in drawing the inference that financial markets are not highly integrated. There have been many econometric critiques, falling into two general categories.

Most commonly made is the point that national saving is endogenous, or in our terms is correlated with  $u_i$ . This will be the case if national saving and investment are both procyclical, as they are in fact known to be, or if they both respond to the population or productivity growth rates.<sup>5</sup> It will also be the case if governments respond endogenously to incipient current account imbalances with policies to change public (or private) saving in such a way as to reduce the imbalances. This "policy reaction" argument has been made by Fieleke (1982), Tobin (1983), Westphal (1983), Caprio and Howard (1984), Summers (1988), Roubini (1988) and Bayoumi (1989). But Feldstein and Horioka made an effort to handle the econometric endogeneity of national saving, more so than have some of their critics. To handle the cyclical endogeneity, they computed averages over a long enough period of time that business cycles could be argued to wash out.<sup>6</sup> To handle other sources of endogeneity, they used demographic variables as instrumental variables for the saving rate.

The other econometric critique is that if the domestic country is large in world financial markets,  $r^*$  will not be exogenous with respect to  $(NS/Y)_i$ , and therefore even if  $r=r^*$ ,  $r$  and in turn  $(I/Y)_i$  will be correlated with  $(NS/Y)_i$ . In other words, a shortfall in domestic savings will drive up the world interest rate, and thus crowd out investment in the domestic country as well as abroad. This "large-country" argument has been made by Murphy (1984) and Tobin (1983). An insufficiently-appreciated point is that the large-country argument does not create a problem in cross-section studies, because all countries share the same world interest rate  $r^*$ .

Since  $r^*$  simply goes into the constant term in a cross-section regression, it cannot be the source of any correlation with the righthand-side variable. The large-country problem cannot explain why the countries that are high-saving relative to the average tend to coincide with the countries that are high-investing relative to the average. <sup>7</sup>

If the regressions of saving and investment rates were a good test for barriers to financial market integration, one would expect to see the coefficient falling over time. Until now, the evidence has if anything showed the coefficient rising over time rather than falling. This finding has emerged both from cross-section studies, which typically report pre-and post-1973 results -- Feldstein (1983), Penati

and Dooley (1984), and Dooley, Frankel and Mathieson (1987) - and from pure time-series studies -- Obstfeld (1986, 1989)<sup>8</sup> and Frankel (1986) for the United States. The econometric endogeneity of national saving does not appear to be the explanation for this finding, because it holds equally well when instrumental variables are used.<sup>9</sup>

The easy explanation for the finding is that, econometric problems aside, real interest parity -- criterion (II) above -- has not held any better in recent years than it did in the past. Mishkin (1984, 1352), for example, found even more significant rejections of real interest parity among major industrialized countries for the floating rate period after 1973/II than he did for his entire 1967/II-1979/II sample period. Caramazza et al (1986, pp. 43-47) also found that some of the major industrialized countries in the 1980s (1980.1-1985.6) moved farther from real interest parity than they had been in the 1970s (1973.7-1979.12).<sup>10</sup> In the early 1980s, the real interest rate in the United States, in particular, rose far above the real interest rate of its major trading partners, by any of a variety of measures.<sup>11</sup> If the domestic real interest rate is not tied to the foreign real interest rate, then there is no reason to expect a zero coefficient in the saving-investment regression. We discuss in a later section the factors underlying real interest differentials.

## 2.2. The U.S. saving-investment regression updated to the 1980s

In the 1980s the massive fiscal experiment carried out under the Reagan Administration rapidly undermined the statistical finding of a high saving-investment correlation for the case of the United States. The increase in the structural budget deficit, which was neither accommodated by monetary policy nor financed by an increase in private saving, reduced the national saving rate by 3 per cent of GNP, relative to the 1970s. The investment rate -- which at first, like the saving rate, fell in the 1981-82 recession -- in the late 1980s approximately reattained its 1980 level at best.<sup>12</sup> The saving shortfall was made up, necessarily, by a flood of borrowing from abroad equal to more than three per cent of GNP. Hence the current account deficit of \$161 billion in 1987. (By contrast, the U.S. current account balance was on average equal to zero in the 1970s.)

By the late 1980s, the divergence between U.S. national saving and investment had been sufficiently large and long-lasting to show up in longer-term regressions of the Feldstein-Horioka type. If one seeks to isolate the degree of capital mobility or crowding out for the United States in particular, and how it has changed over time, then time series regression is necessary (whereas if one is concerned

with such measures worldwide, then cross-section regressions of the sort performed by Feldstein and Horioka are better). Table 1 reports instrumental variables regressions of investment against national saving for the United States from 1869 to 1987.<sup>13</sup> Figure 2.1 illustrates. Decade averages are used for each variable, which removes some of the cyclical variation but gives us only 12 observations. That is one more observation than was available in Frankel (1986, Table 2.2), which went only through the 1970's.

As before, the coefficient is statistically greater than zero and is not statistically different from 1, suggesting a high degree of crowding out (or a low degree of capital mobility, in Feldstein and Horioka's terms). But the point estimate of the coefficient (when corrected for possible serial correlation) drops from .91 in the earlier study to .79. We can allow for a time trend in the coefficient; it drops from plus .01 a year in the earlier study to minus .01 a year (or plus .001, when corrected for serial correlation) in the longer sample. Thus the additional years 1980-1987 do show up as anticipated: as exhibiting a lower U.S. degree of crowding out, even if the change is small. [The trend is not statistically significant, but this is not surprising given the small number of observations.]

A data set that begins later would seem more promising than the 12 decade averages. Yearly data are available

beginning in 1930.<sup>14</sup> But much of the variation in the yearly data is cyclical, and the preferred method for cyclical adjustment is not possible that early. So Table 2 here reports tests on saving and investment rates that have been cyclically adjusted, for a sample period that begins in 1955, as illustrated in Figure 2.2. The cyclical adjustment of each is accomplished by first regressing it on the GNP gap, defined as the percentage deviation from the Bureau of Economic Analysis's "middle expansion trend" of GNP, and taking the residuals.

In previous work with a sample period of 1956-1984, the coefficient in a regression of cyclically adjusted saving and investment rates was estimated at .80, statistically indistinguishable from 1. (Frankel(1986, 43-44)). But now the coefficient has dropped essentially to zero, suggesting a zero degree of crowding out, or a zero degree of "saving-retention" (or, in the Feldstein-Horioka terminology, "perfect capital mobility"). This finding is the result of the addition to the sample of another three years of record current account deficits, 1985-87, a period also in which the cyclically adjusted national saving rate was historically low. When the equation is estimated with an allowance for a time trend in the coefficient, the trend is negative (though statistically insignificant), whereas the earlier sample that stopped in 1984 showed a time trend that was positive (and

insignificant).

To verify that the 1980s experience is indeed the source of the precipitous fall in the saving-investment coefficient,<sup>15</sup> the sample period is split at 1980. For the period 1955-79, not only is the coefficient statistically indistinguishable from 1, but the point estimate is slightly over 1.<sup>16</sup> It is clearly the unprecedented developments of the 1980s that overturned the previously-robust saving-investment relationship for the case of the United States. It is likely that financial liberalization in Japan, the United Kingdom, and other countries, and continued innovation in the Euromarkets (and perhaps the 1984 repeal of the U.S. withholding tax on borrowing from abroad), resulted in a higher degree of capital mobility, and thereby facilitated the record flow of capital to the United States in the 1980s.

But the magnitude of the inflow was in the first instance attributable to the unprecedented magnitude of the decline in national saving.<sup>17</sup>

### 3. Differentials in Expected Rates of Return, and Expected Real Depreciation

If the goal is to measure the degree of integration of capital markets, rather than the degree to which decreases in national saving have crowded out investment, then it is better to look at differences in rates of return across

countries rather than looking at saving-investment correlations.<sup>18</sup> But measuring real interest differentials will not do the trick. An international investor, when deciding what country's assets to buy, will not compare the interest rates in different countries each expressed in terms of expected purchasing power over that country's goods. When he or she thinks to evaluate assets in terms of purchasing power, all assets will be evaluated in terms of the same basket, the one consumed by that particular investor. The expected inflation rate then drops out of differentials in expected rates of return among assets.

The differential in expected rates of return on two countries' bonds is the uncovered interest differential, the nominal interest differential minus the expected change in the exchange rate:  $i - i^* - (Ds^e)$ . If asset demands are highly sensitive to expected rates of return, then the differential will be zero, which gives us uncovered interest parity:

$$(3) \quad i - i^* - (Ds^e) = 0.$$

To distinguish this parity condition, which is Criterion (III) above, from the other definitions, it has often been designated "perfect substitutability:" not only is there little in the manner of transactions costs or government-

imposed controls to separate national markets, but also domestic-currency and foreign-currency bonds are perfect substitutes in investors' portfolios.

Just as Criterion (I) is considerably stronger than Criterion (II), so is Criterion (II) considerably stronger than Criterion (III). For real interest parity to hold, one must have not only uncovered interest parity, but an additional condition as well, which is sometimes called ex ante relative purchasing power parity:

$$(2') \quad \vartheta_{0s}^e = \vartheta_{0p}^e - Dp^{e*}.$$

Equation (2') and equation (3) together imply equation (2). If goods markets are perfectly integrated, meaning not only that there is little in the manner of transportation costs or government-imposed barriers to separate national markets, but also that domestic and foreign goods are perfect substitutes in consumers' utility functions, then purchasing power parity holds. Purchasing power parity (PPP) in turn implies (2'). But as is by now well-known, goods markets are not in fact perfectly integrated. Because of the possibility of expected real depreciation, real interest parity can fail even if criterion (III) holds perfectly. The remainder of this section considers the question whether ex ante relative PPP, equation (2'), holds.

The enormous real appreciation of the dollar in the early 1980s and subsequent real depreciation have by now convinced the remaining doubters, but abundant statistical evidence against PPP was there all along. Krugman (1978, p.406), for example, computed for the floating rate period July 1973-December 1976 standard deviations of the (logarithmic) real exchange rate equal to 6.0 per cent for the pound/dollar rate and 8.4 per cent for the mark/dollar rate. He also computed serial correlation coefficients for PPP deviations of .897 and .854, respectively, on a monthly basis, equal to .271 and .150 on an annual basis. The serial correlation coefficient is of interest because it is equal to one minus the speed of adjustment to PPP. It may be best not to rely exclusively on the standard deviation of the real exchange rate as a summary statistic for the degree of integration of goods markets, because it in part reflects the magnitude of monetary disturbances during the period.<sup>19</sup>

Consider a longer time span of annual data on the real exchange rate between the United States and Great Britain. [The statistics described here are reported in Table 7.1 of this volume.] During the floating rate period 1973-1987, though there is no significant time trend, there is a large standard error of 15.6 per cent. The serial correlation in the deviations from PPP is estimated at .687, with a standard error of .208. This means that the estimated speed of

adjustment to PPP is .313 per year, and that one can easily reject the hypothesis of instantaneous adjustment.

From the ashes of absolute PPP, a phoenix has risen. In response to findings such as those reported here, some authors have swung from one extreme, the proposition that the tendency of the real exchange rate to return to a constant is complete and instantaneous, to the opposite extreme that there is no such tendency at all. The hypothesis that the real exchange rate follows a random walk is just as good as the hypothesis of absolute PPP for implying ex ante relative PPP. But there is even less of an a priori case why PPP should hold in rate-of-change form than in the level form.

Even though ex ante relative PPP has little basis in theory, it does appear to have some empirical support. Typically, the estimated speeds of adjustment during the floating rate period, .31 in the table (1973-1987), while not so low as to be implausible as point estimates, are nevertheless so low that one statistically cannot reject the hypothesis that they are zero. In other words one cannot reject the random-walk hypothesis that the autoregression coefficient is 1.0.

A 95-percent confidence interval on the autoregressive coefficient **AR** covers the range 0.27-1.10. If the null hypothesis is an autoregressive coefficient of 1.0, one cannot legitimately use the standard t-test derived from a

regression where the righthand-side variable is the level of the real exchange rate, because under the null hypothesis the variance is infinite. There are a number of ways of dealing with this nonstationarity problem. Here one simply applies the corrected Dickey-Fuller 95-percent significance level, 3.00. The .31 estimate for the floating-rate period is insignificantly different from zero.

This failure to reject a random walk in the real exchange rate is the same result found by Roll (1979), Frenkel (1981, p.699), Adler and Lehman (1983), Darby (1981), Mishkin (1984, pp.1351-53), and Piggott and Sweeney (1985). Most of these studies used monthly data. On the one hand, the greater abundance of data reduces the standard error of the estimate but, on the other hand, one is no longer testing whether  $AR = .69$  is different from 1.0, but rather whether  $.97 (= AR^{1/12})$  is different from 1.0, so that it may not be much easier to reject. Another problem is that one does not know that the nature of the true autoregressive process is truly first-order on a monthly (or continuous-time) basis. In any case, the monthly data in the studies cited were generally not powerful enough to reject the random walk.<sup>20</sup>

A more promising alternative is to choose a longer time sample to get a more powerful estimate. The table also reports statistics for the entire postwar period 1945-1987. PPP held better for the Bretton Woods years than it did after

1973, as measured either by the mean absolute deviation and standard deviation of the real exchange rate, or by the ability to reject the hypothesis of zero autocorrelation. But, despite the longer time sample, one is only at the borderline of being able to reject the random walk. The 95-percent confidence interval for **AR** runs from 0.64 to 1.02, and the t-ratio of 1.85 falls short of the Dickey-Fuller 95-percent significance level of 2.93.

The asymptotic standard error of an estimate of **AR** is approximately the square root of  $(1-AR^2)/N$ . So if the true speed of adjustment is on the order of 30 per cent a year (**AR** = .7), a simple calculation suggests that we might require at least 49 years of data  $(2.93^2(1-.7^2)/(1-.7)^2 = 48.6)$  to be able to reject the null hypothesis of **AR** = 1. It is not very surprising that 43 years of data is not enough, much less the 15 years of data used in most studies.<sup>21</sup> (Econometricians consider the asymptotic standard error on which this calculation is based to be a bad approximation in small samples. But the correct power calculation suggests that, if anything, the sample required to reject a random walk would be even larger than 49.<sup>22</sup>)

The last column of the table presents an entire 119 years of U.S.-U.K. data. With this long a time sample, the standard error is reduced considerably. The rejection of no serial correlation in the real exchange rate is even stronger

than in the shorter time samples. More importantly, one is finally able to detect a statistically significant tendency for the real exchange rate to regress to PPP, at a rate of 16 per cent a year. The confidence interval for AR runs from 0.75 to 0.94, safely less than unity, and the t-ratio of 3.12 exceeds the Dickey-Fuller significance level of 2.89.<sup>23</sup>

The motivation for looking at PPP in this section has been to obtain insight into the expected rate of real depreciation, because that is the variable that can give rise to real interest differentials even in the presence of uncovered interest parity.<sup>24</sup> In rejecting the random walk description of the real exchange rate, one has rejected the claim that the rationally expected rate of real depreciation is zero.<sup>25</sup> To take an example, in 1983-84, when the dollar had appreciated some 30 percent above its PPP value, survey data show expected future real depreciation of 4.3 percent per year. It is thus not difficult to explain the existence of the U.S. real interest differential, even without appealing to any sort of risk premium. There is not much support for authors such as Koraczyk (1985, p.350) and Darby (1986, p.420) ruling out the possibility of expected real depreciation a priori and thereby concluding that real interest differentials necessarily constitute risk premiums.

If the failure of ex ante relative purchasing power parity could, in itself, explain the failure of real interest

parity, then it could also, by itself, explain the failure of saving and investment to be uncorrelated. In the recent U.S. context, a fall in national saving could cause an increase in the real interest differential and therefore a fall in investment, even if financial markets are perfectly integrated and even if the fall in saving is truly exogenous, provided the real interest differential is associated with expected real depreciation of the dollar.

Demonstrating that the failure of ex ante relative purchasing power parity is capable of producing a correlation between saving and investment is, of course, not the same thing as asserting that this in fact is the explanation for the observed correlation. There are plenty of other competing explanations that have been proposed. But some support for the idea that the existence of expected real depreciation is key to the observed correlation comes from Cardia (1988). She simulates saving and investment rates in a sequence of models featuring shocks to fiscal spending, money growth, and productivity, in order to see which models are capable, for empirically-relevant magnitudes of the parameters, of producing saving-investment correlations as high as those observed. To get at some of the explanations that have been most prominently proposed, she constructs models both with and without purchasing power parity, both with and without endogenous response of fiscal policy to

current account imbalances, and both with and without the small-country assumption. The finding is that the model that allows for deviations from purchasing power parity is able to explain saving-investment correlations as high as one, while the various models that impose purchasing power parity are generally not able to do so.<sup>26</sup>

Further empirical support for the idea that the Feldstein-Horioka results may in fact be due to imperfect integration of goods markets, rather than imperfect integration of financial markets, is provided by tests of saving and investment rates across sub-regions that are known to be more integrated with each other than is the modern world economy. Bayoumi and Rose (1991) look at correlations of saving and investment rates across sub-regions within the United Kingdom. Sinn (1992) looks at correlations across states within the United States (on 1950s data). Bayoumi and Sterne (1992) do the same for provinces within Canada (for 1961-1990). In every case, the finding is no positive correlation. These regions are known to share a common currency and to be highly integrated with respect to their goods markets, suggesting that exchange rate variability or other sources of imperfect integration of goods markets may be the source of high saving-investment correlations across countries (although this is not necessarily the authors' interpretations of their own results).

#### 4. A Decomposition of Real Interest Differentials for 25 Countries

Because there are so many competing definitions of the degree of international capital mobility, it would be worth knowing if the sort of countries that register high by one criterion are also the sort that register high by the others.

In this section we look at rates of return in the 1980s across a sample of 25 countries. We begin with the broadest measure of barriers to international capital mobility, the differential in real interest rates, defined as:

$$(4) \quad r - r^* = (i - \theta_0 p^e) - (i^* - \theta_0 p^{e*}).$$

Subsequently we will decompose the real interest differential into a component due to "political" or country factors and a component due to currency factors:

$$(5) \quad r - r^* = (i - i^* - fd) - (fd - \theta_0 p^e + \theta_0 p^{e*}),$$

where  $i$  is the domestic nominal interest rate,  $i^*$  is the foreign nominal interest rate, and  $fd$  is the forward discount on the domestic currency. The first term  $(i - i^* - fd)$  is the covered interest differential. We call it the political or country premium because it captures all barriers to

integration of financial markets across national boundaries: transactions costs, information costs, capital controls, tax laws that discriminate by country of residence, default risk, and risk of future capital controls. The second term could be described as the real forward discount. We call it the currency premium because it captures differences in assets according to the currency in which they are denominated, rather than in terms of the political jurisdiction in which they are issued. As we will see, the currency premium can in turn be decomposed into two factors, the exchange risk premium and expected real depreciation.

The decomposition of the real interest differential would not be possible without the use of data on forward exchange rates. Many previous studies have used forward rate data to test covered interest parity, but only for a few countries. The present study uses forward rate data for panel of 25 countries, which so far as I know is the largest set ever examined. The set of 25 includes countries both large and small, industrialized and developing, Atlantic and Pacific. The forward rate data for most of the countries come from Barclay's Bank in London, via Data Resources, Inc.<sup>27</sup>

#### 4.1. Real interest differentials

Table 3 reports statistics on three-month real interest differentials for the 25 countries, in each case

expressed as the local interest rate measured relative to the Eurodollar interest rate. For local interest rates we use the interbank market rate or, where no market rate exists, the most flexibly-determined interest rate available.<sup>28</sup> We use, to begin with, the realized inflation rates during the ex post three-month period. Column (1) reports the mean real interest differential during the sample period, September 1982 to January 1988. (In this and subsequent tables, because the ex post data run three months behind the ex ante expectations, they go up to April 1988.) The numbers are negative for a majority of countries, averaging -1.74 across all 25, which reflects the high level of real dollar interest rates during this period.

The countries are classified into five groups chosen on a priori grounds. The group with real interest rates the farthest below the world rate is Bahrain, Greece, Mexico, Portugal and South Africa. These five (very diverse) countries bear the burden of representing a wide class of LDCs in our sample. Altogether there are eight countries classified as LDCs that happen to have forward rate data available, and thereby appear in our sample; three of these are East Asian countries that are thought to have open financial markets in the 1980s (Hong Kong, Singapore and Malaysia) and so are here classified separately.

One might object that the large negative real interest

differentials in the group of five reflect administered local interest rates that are kept artificially low by "financial repression." But countries cannot maintain artificially low interest rates without barriers to capital outflow. These statistics reflect a low degree of capital mobility precisely as we want them to. In this respect our group of five is typical of LDCs. A number of studies, including much larger LDC samples than available here, have shown the extremes to which real interest rates can go, particularly some very negative levels in the 1970s.

As with the other measures of interest rate differentials that we will be considering below, the mean is not always the most useful statistic. A small mean over a particular sample period may hide fluctuations in both directions. Even if a mean is statistically significant,<sup>29</sup> it is useful to know in addition the variability of the differential. The standard deviation is reported in column (2). We also report the root-mean-squared error in column (3). [This would be a superior measure of how closely the rates are tied together if, for example, we are worried about the possibility of a large differential that is fairly constant over time because of government administration of interest rates.] Finally we report in column (4) how big a band would be needed to encompass 95 percent of the deviations from real interest parity.

Country-group comparisons of the measures of real interest differential variability in some respects suit a priori expectations: the five closed LDCs constitute the group with the highest variability, and the five open Atlantic countries the group with the lowest.<sup>30</sup> But there are some results that are anomalous if the real interest differential is taken as a measure of financial market integration. France, for example, had stringent capital controls in place during our sample period (at least until the latter part) and yet appears to have a higher degree of capital mobility by the criterion of real interest differential variability than Japan, which announced liberalization of its capital controls before our sample period (1979-80). One might conceivably argue that the Japanese liberalization must not have been genuine. But the French real interest differential is smaller and less variable even than those of the Netherlands and Switzerland, major countries that are known to be virtually free of capital controls. Only Canada shows a smaller and less variable real interest differential than France.

Because the realized inflation rates could not have been precisely known a priori, it is necessary to project them onto contemporaneously known variables. Three such variables were used: the forward discount, nominal interest differential, and lagged inflation differential.<sup>31</sup> In a

majority of cases, a statistically significant amount of the variation in the real interest differential turned out to be forecastable.<sup>32</sup> The standard deviation of the projected differential gives us our final measure of variability. The results for the ex ante real interest differential are mostly similar to those for the ex post. France, for example, still shows a lower degree of variability than the Netherlands.

#### 4.2. Covered interest differentials: The country premium

We now use the Barclay's forward rate data to decompose the real interest differential into one part due to country factors and another due to currency factors, as in equation (5). The first component, the covered interest differential, encompasses all factors related to the political jurisdiction in which the asset is issued. Its size and variability measures barriers to international capital mobility most narrowly and properly defined.

Column (1) of Table 4 reports the mean of the covered interest differential for each of our 25 countries. A good rule of thumb, when the absolute magnitude of the mean or the variability of the differential indicates the existence of significant barriers, is as follows: a negative differential vis-a-vis the Eurocurrency market indicates that, to the extent that barriers exist, they are capital controls or

transactions costs currently operating to discourage capital from flowing out of the country. Investors would not settle for a lower return domestically if they were free to earn abroad the higher return covered to eliminate exchange risk.

This is the case for all the LDCs in the sample, with the exception of Hong Kong, and for all of the traditionally "closed" European countries, with the exceptions of Austria and Belgium (which should by now probably be classified with the "open" countries). The negative differential that existed for the United Kingdom before Margaret Thatcher removed capital controls in 1979 is now extremely small.<sup>33</sup> Similarly, Canada's differential is effectively zero.<sup>34</sup>

Column (4), the size of the band wide enough to encompass 95 per cent of deviations from international covered interest parity, can be compared with the approach of Frenkel and Levich (1977). They tested a larger band meant to represent transactions costs between pound and dollar securities. They found, for the case of the United Kingdom, that a smaller percentage of deviations (87.6 - 89.7 percent, p.1217) fell within the band. This confirms that capital mobility has increased since the 1970s.

Germany and several other neighboring European countries [Switzerland, the Netherlands, Austria, and Belgium] show higher interest rates locally than offshore, which suggests some barriers discouraging capital inflow: investors would

not settle for a lower mark return in the Euromarket if they were free to get the higher return in Germany. But the magnitude is quite small, as it has been observed to be ever since Germany removed most of its controls on capital inflow in 1974. Figure 2.4 shows the evidence of the 1974 liberalization (see also Dooley and Isard, 1980; and Giavazzi and Pagano, 1985, p.27).

Japan has a covered differential that by all measures is smaller and less variable than those of Switzerland and Germany, let alone France and most of the other countries. This might come as a surprise to those accustomed to thinking of Japanese financial markets in terms of the large barriers to capital inflow that were in place in the 1970s. The liberalization of Japanese markets, which has been documented elsewhere, continued during our sample period.<sup>35</sup> (See Figure 2.5.) Australia and New Zealand, while lagging well behind Japan, also showed signs of liberalization during the course of our sample period.<sup>36</sup>

The covered interest differential for France is much larger and more variable than that for the other major industrialized countries known to be free of capital controls. This is the reverse of the finding from the criterion of real interest differentials in Table 3. It supports the value of the criterion of covered interest differentials as the proper test of financial market

integration. The differential, with its negative sign signifying controls on French capital outflows, has been previously studied, especially its tendency to shoot up shortly before devaluations of the franc.<sup>37</sup> Our data indicate that the last major occurrence of this phenomenon was February 1986; since then the differential has been close to zero.

Similarly, the same phenomenon for Italy, which has also been previously studied (e.g., Giavazzi and Pagano, 1985), appears to have ended after the February 1986 realignment. France and Italy apparently dismantled their capital controls quickly enough to meet a 1990 deadline for liberalization set by the EEC Twelve.<sup>38</sup> Of four countries that required a later deadline, Spain and Portugal by our measures began liberalizing in the 1980s,<sup>39</sup> but Greece and Ireland did not. Sweden is one non-EC European country that appears to have moved toward liberalization during our sample period, while Norway does not. All of these European countries show up with negative mean differentials, which implies that the remaining controls act to discourage capital outflow rather than inflow. For the EEC countries, this finding supports records of the European Commission, which report more freedom for short-term inflows than short-term outflows.<sup>40</sup>

Registering impressively open financial markets are our three East Asian LDCs (which, especially in the case of

Singapore, have rapidly outgrown the appellation "less developed"). Hong Kong and Singapore show smaller covered differentials even than some open European countries like Germany. Malaysia's differential has been considerably higher, particularly in 1986, but still compares favorably with some European countries.

Not surprisingly, our remaining LDCs [Mexico, Greece, Portugal, Bahrain and South Africa] show by far the largest and most variable covered interest differentials.<sup>41</sup> Again, the results are precisely what one would expect if covered interest differentials are the proper criterion for capital mobility, but the reverse of what the saving-investment criterion shows.

Why does the covered differential criterion give such different answers from the saving-investment criterion, which shows a high degree of saving-retention among industrialized countries? Feldstein and Horioka (1980, p.315) argue that financial markets are less well integrated at longer-term maturities, as compared to the three-month maturities used in tests of covered interest parity such as those reported above:

It is clear from the yields on short-term securities in the Eurocurrency market and the forward prices of those

currencies that liquid financial capital moves very rapidly to arbitrage such short-term differentials....There are however reasons to be sceptical about the extent of such long-term arbitrage.

Studies of international interest parity have been restricted by a lack of forward exchange rates at horizons going out much further than one year.<sup>42</sup> But even without the use of forward rate data, there are ways of getting around the problem of exchange risk. Data on currency swap rates can be used in place of forward exchange rates to test the long-term version of interest rate parity. Popper (1990) finds that the swap-covered return differential on 5-year U.S. government bonds versus Japanese bonds averaged only 1.7 basis points from October 3, 1985 to July 10, 1986, and that the differential on 7-year bonds averaged only 5.3 basis points. The means mask some variation in the differential. But a band of 46 basis points is large enough to encompass 95 per cent of the observations for the 5-year bonds. The band is 34 basis points for the 7-year bonds. The means on 5-year bonds for some other major countries are as follows: Canada 15.9, Switzerland 18.7, United Kingdom 51.1, and Germany 28.4.

The magnitude of these long-term differentials compares favorably with the magnitude of the short-term differentials.

The implication is that Feldstein and Horioka are wrong in their conjecture that there is a term-structure wedge separating national capital markets.<sup>43</sup> The most relevant distinction appears to be, not long-term vs. short-term, but rather real vs. nominal.

#### 4.3. "Real forward discounts:" The currency premium

Even for those countries that exhibit no substantial country premium, as reflected in covered interest parity [ $fd - (i - i^*) = 0$ ], there may still be a substantial currency premium that drives real interest differentials [ $(i - \rho_0 p^e) - (i^* - \rho_0 p^{e*})$ ] away from zero. If real interest differentials are not arbitrated to zero, then there is in turn no reason to expect saving-investment correlations to be zero. Table 5 reports the statistics for the currency premium, as measured by the "real forward discount:"

$$fd - (\rho_0 p^e - \rho_0 p^{e*}).$$

Germany, Switzerland, the Netherlands, Austria and Japan, for example, all have substantial real forward discounts (or -- more precisely -- real forward premia), which constitute approximately the entirety of their real interest differentials. These are countries with currencies that have experienced a lot of exchange rate variability, both nominal and real, vis-a-vis the dollar since 1973, and especially

since 1980. As a consequence, some combination of exchange risk premiums and expected real depreciation -- factors pertaining to the currency, not to the political jurisdiction -- produces the gap in real interest rates. For these five financially open industrialized countries, and for Hong Kong as well, the currency factors produce a negative real interest differential, while the covered interest differential (though small) is positive: the small regulations or frictions that remain in these countries are, if anything, working to resist capital inflow (at least at the short end of the maturity spectrum), not outflow as one would mistakenly conclude from the real interest differential criterion. The other countries all have highly variable currency premiums as well. Indeed the real forward discount (currency premium) is more variable than the covered interest differential (country premium) for all but three of our 25 countries (Greece, Mexico, and France). The last rows of Tables 4 and 5 show that the average variability across all countries is higher for the currency premium than for the country premium.

We can project the real forward discount on the same three variables as we did for the real interest differential (the forward discount, nominal interest differential, and lagged inflation differential) to get an ex ante measure.<sup>44</sup> Its standard deviation now shows six countries for whom the

currency premium is less variable than the country premium (Greece, Mexico, Portugal, France, Italy and Spain). But the currency premium remains the major obstacle to real interest parity for most countries.

#### 4.4. Further Decomposition into Exchange Risk Premium and Expected Real Depreciation

Our decomposition so far has lumped two terms, the exchange risk premium and expected real depreciation, together into the currency premium:

$$fd - \vartheta_{0p}^e + \vartheta_{0p}^{e*} = (fd - \vartheta_{0s}^e) + (Ds^e - \vartheta_{0p}^e + \vartheta_{0p}^{e*}).$$

In this section we attempt to complete the decomposition by separating these two terms. To do so requires a measure or model of expected depreciation. The usual approach is to use the ex post changes in the spot rate ( $\vartheta_{0s}$ ) as a measure of **ex ante expectations** ( $\vartheta_{0s}^e$ ), and to argue that under rational expectations the expectational error ( $e \equiv \vartheta_{0s} - \vartheta_{0s}^e$ ) should be random (uncorrelated with information currently available contemporaneously).

We can compute the mean value of  $(fd - \vartheta_{0s})$  for each of our countries.<sup>45</sup> Most of the means are positive, showing that the weak-dollar period (1985-88) dominates over the strong-dollar period (1982-1985).<sup>46</sup> But only three currencies have mean risk premiums, of either sign, that are statistically

significant.<sup>47</sup> Furthermore, in a majority of cases [16/25], the sign of the mean return differential is the opposite of the sign of the mean real interest differential during the same period (Table 3, column 1). So this measure of the exchange risk premium does not explain any positive part of the real interest differential.

Measures such as the standard deviation, root-mean-squared-error, and 95 % band, show very high variability in (fd - <sup>0</sup>0s).. These are measures of the variability of ex post return differentials, not ex ante. They tell us little about the variability of the exchange risk premium. But the high variability of the exchange rate does tell us two things. First, it provides an obvious explanation -- low power -- why the first moments might not be statistically significant. On the other hand, the existence of substantial uncertainty regarding the future spot rate suggests, via the theory of optimal portfolio diversification, that a non-zero exchange risk premium must exist, to reward risk-averse investors for holding currencies that are perceived as risky or that are in oversupply.

To estimate the ex ante exchange risk premium, we can project (fd - depr) onto our same three variables: the forward discount, interest differential and inflation differential.<sup>48</sup> The regression is statistically significant for a majority of currencies, as many others have found.<sup>49</sup>

The standard deviation shows the most variable exchange risk premiums belong to Mexico and New Zealand, but the United Kingdom, Netherlands, Austria, Germany and Switzerland follow close behind.

The other component of the currency premium is expected real depreciation. As noted earlier, given the widely-accepted failure of purchasing power parity on levels, there is no theoretical reason to expect it necessarily to hold in terms of expected rates of change, the hypothesis sometimes known as ex ante relative purchasing power parity. The means of ex post real depreciation are negative, indicating real appreciation of the currency against the dollar, for all European countries and for most others as well. The only five exceptions, countries that experienced real depreciation against the dollar, were our three East Asian developing countries, Australia, and Bahrain. This last was the only one, of either sign, that was statistically significant.<sup>50</sup>

We already know, from the results reported above for the 119 years of U.S.-U.K. data, that we cannot expect to reject ex ante relative PPP on just a few years of data: new disturbances to the real exchange rate are so large, that one needs a much longer time sample to find evidence of systematic movement. But the signs of the mean real depreciations are usually the same as the signs of the mean real interest differentials in Table 3 [20/25], suggesting a

high correlation of the real interest differential and expected real depreciation across countries.

To estimate ex ante expected real depreciation, we project ex post real depreciation, again, on the same three contemporaneous variables.<sup>51</sup> The standard deviations for the various currencies are quite similar to those for the projected exchange risk premium.<sup>52</sup> In most cases [18/25] the projected exchange risk premium is slightly more variable than projected real depreciation.

## 5. Conclusion

We can sum up with four conclusions.

(1) Capital controls and other barriers to the movement of capital across national borders remained for such countries as the United Kingdom and Japan as recently as 1979, and France and Italy as recently as 1986. But a continuing worldwide trend of integration of financial markets in the 1980s had all but eliminated short-term interest differentials for major industrialized countries by 1988.

(2) Only the country premium has been eliminated; this means that only covered interest differentials are small. Real and nominal exchange rate variability remain, and indeed were larger in the 1980s than in the 1970s.<sup>53</sup> The result is that a currency premium remains, consisting of an exchange risk premium plus expected real currency depreciation. This means

that, even with the equalization of covered interest rates, large differentials in real interest rates remain.

(3) The United States in the 1980s began to borrow on such a massive scale internationally that the traditional "Feldstein-Horioka" finding of a near-unit correlation between national saving and investment has broken down. The process of liberalization in Japan and other major countries was probably one factor behind this massive flow of capital to the United States.

(4) In addition to the gaps that distinguish covered interest parity from real interest parity, there is a further gap that separates real interest parity from the proposition that changes in national saving do not crowd out investment because they are readily financed by borrowing from abroad. Bonds are not perfect substitutes for equities, and equities are not perfect substitutes for plant and equipment. Thus at each stage, there are good reasons to think that it continues to be possible for shortfalls in national saving to crowd out investment, even if to a smaller extent than before 1980.

### References

Adler, Michael and Bruce Lehman, 1983, "Deviations from Purchasing Power Parity in the Long Run," Journal of Finance 39, 5, 1471-1478.

Argy, Victor, 1987, "International Financial Liberalisation - The Australian and Japanese Experiences Compared," Bank of Japan Monetary and Economic Studies 5, 1, 105-168.

Bayoumi, Tamim, 1990, "Saving-Investment Correlations: Immobile Capital, Government Policy, or Endogenous Behavior," IMF Staff Papers vol.37, pp.360-387.

Bayoumi, Tamim, and Andrew Rose, 1991, "Domestic Saving and Intra-National Capital Flows," European Economic Review, forthcoming.

Bayoumi, Tamim, and Gabriel Sterne, 1992, "Regional Trading Blocs, Mobile Capital and Exchange Rate Coordination," International Monetary Fund.

Boothe, P., K. Clinton, A. Cote, and D. Longworth, 1985, "International Asset Substitutability: Theory and Evidence for Canada," Ottawa, Bank of Canada.

Caprio, G. and D. Howard, 1984, "Domestic Saving, Current Accounts, and International Capital Mobility," International Finance Discussion Papers no. 244, (Washington, D.C., Federal Reserve Board).

Caramazza, F., K. Clinton, A. Cote, and D. Longworth, 1986, "International Capital Mobility and Asset Substitutability: Some Theory and Evidence on Recent Structural Changes," Bank of Canada, Technical Report 44.

Cardia, Emanuela, 1988, "Crowding Out in Open Economies," Cahier 8823, Universite de Montreal, June.

Claassen, Emil and Charles Wyplosz, 1982, "Capital Controls: Some Principles and the French Experience," Annales de l'INSEE 47-48, 237-267.

Cumby, R. and F. Mishkin, 1986, "The International Linkage of Real Interest Rates: The European-U.S. Connection," Journal of International Money and Finance 5, 5-24.

Cumby, R. and M. Obstfeld, 1984, "International Interest Rate and Price Level Linkages under Flexible Exchange Rates: A

Review of Recent Evidence," in: J. Bilson and R. Marston, eds., Exchange Rate Theory and Practice, Chicago: University of Chicago Press.

Darby, Michael, 1981, "Does Purchasing Power Parity Work?" Proceedings of the Fifth West Coast Academic/Federal Reserve Economic Research Seminar, Federal Reserve Bank of San Francisco.

Darby, Michael, 1986, "The Internationalization of American Banking and Finance: Structure, Risk and World Interest Rates," Journal of International Money and Finance 5, 4, 403-428.

Dominguez, Kathryn, 1986, "Expectations Formation in the Foreign Exchange Market: New Evidence From Survey Data," Economic Letters.

Dooley, Michael, Jeffrey Frankel, and Donald Mathieson, 1987, "International Capital Mobility: What Do Saving-Investment Correlations Tell Us?" International Monetary Fund Staff Papers, 34, no.3, 503-530.

Dooley, M. and P. Isard, 1980, "Capital Controls, Political Risk and Deviations from Interest-Rate Parity," Journal of Political Economy 88, 2, 370-384.

Dornbusch, Rudiger, 1983, "Real Interest Rates, Home Goods and Optimal External Borrowing," Journal of Political Economy, February.

Engel, Charles, and Kenneth Kletzer, 1987, "Saving and Investment in an Open Economy with Non-Traded Goods," NBER Working Paper no. 2141, February. International Economic Review, forthcoming.

Feldstein, M., 1983, "Domestic Saving and International Capital Movements in the Long Run and the Short Run," European Economic Review 21, 139-151.

Feldstein, Martin, ed., 1987, The Effects of Taxation on Capital Accumulation, Chicago: University of Chicago Press.

Feldstein, M. and P. Bacchetta, 1989, "National Savings and International Investment," NBER Conference on Saving [this volume].

Feldstein, M. and C. Horioka, 1980, "Domestic Saving and International Capital Flows," Economic Journal 90, 314-329.

Fieleke, Norman, 1982, "National Saving and International Investment," in: Saving and Government Policy, Conference Series no. 25, Federal Reserve Bank of Boston.

Frankel, Jeffrey, 1982, "On the Franc," Annales de l'INSEE, 47-48, 185-221.

Frankel, Jeffrey, 1984, "The Yen/Dollar Agreement: Liberalizing Japanese Capital Markets," Policy Analyses in International Economics no. 9, Washington, D.C.: Institute for International Economics.

Frankel, Jeffrey, 1986, "International Capital Mobility and Crowding-out in the U.S. Economy: Imperfect Integration of Financial Markets or of Goods Markets?" In R. Hafer, ed., How Open is the U.S. Economy?, Lexington, Ma.: Lexington Books, 33-67.

Frankel, Jeffrey, 1988a, "International Capital Flows and Domestic Economic Policies." In M. Feldstein, ed., The United States in the World Economy, University of Chicago Press: Chicago.

Frankel, Jeffrey, 1988b, "International Capital Mobility and Exchange Rate Variability," International Payments Imbalances, Bald Peak, N.H., Federal Reserve Bank of Boston (forthcoming).

Frankel, Jeffrey and Kenneth Froot, 1987, "Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations," American Economic Review 77, 1 (March 1987).

Frankel, Jeffrey and Kenneth Froot, 1988, "Chartists, Fundamentalists, and the Demand for Dollars", Greek Economic Review, 10, no. 1. Also forthcoming in Policy Issues for Interdependent Economies, edited by A. Courakis and M. Taylor, Oxford University Press: United Kingdom.

Frankel, Jeffrey, and Alan MacArthur, 1988, "Political vs. Currency Premia in International Real Interest Differentials: A Study of Forward Rates for 24 Countries," European Economic Review, 32.

Frenkel, Jacob, 1981, "Flexible Exchange Rates, Prices and the Role of 'News': Lessons from the 1970s," Journal of Political Economy 89, no. 4, 665-705.

Frenkel, J. and R. Levich, 1977, "Transaction Costs and Interest Arbitrage: Tranquil versus Turbulent Periods," Journal of Political Economy 85, 6, 1209-1226.

Froot, Kenneth and Jeffrey Frankel, 1989, "Forward Discount Bias: Is It An Exchange Risk Premium?" Quarterly Journal of Economics.

Giavazzi, Francesco and Marco Pagano, 1985, "Capital Controls and the European Monetary System," in Capital Controls and Foreign Exchange Legislation, Occasional Paper, Milano: Euromobiliare.

Glick, Reuven, 1987, "Interest Rate Linkages in the Pacific Basin," Economic Review No. 3, pp.31-42.

Harberger, Arnold C., 1980, "Vignettes on the World Capital Market," American Economic Review, Vol. 70, 331-337.

Hatsopoulos, George, Paul Krugman, and Larry Summers, 1988, "U.S. Competitiveness: Beyond the Trade Deficit," Science, vol. 24 (July 15), 299-307.

Huizinga, John, 1987, "An Empirical Investigation of the Long Run Behavior of Real Exchange Rates" Carnegie-Rochester Conference Series.

Koraczyk, Robert, 1985, "The Pricing of Forward Contracts for Foreign Exchange," Journal of Political Economy 93, 2, 346-368.

Krugman, Paul, 1978, "Purchasing Power Parity and Exchange Rates: Another Look at the Evidence," Journal of International Economics 8, no. 3, 397-407.

Mark, Nelson, 1985, "Some Evidence on the International Inequality of Real Interest Rates," Journal of International Money and Finance 4, 189-208.

MacArthur, Alan, 1988, "International Financial Market Integration: Empirical Analysis with Data from Forward and Futures Currency Markets," Ph.D. thesis, University of California, Berkeley.

Mishkin, Frederic, 1984a, "Are Real Interest Rates Equal Across Countries? An Empirical Investigation of International Parity Conditions," Journal of Finance 39, 1345-1358.

Mishkin, Frederic, 1984b, "The Real Interest Rate: A Multi-Country Empirical Study," Canadian Journal of Economics 17, no. 2, 283-311.

Morgan Guaranty Trust Company, 1988, "Financial Markets in Europe: Toward 1992," World Financial Markets 5, Sept. 9, 1-15.

Murphy, Robert, 1984, "Capital Mobility and the Relationship between Saving and Investment in OECD Countries," Journal of International Money and Finance 3, 327-342.

Obstfeld, Maurice, 1986, "Capital Mobility in the World Economy: Theory and Measurement," Carnegie-Rochester Conference Series on Public Policy, 31, 1-24.

Obstfeld, Maurice, 1989, "How Integrated are World Capital Markets? Some New Tests," in R. Findlay et al., eds., Debt, Stabilization and Development: Essays in Memory of Carlos Diaz-Alejandro. Oxford: Basil Blackwell.

Otani, Ichiro, 1983, "Exchange Rate Instability and Capital Controls: The Japanese Experience 1978-81," in: D. Bigman and T. Taya, eds., Exchange Rate and Trade Instability: Causes, Consequences and Remedies, Cambridge, MA: Ballinger.

Penati, A. and M. Dooley, 1984, "Current Account Imbalances and Capital Formation in Industrial Countries, 1949-1981," IMF Staff Papers 31, 1-24.

Pigott, Charles and Richard Sweeney, 1985. In Exchange Rates, Trade and the U.S. Economy, edited by S. Arndt, R. Sweeney and T. Willett, Washington, D.C.: American Enterprise Institute.

Popper, Helen, 1990, "International Capital Mobility: Direct Evidence from Long-term Currency Swaps," International Finance Discussion Papers No. 386, Federal Reserve Board, September.

Roll, Richard, 1979, "Violations of Purchasing Power Parity and their Implications for Efficient International Commodity Markets," in M. Sarnat and G. Szego, eds., International Finance and Trade, vol. 1, Cambridge, Mass.: Ballinger.

Roubini, Nouriel, "Current Account and Budget Deficits in an Intertemporal Model of Consumption and Taxation Smoothing: A Solution to the 'Feldstein-Horioka Puzzle'?" Yale University, October 1988.

Sinn, Stefan, 1992, "Saving-Investment Correlations and Capital Mobility: On the Evidence from Annual Data," January; forthcoming, Economic Journal.

Summers, L., 1988, "Tax Policy and International Competitiveness." In Jacob Frenkel, ed., International Aspects of Fiscal Policies, NBER, Chicago: University of Chicago Press.

Taylor, Mark, 1988, "Covered Interest Arbitrage and Market Turbulence: An Empirical Analysis." Centre for Economic Policy Research Discussion Paper No. 236.

Tesar, Linda, 1988, "Savings, Investment and International Capital Flows," University of Rochester, Working Paper No. 154, August.

Tobin, James, 1983, "'Domestic Saving and International Capital Movements in the Long Run and the Short Run,' by M. Feldstein: Comment," European Economic Review 21, 153-156.

Westphal, Uwe, 1983, "Comments on Domestic Saving and International Capital Movements in the Long Run and the Short Run," European Economic Review 21, 157-159.

Wyplosz, Charles, 1986, "Capital Flows Liberalization and the EMS: A French Perspective," INSEAD Working Papers No. 86/40. European Economy, European Economic Community, June 1988.

### Endnotes

. Despite the increased attention to inward foreign direct investment in the United States in recent years, it continues to be a smaller component of the capital inflow than portfolio investment. As of the end of 1987, foreign direct investment accounted for only 13 per cent of the total stock of foreign-held assets in the United States.

. There were relatively large differentials separating U.S. interest rates from the Eurodollar rates; at the long-term end of the spectrum, well-known U.S. corporations could borrow more cheaply in the Euromarket than domestically. These differentials fell steadily toward zero between 1982 and 1986, probably as the outcome of an innovation that occurred in the Euromarkets -- partly in response to these differentials -- making it easier for U.S. corporations to borrow there. Much of this innovation went under the name of securitization. See Frankel (1988) for documentation and further references. [It appears that the securitization trend suffered a setback in 1987 and 1988, in part associated with the October 1987 stock-market crash; it is now said to be slightly more costly for U.S. corporations to issue bonds in the Euromarket than domestically. It remains to be seen whether this reversal of the trend toward perfect integration is serious or lasting.]

. And even if this relationship doesn't break down in the future under pressure from fears of international creditors that U.S. indebtedness is becoming excessive.

. There is a fifth possible -- yet more narrowly defined -- criterion for the degree of integration of financial markets: the size of transactions costs as measured directly by the bid-ask spread in, for example, the foreign exchange market. Surprisingly, the covered interest differential does not appear to be statistically related to the bid-ask spread (MacArthur 1988).

. Obstfeld (1986) and Summers (1988) argue that the saving-investment correlation may be due to the common influence of growth rates.

. Sinn (1991), on the other hand, points out that the practice of averaging rates over a longer period may eliminate some of the international capital movements that one is looking for: current accounts must average out to zero over a sufficiently long run.

. Obstfeld (1986) makes the large-country point in a time-series context, where it properly belongs. But even in a time-series regression for a single country such as the United States, one can correct for the large-country problem by expressing saving and investment rates as deviations from the rest-of-world rates of saving and investment, respectively. Under the null hypothesis, an exogenous fall in the U.S. saving rate may drive up the world real interest rate and crowd out investment, but there is no evident reason for the crowding-out to be reflected in U.S. investment to a greater extent than in rest-of-the-world investment. In Frankel

1986, 44-45), I found that the close correspondence between U.S. saving and investment for 1970-1985 remains, even with this adjustment.

Obstfeld (1986) finds that the coefficient fell after 1973, in the time series correlations for most of his countries, but Obstfeld (1989) finds that it has risen over time (1967-84 vs. 1956-66), with the United States showing the highest correlation of any.

In a U.S. time series context, Frankel (1986) used two instrumental variables: the fraction of the population over 65 years of age and the ratio of military expenditure to GNP. The former is considered a determinant of private saving and the latter of public saving, and both have some claim to exogeneity. In the context of cross-sections of developing and industrialized countries, Frankel and Mathieson (1987) used the dependency ratio and, again, the military expenditure variable.

Other studies that reject real interest parity for major industrialized countries include Mishkin (1984a, 1984b), Cumby and Obstfeld (1984), Mark (1985), and Cumby and Mishkin (1986). Glick (1987) examines real interest differentials for six Pacific Basin countries vis-a-vis the United States.

The 10-year real interest differential vis-a-vis a weighted average of countries was about 3 per cent in 1984, whether expected inflation is measured with a distributed lag, by OECD forecasts, or by DRI forecasts. In 1980, by contrast, the differential was about -2 per cent. Frankel (1986, pp. 35-36).

Gross investment was 16.0 per cent of GNP in 1980, which was itself considered a low number [down 0.5 % from 1971-80].

The instrumental variables used are the dependency ratio (the ratio of those older than 64 and those younger than 21, divided by the working-age population in between), which is a determinant of private saving, and military expenditure as a share of GNP, which is a determinant of the federal budget deficit. A data appendix is available, for details on these and the other variables.

Regressions for yearly data beginning in 1930 were reported in Table 2 of the original published version of this paper.

There are two other potential sources of differences from the results in Frankel (1986): the Commerce Department released revised national accounts data for the entire period in 1986, and we now use the dependency ratio as the demographic instrumental variable in place of the ratio of the over-65 to the over-20 population. But the years 1985-87 are indeed the source of the fall in the coefficient; when these three years are omitted the coefficient is near 1 [as when the 1980's are omitted in Table 2].

If the 1956-1987 sample is split at 1974, when the United States and Germany removed capital controls, rather than at 1979, there is still a precipitous decline in the cyclically-adjusted saving-investment coefficient over time: from .7 (statistically, no difference from 1) to .31 (borderline difference from 0 in Table 3a in the working paper version.) If the 1930-1987 sample is split in 1958, when many European countries restored currency convertibility, there is a small increase in the coefficient over time: from .83 (statistically different from 1) to 1.14 (no difference from 1). [Table 2a.] But this is no doubt because

... saving and investment rates are not cyclically adjusted for this period, (the A series is not available back to 1930). Only when expressed on a cyclically adjusted basis is the U.S. national saving rate of 1985-1990 especially low. ... Feldstein and Bacchetta (1989) and Bayoumi (1992) find similar drops in the saving-investment coefficient in the 1980s, for cross-sections of industrialized countries (though they do not use instrumental variables, and are thus liable to econometric criticisms that others have raised concerning the endogeneity of national saving).

... Measuring barriers to integration by differences in rates of return has the problem that a given degree of integration can appear smaller or larger depending on the disturbances to saving (or to other variables) during the sample period in question. For example, a greater degree of variability in the U.S. real interest rate differential in the 1980s, as compared to the 1970s or 1960s, could be attributed to the greater swings in variables such as the structural budget deficit, rather than to a lower degree of capital mobility. All we can say for sure is that if the barriers to integration are essentially zero (the degree of capital mobility is essentially perfect), then differentials in rates of return should be essentially zero.

... For example, Krugman found that the standard deviation for the real mark/dollar exchange rate during the German hyperinflation, January 1920-December 1923, was much larger (20.8 percent) than during the 1970s, even though the serial correlation was no higher (1965).

... Cumby and Obstfeld (1984, p.146) used a Q-statistic to test for higher order serial correlation in monthly real exchange rate changes and found none. However they also found that expected inflation differentials were unrelated to expected exchange rate changes, rejecting the random walk characterization of the real exchange rate. Huizinga (1986) was also able to reject the random walk in some cases.

... As already noted, an AR coefficient of .7 on a yearly basis corresponds to an AR of .97 on a monthly basis ( $.97^{12} = .70$ ). Thus one might take 564 months of data ( $2.93^2(1-.97^2)/(1-.97)^2 = 563.7$ ) to be able to reject the null hypothesis of AR = 1. This is 47 years, a very little gain in efficiency over the test on yearly data. Summers (1986) demonstrates the low power of random walk tests in the context of stock market prices.

... DeJong, Nankervis, Savin and Whiteman (1988, table II) offer power tables for the Dickey-Fuller test which show that when the true AR parameter is .8, even a sample size of 100 is sufficient to reject a random walk only about 65 percent of the time.

... As the sample period covers a number of changes in exchange rate regime, it would be desirable to allow for shifts in the coefficient (and in the variance of the disturbance term). But many of the proponents of a random walk in the real exchange rate claim this as evidence in favor of an "equilibrium" hypothesis, under which fluctuations in the real exchange rate are caused only by real, as

posed to monetary, factors. Under this null hypothesis, changes in the exchange rate regime should not matter for the real exchange rate. Thus our statistical test is a valid rejection of the null hypothesis, even though it lumps together all 119 years of observations.

.. Sticky goods prices are only one of a number of possible sources of deviations from ex ante relative PPP. Another is the existence of the prices of nontraded goods in the relevant price index. Dornbusch (1983) shows how movement in the relative price of non-traded goods affects the real interest rate, saving, and borrowing from abroad, while Engel and Kletzer (1987) show specifically how such movement can give rise to the Feldstein-Horioka finding. Bovenberg (1989) too shows how imperfect substitutability of goods can give rise to the finding.

.. The rationally expected rate of real depreciation estimated from a specific time series process is not necessarily the same as the actual expectation of real depreciation held by investors. Frankel (1986, pp.58-59) used survey data on expectations of exchange rate changes (collected by the Economist-affiliated Financial Report) and forecasts of price level changes (by DRI) to compute a direct measure of expected real depreciation for the dollar against five currencies. The numbers showed an expectation that the real exchange rate ten percent regress back toward PPP at a statistically significant rate of 8 to 12 percent per year.

.. Obstfeld (1986) shows, in a life-cycle model of saving with actual OECD data on the functional distribution of income and on population growth, that the coefficient in an investment regression can be similar to those estimated by Feldstein and Horioka. Similar claims based on models of intertemporal optimization are made by Ghosh, 1988, Roubini, 1988, Tesar, 1988, and Leiderman and Zin, 1989.) But Feldstein and Bacchetta (1989) argue that the growth rate is not in fact responsible for the observed coefficient.

.. Some of these data were also analyzed in Frankel & MacArthur (1988). Some forward rate observations for Italy, Austria, and Belgium in the Barclay's data looked suspicious. In addition, Barclay's does not quote a rate for Portugal. For this study, forward exchange rates for Italy and Belgium are taken from the Bank of America (also obtained via DRI), and for Austria and Portugal from the Financial Times. The Barclay's data for Ireland also appear suspect (1986-1988).

.. The data appendix to NBER Working Paper 2309 gives details.

.. The standard errors for individual country means are usable, indeed are conservative, despite the use of overlapping observations, because they are calculated as if there were T/3 observations rather than the actual T observations used.

.. Saving-investment regressions, by contrast, show the counterintuitive result: coefficients for LDCs that are lower (suggesting higher capital mobility, in Feldstein and Horioka's terms) than for industrialized countries. Fieleke (1982), Dooley, Frankel and Masson (1987) and Summers (1988).

.. The results were reported in NBER working paper 2856, but were

itted here to save space.

.. It is possible that, for some countries, seasonal variation constitutes a predictable component.

.. The British liberalization of 1979 is explained and analyzed in Cluis and Taylor (1989). See Figure 4.

.. As shown, e.g., by Boothe, et al, 1985, p.112.

.. For example, Otani (1983) and Frankel (1984).

.. The frequently large negative covered differential that had been observed in Australia up to mid-1983 (see, e.g., Argy, 1987) largely vanished thereafter.

.. Clausen and Wyplosz (1982), Giavazzi and Pagano (1985, pp.27-30), Frankel (1982) and Wyplosz (1986), among others.

.. "Capitalism," The Economist, May 21, 1988, p.95.

.. The magnitude of the covered interest differential fell sharply in 1987 for these two countries. [See de Macedo and Torres (1988).]

.. For France, Italy, Ireland, Spain and Greece (as reported in World Financial Markets, September 9, 1988, p.5). Denmark's covered differential remains quite high in our sample. The country has been reported to have no capital controls (Economist, op.cit.), but this evidently applies only to securities: the European Commission reports that deposits and other short-term transactions are mainly subject to authorization in Denmark as of 1988.

.. Bahrain shows a smaller differential than the others, and even smaller than some of the European countries with controls, like Spain and Ireland. (It should be noted that the forward rate quoted by McClay's applies to the Saudi riyal; we match it up with the Bahraini interest rate because no local interest rate is available in Saudi Arabia and the two countries are said to be closely tied financially. The riyal is classified by the IMF under the same exchange rate arrangement as Bahrain's currency, the dinar, which would suggest that the same forward rate could be applied to both. But the riyal exchange rate does in fact vary somewhat, so that our assumed covered interest differential is not entirely legitimate.)

.. Taylor (1988) studies covered interest parity within the London market. Such studies do not get at the degree of financial market integration across national boundaries. When authors find deviations from covered interest parity in such data (e.g., Mishkin, 1984a, p.1350), it is often due to low quality of the data, e.g., exact timing. With high-quality data, Taylor finds that covered interest parity held extremely well in 1985, that it held less well in the 1970s, particularly during "turbulent" periods, that the differential had mostly vanished by 1979, and that the differentials that do exist are slightly larger at the longer-term than shorter-term maturities. But, like other studies, Taylor has no data on securities longer than one year.

.. It is still quite likely, however, that there is a wedge in each country separating the long-term interest rate from the after-tax cost of capital facing firms. Such a wedge could be due either to the corporate income tax system or to imperfect substitutability between bonds and capital. Hatsopoulos, Krugman and Summers (1988) argue that the cost of capital facing U.S. corporation is higher

an that facing Japanese corporations, even when real interest rates are equal, because U.S. companies rely more heavily on equity financing, which is more expensive than debt financing. See also papers in Feldstein (1987).

.. The results are reported in NBER working paper no. 2856, but are omitted here to save space.

.. Reported in Column (1) of Table 8 in the originally-published version of this paper.

.. The five exceptions, currencies that depreciated against the dollar at a rate more rapid than predicted by the forward discount, were the Hong Kong dollar, Malaysian ringgit, Singapore dollar, Saudi Arabian riyal, and South African rand.

.. The currencies are the Saudi Arabian riyal, and two that appreciated strongly against the dollar, relative to the forward rate: the Japanese yen and the Portuguese escudo.

.. Again, the results are reported in a working paper but are omitted here.

.. Many others have found a highly significant predictable component of  $(fd - e)$ , often when regressing against  $fd$ , and particularly in-sample. It is possible that such findings are not due to a time-varying premium, as traditional expectations approach would have it, but rather to a time-varying model of spot rate determination (together with insufficiently long sample periods and learning by investors. Such speculations go outside the scope of this paper. See Frankel and Froot, 1988, and Froot and Frankel, 1989.)

.. The statistics on real depreciation were reported in Table 9 of the originally-published version of this paper.

.. Once again, the results are reported in a working paper, but are omitted here.

.. It seems that in both cases an apparently predictable component of the spot rate changes constitutes most of the variation (as opposed to variation in the forward discount or inflation differential, respectively): the significant coefficients on the forward discount, interest differential and ex post inflation differential when  $(Ds - Dp - Dp^*)$  is the dependent variable are always of opposite sign and similar magnitude as the coefficients when  $(fd - Ds)$  is the dependent variable.

.. One view is that the high degree of integration of financial markets is one of the causes of the high degree of volatility of exchange rates. The issue is discussed, and further references given, in Frankel (1988b).