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Capital Market Integration in the Pacific Basin Region: An Analysis of Real Interest Rate Linkages

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Abstract

This paper investigates the extent to which financial markets in the Pacific Basin Region have become more integrated, by analyzing the comovements of real interest rates. The paper uses cointegration and error correction models and draws inferences on the degree of capital market integration by looking at the speed of adjustment of real interest rates following a shock. The results show that there has been an increase in capital market integration with both U.S. and Japan during the 1980s. Japan has not, however, overtaken U.S. in dominating the financial markets of these countries, except possibly in the case of Malaysia. Capital market integration is found to be greater in Singapore, Hong Kong and Taiwan Province of China. On the other hand, Japan is the least integrated country with the United States.

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Summary

By examining comovements of real interest rates in Japan, Singapore, Hong Kong, Taiwan Province of China, Malaysia, and Korea, this paper investigates the extent to which financial markets in the Pacific Basin Region have become more integrated in recent years.

In particular, the paper focuses on the following questions. First, as a result of financial liberalization and innovation, particularly the removal of capital controls and other barriers to international capital mobility, are real interest rates becoming increasingly linked to the core world financial markets (e.g., the United States and Japan)? Second, to the extent that interest rates in the Pacific Basin countries are now influenced by interest rates in world financial markets, is the power of Tokyo in the region gaining over that of New York?

The analysis uses cointegration methodology, which tests whether real interest rates have a long-run relationship but allows for movements in rates within a band defined by various types of transaction costs and taxes, including the implicit tax of capital controls and the political risk premium relating to future capital controls. In addition, capital market integration is examined from another aspect. The various capital market imperfections that drive a wedge between market rates of return also reduce the sensitivity of capital supply that would eliminate differentials beyond the band. An attempt to capture this effect is made by studying the speed at which interest rates adjust following a shock--in particular, the time it would take to eliminate a differential that is greater than that defined by the band, and whether interest rates in both markets respond to the disequilibrium. The greater is the degree of capital mobility, the faster real interest rates should adjust to attain long-run equilibrium.

The above approach yields the following conclusions:

- The ex post real interest rates of the Pacific Basin countries in the sample have been moving together since the 1970s, with respect to both the United States and Japan.

- As regards the speed of adjustment following a shock, the differences in the degree of market integration before and after liberalization emerge. For comparisons with the United States and Japan, capital market integration is greater in the post-liberalization period.

- The speed of adjustment is on the whole slower versus Japan than versus the United States (except, possibly, for Malaysia).

- Capital market integration is greater in Singapore, Hong Kong, and Taiwan Province of China. On the other hand, Japan is the least integrated country with respect to the United States.

I. Introduction

This paper investigates the extent to which financial markets in the Pacific Basin Region have become more integrated, by analyzing the comovements of real interest rates. In recent years countries in the Pacific Basin region have attempted to promote economic efficiency by taking steps to liberalize their domestic financial systems and remove restrictions in international capital flows. Hong Kong and Singapore were the first to begin liberalizing their financial systems by removing or relaxing interest rate regulations and abolishing exchange controls in the mid 1970s. Japan and Malaysia followed with significant financial reforms in the late 1970s, while Korea and Taiwan Province of China took steps towards liberalization in the second half of the 1980s. Although the timing and extent of liberalization has varied across countries, all countries in the region have allowed domestic and foreign market forces to play a greater role in their financial markets.

An effect of this liberalization process is the impact on the degree of integration between the financial markets of Pacific Basin countries and the world financial markets. If financial markets are highly integrated, it implies that a given country's economy cannot be effectively insulated from foreign influences. Many studies on capital market integration in the Pacific Basin region have concentrated on integration between Japan and U.S. (see e.g., Otani and Tiwari, 1981; Ito, 1988; and Bosner-Neal and Roley, 1994). Recently, there has been a lot of interest in other Pacific Basin countries. For example, Bhoocha-Oom and Stansell (1990) looks at interest rates (adjusted and unadjusted for exchange rate changes) between Hong Kong and Singapore versus U.S. Faruquee (1992) examines the uncovered interest rate differential between Singapore, Malaysia, Korea and Thailand versus the Japanese LIBOR - taken to represent the world rate of interest. 1/ Dooley and Montiel (1994) look at seven Pacific Basin Countries versus U.S. using an analytical framework for interest rate determination, where the prevailing interest rate represents a weighted average of open (U.S. interest rate adjusted for the change in the exchange rate) and closed economy rates that would have existed otherwise. 2/ Reisen and Yeches (1993) using the same framework examine Korea and Taiwan Province of China in greater detail. The results of these studies support the view that on the basis of covered and/or uncovered interest rate parity there is substantial integration between domestic and international financial markets in Japan, Hong Kong, Singapore and Malaysia, while the views are divided for Korea and Thailand. In Taiwan Province of China capital market integration with world financial markets has been found to be limited.

1/ The change in the exchange rate is assumed to be zero.

2/ This is based on work done by Edwards and Khan (1985) for the case of Singapore and Colombia; and Haque and Montiel (1991) for 15 developing countries.

In the current paper, we examine financial market integration by concentrating on *real interest rates* for a group of Pacific Basin Countries: Japan, Singapore, Hong Kong, Taiwan Province of China, Malaysia and Korea. Previous studies on real interest rate linkages concentrate on the United States, Canada and some European countries (see e.g., Mishkin, 1984a,b; Mark, 1985; Cumby and Mishkin, 1986; and Merrick and Saunders, 1986). The results are on the whole unfavorable to real interest rate equalization with the exception of the study by Grennes and Goodwin (1994). 1/

In the current paper, we follow Grennes and Goodwin's suggestion and use cointegration methodology which examines whether real interest rates have a long-run relationship, but allows for movements in rates within a band defined by various types of transaction costs and taxes, including the implicit tax of capital controls and the political risk premium relating to future capital controls. 2/ In addition, we look at capital market integration from another aspect. The various capital market imperfections which drive a wedge between market rates of return also reduce the sensitivity of capital supply that would eliminate differentials beyond the band. We try to capture this effect by studying the speed of adjustment of interest rates following a shock. We examine how long it will take to eliminate a differential which is greater than that defined by the band and whether interest rates in both markets respond to the disequilibrium. Situations where all the adjustment to long-run real interest rate differential is done by the interest rate in the Pacific Basin country, while the foreign interest rate (U.S./Japan) does not change, are indicative of foreign capital market domination. The greater the degree of capital mobility the faster the adjustment to long-run equalization of real interest rates. This indicator of capital market integration is of greater use to policy makers. The existence of a wedge between interest rates gives a country the opportunity to pursue a stance of monetary policy which entails a different interest rate from the world interest rate (under fixed exchange rates). If this stance, however, changes and entails a bigger differential than the existing wedge (the tightness of capital controls remaining the same), the length of time it takes for the initial wedge to be reestablished, indicates the breathing space that the monetary authorities have.

In particular, the paper focuses on the following questions. First, as a result of financial liberalization and innovation, particularly the removal of capital controls and other barriers to international capital mobility, are real interest rates becoming increasingly linked to the core world financial markets e.g., to U.S. and Japan? Secondly, to the extent that interest rates in the Pacific Basin countries are now influenced by interest rates in world financial markets, is the power of Tokyo in the

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1/ The results are robust with respect to countries, interest rates and price deflators.

2/ See Phylaktis and Wood (1984) and Phylaktis (1988) for an explanation of the effects of capital controls on the international parity conditions.

region gaining over that of New York? There are signs that Japanese financial influence is dominant in East Asia. Yuan (1986) examines capital flows among Pacific Basin economies and finds that 65 percent of total net flows (private and public) in 1972 and 55 percent in 1980-82 came from Japan, with the corresponding figures for the U.S. being 31 percent and 41 percent respectively. Tavlas and Ozeki, (1991) examine the role of yen in the region and found Asian Central Banks in the course of the 1980s to have increased their holdings of yen from 13.9 percent of their foreign exchange reserve portfolios to 17.5 percent. The yen is also being used more widely to invoice trade and finance in Asia. The countries that incurred large international debts in the 1970s and early 1980s subsequently shifted the composition away from dollar-denominated debt towards yen-denominated debt.

The paper is structured as follows. Section II explains methodological issues, how cointegration and error correction models can be used to test real interest rate parity. Section III discusses the data, while Section IV presents the empirical results. Finally, Section V summarizes the main findings and policy implications.

II. Methodological Issues

Real interest rate parity as a way of measuring the degree of integration between two different financial markets has usually taken the form of estimating the following regression where r_{it} and r_{jt} are the real interest rates in countries i and j respectively, and testing for the joint hypothesis that $\alpha_o=0$ and $\alpha_1=1$.

The above test suffers from two weaknesses. First, it does not allow for any capital market imperfections such as transaction costs. Such costs even when they are small can lead to estimates of α_o and α_1 taking different values from the expected ones of zero and one. Secondly, the usual

$$r_{it} = \alpha_o+\alpha_1 r_{jt} \qquad (1)$$

regression results assume that individual real rates are stationary, which is not always the case. 1/ If the series are non-stationary then the empirical estimates of the parameters α_o and α_1 will be consistent but their estimated standard errors will not be consistent (see Stock, 1987).

The use of cointegration technique, developed initially by Granger (1981), to explore the long-run relationship between two real interest rates overcomes these problems. Cointegration says that if two series, x and y, are non-stationary (as in the case with many economic magnitudes which typically trend through time), but some linear combination of them is a

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1/ See Mishkin (1995) for evidence on the non-stationary behavior of real interest rates.

stationary process, then x and y are said to be cointegrated. In the context of our paper, the assumption that real interest rates in two different markets tend to move closely in the long-run, suggests that these variables should be cointegrated with a cointegrating parameter, α_1 (see equation (1)).

Apart from the examination of the long-run co-movement of the two real interest rates, we explore the short-run dynamics by using the link between the concept of cointegration and error correction mechanisms, which was established by the Granger Representation Theorem in Engle and Granger (1987). This theorem shows that if two or more variables are cointegrated, there is an error correction representation, that is a vector autoregression of first differences of the variables augmented by one lag of the error term.

In our case, the error correction model (ECM) takes the following form

$$\Delta r_{i,t}=a_1+\rho_1(r_{j,t-1}-\alpha_1 r_{i,t-1})+\sum_{h=1}^{n}\gamma_h\Delta r_{i,t-h}+\sum_{h=1}^{n}\delta_h\Delta r_{j,t-h}+u_{1t} \tag{2}$$

$$\Delta r_{jt}=a_2+\rho_2(r_{j,t-1}-\alpha_1 r_{i,t-1})+\sum_{h=1}^{n}\zeta_h\Delta r_{i,t-h}+\sum_{h=1}^{n}\eta_h\Delta r_{j,t-h}+u_{2t}. \tag{3}$$

The ECM describes the mechanics of adjustment to the long-run equilibrium embodied in the cointegrating regression. In particular, the coefficient on the error correction term, ρ_1 in equation (2) and ρ_2 in equation (3), measures the single period response of the dependent variable to departures from equilibrium. If this coefficient is small or statistically insignificant in the ECM for $r_{i,t}$, then $r_{i,t}$ does not adjust to correct departures from equilibrium. In our exercise, if j is the U.S. and i one of the Pacific Basin countries, we would expect to find ρ_1 statistically significant and ρ_2 statistically insignificant. That is, we would expect to find the interest rates in the Pacific Basin countries adjusting to those in U.S. confirming the important role of U.S. for those countries.

We also perform another exercise to test for real interest rate parity which too allows for interest rate movements within a band. We impose the restriction of unity in the real interest rate r_i and test whether the interest rate differential e_{it} given by equation (4) is stationary

$$e_{it}= r_{jt}-r_{it}. \tag{4}$$

This exercise allows us also to estimate the speed of adjustment of the interest rate differential in the aftermath of a shock. Suppose that e follows a first-order autoregressive process:

$$e_{t+1}=c_o+c_1e_t+u_{t+1}, \tag{5}$$

where c_o and c_1 are constants and the error term u_t is normally and independently distributed over time. Taking the unconditional expectation of the process in (5), assuming that $|c_1|<1$, and rearranging gives us the long-term equilibrium real interest rate differential, $e=c_o/(1-c_1)$. 1/

Long-run real interest rate parity is violated if $|c_1|\geq 1$ and if c_o and/or c_1 are not time invariant constants. Provided that long-run interest rate parity holds, short-run parity is violated whenever e_t does not equal its long-run value e. If $c_1<1$, however, shocks to the system are corrected at the rate of $(1-c_1)$ per period. 2/

In order to test whether the real interest rates are cointegrated, we first test for the existence of unit roots in the stochastic process of each of the rates. We test for unit roots using the Augmented Dickey Fuller

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1/ It should be noted that if we have a higher order autoregressive process, equation (5) is modified to

$$e_{t+1}=c_o+\sum_{i=1}^{k} c_ie_{t+1-i}+u_{t+1}, \tag{5a}$$

and the long-term equilibrium real interest rate differential is

$$e=c_o/(1-\sum_{i=1}^{k} c_i),$$

after taking the unconditional expectation of the process in (5a) and assuming that $|\Sigma c_i|<1$.

2/ In the case of higher order autoregressive process shocks to the system are corrected at the rate of $(1-\sum_{i=1}^{k} c_i)$, where c_i are the autoregressive coefficients.

(ADF) test as recommended by Engle and Granger (1987). 1/ Assuming that both variables are nonstationary and integrated of the same order, we test whether they form a cointegrating system by applying both likelihood ratio test due to Johansen (1988) and the ADF test. 2/

1/ The ADF test for unit roots involve estimating the following regression using ordinary least squares:

$$Dx_t = a + (1-\gamma)\, x_{t-1} + \sum_{j=1}^{N} b_j\, Dx_{t-j} + \epsilon_t$$

where x_t is the individual time series, D is the first difference operator (i.e. $Dx_t = x_t - x_{t-1}$), ϵ_t is a serially uncorrelated random term, and a is a constant. The terms Dx_{t-j}, j=1, 2,....N, are included to ensure that ϵ_t is white noise. Rejection of a unit root, which implies that the series is stationary, requires the coefficient on x_{t-1}, $(1-\gamma)$ to be negative and significant. The ADF test (or the DF test when it is not necessary to add any lagged differences in order to induce whiteness in the residuals) is based on the conventionally computed t-statistic (Fuller 1976; Dickey and Fuller 1981). The distribution for this statistic is non-standard and depends on the presence of an intercept in the equation. Critical values are reported in Fuller (1976) and Dickey and Fuller (1981).

2/ The likelihood ratio test for the existence of at most r cointegrating factors or at least (p-r) unit roots in a set of p variables is:

$$-2\ln Q_r = -T \sum_{i=1+r}^{p} \ln (1-\hat{w}_i).$$

The $\hat{w}_i$s are the squared canonical correlations ($\hat{w}_1 > \hat{w}_2 > \ldots > \hat{w}_p$) between the two sets of residual vectors, R_{0t} and R_{1t}, obtained in the following two regressions:

$$DX_t = \sum_{i=1}^{k-1} \Gamma_{0i}\, DX_{t-i} + R_{0t}$$

$$X_{t-k} = \sum_{i=1}^{k-1} \Gamma_{1i}\, DX_{t-i} + R_{1t}$$

where X_t is the p-vector of variables and Γ_{ji} are matrices of coefficient estimates. Cointegration holds if r is greater than or equal to 1. Johansen (1988) shows that $-2\ln Q_r$ is distributed as a function of a (p-r) dimensional standard Brownian motion and tabulates the distribution of the test statistic. In the case where p=1 this test reduces to a unit root test for a single series.

III. Discussion of the Data

Six Pacific Basin countries were selected for the empirical analysis: Singapore, Malaysia, Hong Kong, Korea, Taiwan Province of China and Japan. The sample period varies for each country according to the availability of data. For Singapore the sample period is 1973.08 to 1993.12; for Malaysia 1982.01 to 1993.12; for Taiwan Province of China and Korea 1972.02 1993.12; for Hong Kong 1976.1 to 1993.12; and for Japan 1974.01 to 1993.12. We have used end of month data apart from the case of Korea, where we have used end of quarter. The money markets interest rates used were as follows: 90-day Treasury Bill rate for the U.S.; the three-month Gensaki rate for Japan; 1/ the three month regulated deposit rate for Hong Kong; and the three month interbank rate for Singapore and Malaysia. For Taiwan Province of China and Korea, we have used short-term curb rates. The curb market is an unofficial, largely unregulated financial market involving small borrowers and lenders. 2/ We have used these rates because the domestic financial markets were highly regulated even during the 1980s. 3/

In order to examine the effects of deregulation we divided the sample into two sub-periods. The first period ends in December 1980 and represents the period of financial regulation. The second sub-period covers January 1981 to December 1993 and represents the post-liberalization period. As it has already been mentioned substantial deregulation took place in many of the countries under consideration in the late 1970s and early 1980s. The exact date of the division of the sample period was chosen because of the drastic shift in foreign exchange control policy that took place in Japan. The Foreign Exchange and Foreign Trade Control Law was passed which freed most capital flows. In addition, restrictions on nonresidents' Gensaki transactions were completely eliminated. This relaxation of foreign exchange controls makes possible the examination of capital market

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1/ Gensaki transactions consist of the resale or repurchase of bonds at a fixed price after a fixed period. They are short-term capital transactions using bonds as collateral. Prior to 1977.02 we have used the 60-day Gensaki rate.

2/ The size of these markets remains substantial, but has fallen over the years. For example, in the mid 1970s the aggregate size of the curb market in Taiwan was as large as that of all financial institutions put together. In 1986, according to flow of funds accounts for private business enterprises, the ratio of curb market to total bank borrowing was 48 percent in 1986 (see Fry, 1990).

3/ Data on prices refer to consumer price index and were taken from the International Financial Statistics published by he International Monetary Fund, except for Taiwan where prices were taken form Monthly Statistics of the Republic of China. Data on interest rates for Malaysia, Hong Kong and Singapore were provided by Nomura Bank; for Korea by the International Monetary Fund; for Taiwan were taken from the Financial Statistics Monthly, Taiwan District, Republic of China; and for U.S. and Japan from Datastream.

integration between Japan and the Pacific Basin countries during the 1980s. 1/

Following Cumby and Mishkin (1986), the ex post real interest rate on a j period financial instrument held until maturity was defined from the Fisher Condition as

$$r_{t,j} = i_{t,j} - \pi_{t,j}, \tag{6}$$

where $r_{t,j}$ is the real return at time t earned from holding the asset for j periods; $i_{t,j}$ is the nominal j period interest rate; and $\pi_{t,j}$ is the rate of inflation from t to t+j. 2/

IV. Empirical Results

In Table 1 we present summary statistics for the real interest rate differentials between the U.S. and the rest of the countries. The information is given for both sub-periods. Various points can be made. During the 1970s only in the case of Japan the mean is close to zero and even that exhibits a high degree of variability as manifested by the standard deviation. During the 1980s and early 1990s the value of the mean is close to zero and statistically insignificant in the case of Japan and Singapore, it falls in the case of Korea, and it rises in the case of Hong Kong and Taiwan Province of China. In the case of Malaysia, it is small but statistically significant. In all the cases, however, there has been a substantial reduction in variability during the second sub-period.

These results may suggest the existence of apparent riskless profit opportunities for investing in the Pacific Basin Countries apart from the case of Hong Kong when the sign of the mean is positive. Without specific knowledge of transaction costs or any other type of costs such as search costs, or risk differences in the two assets involved, one cannot conclude that the mean differentials persistently exceed the band. For example, the very high mean differentials in the case of Taiwan Province of China and Korea, where curb interest rates are used, could reflect the substantially higher transaction costs and the higher degree of default risk.

We proceeded to test for unit roots in the real interest rates for the two sub-periods whenever that was possible. Table 2 presents the results. We reject the null hypothesis of a unit root for the first difference for all real interest rates. But, we accept at the 5 percent level the null hypothesis of a unit root in levels of all cases apart from two: the pre-

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1/ It should be noted that U.S. had no foreign exchange controls during the whole sample period, so that the current exercise on the degree of capital market integration reflects developments in the Pacific Basin countries.

2/ All returns and inflation rates are continuously compounded.

Table 1. Summary Statistics for Real Interest Rate Differentials between U.S. and selected Pacific Basin Countries

	Market	Mean	Mean (t-ratio)	Standard deviation
First sub-period				
74.01-80.12	Japan	-0.551	-0.899	5.613
73.08-80.12	Singapore	-3.054	-3.709	7.769
76.01-80.12	Hong Kong	3.661	3.281	8.642
72.01-80.04	Korea	-24.141	-13.275	10.912
72.01-80.12	Taiwan	-20.332	-8.156	25.906
Second sub-period				
81.01-93-12	Japan	-0.269	-0.881	3.781
81.01-93.12	Singapore	-0.072	-0.263	3.252
81-01-93.12	Hong Kong	5.194	13.900	4.621
81.01-93.04	Korea	-14.592	-17.472	5.964
81.01-93.12	Taiwan	-22.222	-41.405	6.639
82.01-93.12	Malaysia	-1.280	-3.861	3.936

Notes: The frequency of data for Korea is quarterly.

liberalization sub-period for Singapore, and the post-liberalization sub-period for Taiwan Province of China. Thus, similar to most financial series, these real interest rates are I(1), which means that first differencing is required to achieve stationarity. 1/ We proceeded to test for cointegration for all rates, apart from the rate for the post-liberalization period for Taiwan Province of China and the pre-liberalization period for Singapore, both versus U.S. and Japan. Table 3 presents the results versus U.S. 2/ On the basis of the ADF test statistic, the null hypothesis that the two real rates are not cointegrated can be rejected at the 5 percent level for Singapore, Korea and Hong Kong and at the 10 percent level for Taiwan Province of China and Malaysia. In the case of Japan the null hypothesis of no cointegration cannot be rejected for both sub-periods. On the basis of the J-statistic, we arrive at similar conclusions. The hypothesis of at most one cointegrating vector (H_0 : $r \leq 1$) is in no case rejected, whilst the hypothesis of zero cointegrating vectors (H_0 : $r = 0$) is easily rejected in every case (even in the case of Japan) at the 5 percent level. These results indicate to us that the real rates of these Pacific countries, except possibly the rate for Japan, have had a long-run relationship with the real interest rate of U.S. even during the 1970s in the case of Korea and Taiwan Province of China.

Table 4 presents the results versus Japan. On the basis of the ADF statistic and at the 5 percent level of significance, the real rates of two of the five countries (Korea and Taiwan Province of China) have a long-run relationship with the real rate in Japan. In the case of Singapore, the null hypothesis of no cointegration cannot be rejected at the 10 percent level. 3/ On the basis of the J-statistic the results are more favorable to real interest rate parity. The hypothesis of at most one cointegrating vector (H_0 : $r \leq 1$) is in no case rejected, whilst the hypothesis of zero cointegrating vectors (H_0: $r = 0$) is easily rejected in every case at the 5 percent level.

Multivariate cointegration offers a different perspective to the issue of capital market integration. Stock and Watson (1988) have developed a test for the existence of common trends in a set of non-stationary variables. If a set of real rates have a single common trend, that will mean that any single rate is representative of the group of rates examined

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1/ The Augmented Dickey Fuller regressions were also estimated using a trend term. The order of integration for each of the series remained the same. Thus, the possibility of trend stationarity is rejected.

2/ The particular specification included the U.S. real interest rate on the right hand side regressor. Lags were added to ensure whiteness of the standard error and the Schwarz's (1978) Bayesian criterion was used to select the appropriate lag structure.

3/ Estimates of the cointegrated parameters were smaller than one and had small standard errors. As it has been noted, nonstationarity of the real rates precludes using the parameters and standard errors for formal hypothesis testing.

indicating complete integration of the capital markets. In implementing their test, we use Johansen's multivariate test for unit roots. Although each univariate series might contain a stochastic trend, in a vector process these stochastic trends might be common to several of the variables. When some series contain the same stochastic trend then they are said to be cointegrated. In our case of say five series, if each of them is integrated of order 1, they can be jointly characterized by k stochastic trends, where k=5-r, r being the number of cointegrating vectors.

We have considered two groups of real interest rates. The first group contains rates of U.S., Japan, Malaysia, Singapore, and Hong Kong. We left out Korea because the frequency of the data is quarterly, and Taiwan Province of China because the series was found to be stationary for the post-liberalization sub-period. In the second group of interest rates U.S. was left out. Table 5 reports the results of calculating the Johansen maximum likelihood-ratio test statistic $-2\ln Q_r$ to define the dimensionality of the common stochastic trend process. Using a 5 percent significance level, we cannot reject the hypothesis that in the first group four stochastic trends are present in the full five-dimensional system determining the interest rates. This suggests that any single rate is representative of the five rates included in the group, which implies a considerable degree of integration among these markets. Similar conclusions are drawn with regard to the second group of rates. Using a 5 percent significance level, we cannot reject the hypothesis that three stochastic trends are present, or that there is a single stochastic common trend, confirming the existence of integration amongst the Japanese and other Pacific Basin capital markets.

Though the results are not absolute, real interest rate parity within the framework of cointegration receives substantial empirical support for the Pacific Basin countries, especially versus the U.S. The results, however, did not shed much light on the two issues of interest to us, namely whether there has been a change in the degree of capital market integration in post liberalization times, and whether Japan has come to dominate the region.

We thus proceeded to the next exercise of testing whether the real interest rate differential is stationary, which also allows for variation of the interest rates within the cost band. This test, which can be applied to all countries, including Taiwan Province of China in the post liberalization sub-period as it does not depend on the individual rates being non-stationary, provides us with another insight into the financial market integration issue. When there is a shock which causes real interest rates to move outside the cost band, the speed with which capital flows cause interest rates to return to the band is another indicator of financial market integration. Regulations, information, search and other costs can affect the sensitivity of capital flows. Thus, the slower the speed of adjustment the lower the degree of capital market integration.

Table 2. Unit root tests for real interest rates

Market	Statistic	Levels	First Diferences
United States			
1972.01-80.12	ADF	-2.480	-5.266
1981.12-93.12	ADF	-2.200	-7.049
Japan			
1972.01-80.12	ADF	-2.143	-6.884
1981.01-93.12	ADF	-2.337	-10.858
Singapore			
1973.08-80.12	ADF	-4.204	-5.216
1981.01-93.12	ADF	-2.218	-6.573
Malaysia			
1982.01-93.12	ADF	-2.670	-8.333
Hong Kong			
1976.01-93.12	ADF	-2.168	-7.367
1981.01-93.12	ADF	-1.895	-5.680
Taiwan			
1972.01 - 80.12	ADF	-2.547	-5.937
1981.01 - 93.12	ADF	-3.671	-7.010
Korea			
1972.01 -80.12	ADF	-2.514	-4.418
1981.01-93.12	ADF	-1.184	-6.181

Notes: The null hypothesis is that the series in question contains a unit root in its univariate autoregressive representation. ADF is the t-ratio for the autoregressive coefficients to sum to unity - the augmented Dickey-Fuller statistic. The rejection region, for 100 observations at 5 percent level is {ADF|ADF<-2.88} (Osterwald-Lenum, 1992).

Table 3. Interest Parity Cointegration Test Results: Comparisons with U.S.

Market	ADF Test Statistic	Johansen Test-statistic	
		$H_0 \leq 1$	$H_0: r=0$
Singapore			
1981.01-93.12	-3.768	4.398	49.571
Japan			
1974.01 -80.12	-1.254	6.982	16.064
1981.01 -93.12	-2.528	5.680	17.888
Korea			
1972.01 -80.04	-3.902	5.269	19.148
1981.01 -93.04	-4.429	7.525	16.481
Malaysia			
1982.01 -93.12	-3.059	7.562	3451.8
Hong Kong			
1976.01 -93.12	-3.582	7.492	47.059
1981.01 -93.12	-3.847	6.915	34.368
Taiwan			
1972.01 -80.12	-3.011	5.687	18.972

Notes: The null hypothesis using the ADF statistic is that the two series are not cointegrated. The ADF is the t-ratio for the autoregressive coefficients of the residuals of the cointegrating regression to sum to unity. The rejection region, for 100 observations at 5 percent level is {ADF|ADF <-3.17} and at 10 percent level is {ADF|ADF<-2.84} (Engle and Granger 1987). If r denotes the number of significant cointegrating vectors, then the Johansen statistics test the hypotheses of at most one and zero cointegrating vectors, respectively. The 5 percent critical value for $H_0: r \leq 1$ is 9.24 and for $H_0: r=0$ is 15.67 (Osterwald-Lenum, 1992).

Table 4. Interest Parity Cointegraton Test Results: Comparisons with Japan

Market	ADF test-statistic	Johansen test-statistic	
		H_0:≤1	H_0:r=0
Singapore			
1981.01 -93.12	-2.938	6.019	17.007
Korea			
1972.01 -80.04	-4.254	8.149	17.108
1981.01 - 93.04	-4.405	3.453	17.630
Malaysia			
1982.01 -93.12	-2.667	7.221	3477.2
Hong Kong			
1976.01 -93.12	-2.299	7.928	17.785
1981.01 -93.12	-2.723	6.031	17.978
Taiwan			
1972.01 -80.12	-3.889	8.206	22.636

Notes: See notes to Table 3.

Table 5. Johansen's Multivariate Test for Unit Roots in Real Interest Rates

Group A: US, Japan, Malaysia, Singapore, Hong Kong

r	-2ln Q_r	95 Percent Quantile
0	3557.2*	34.40
1	35.56*	28.13
2	30.59*	22.00
3	16.82*	15.67
4	4.38	9.24

Group B: Japan, Malaysia, Singapore Hong Kong

r	-2ln Q_r	95 Percent Quantile
0	3546.1*	28.13
1	29.79*	22.00
2	20.89*	15.67
3	7.61	9.24

Note: -2ln Q_r tests the number of cointegrating vectors r, or equivalently the number of common unit roots 5-r, in a VAR(4) for the set of 5 monthly real interest rates in group A and 4-r for the set of 4 monthly real interest rates in group B. The period of examination is 1982.01 to 1993.12. The 95 percent quantiles are adapted from Osterwald-Lenum 1992.

* Denotes significance at the 5 percent level.

Once again we perform the tests for pre- and post-liberalization sub-periods wherever possible, and for real interest rates in the Pacific Basin countries versus U.S. and versus Japan. The results of the unit root tests are presented in Tables 6 and 7. 1/ On the basis of the ADF test statistic, we are able to reject the unit root in the real interest rate differentials in all the cases at the 5 percent level including comparisons between Japan and U.S. 2/ The results are comparable to the cointegration tests and lend support to interest parity with transaction and other costs.

In Tables 6 and 7, we report also the speed of adjustment of the real interest rate differential to its equilibrium value in the aftermath of a shock. 3/ It has already been shown that the speed of adjustment of the real interest rate differential is one minus the sum of the autoregressive coefficients. We also present the number of months that a given deviation of the actual from the equilibrium real interest rate differential is reduced to 90 percent of its original amount for each of the countries. Looking first at Table 6 where the real interest rate differential is between U.S. and each of the Pacific Basin countries, the following points can be made. With the exception of Korea, in the rest of the countries where it was possible to divide the sample period into pre- and post-liberalization sub-periods, the speed of adjustment is found to be faster in the latter sub-period. For example, in the case of Singapore the speed of adjustment is 27 percent per month during the 1970s and 87 percent during the 1980s and early 1990s. This implies that 90 percent adjustment takes only one month in the latter period compared with about seven months during the 1970s. In the case of Taiwan Province of China there is a substantial increase in the speed of adjustment as well, and 90 percent adjustment is completed within three months compared to ten months during the 1970s. In the case of Japan, there is only a minor increase, while in the case of Korea, there is a slow down. The results indicate that Singapore is very well integrated with U.S., followed by Hong Kong and Taiwan Province of China. It should be remembered that in the case of Korea and Taiwan Province of China we make use of curb rates which have always been market determined. Japan is the least integrated country with U.S.

Table 7 reports the speed of adjustment versus Japan. As it is the case versus U.S., there has been an increase in the speed of adjustment in the second subperiod. The speed of adjustment is, however, slower versus Japan than versus U.S. in the case of Singapore, Hong Kong and Taiwan Province of China, about the same in the case of Korea and faster in the case of Malaysia.

1/ Once again lags were added to ensure whiteness of the standard error and the Schwarz's (1978) Bayesian criterion was used to select the appropriate lag structure.

2/ Similar results were obtained when using the Johansen test statistic.

3/ By dividing the sample period into pre- and post-liberalization sub-periods we take care of the possible changes in the long-run equilibrium real interest rate differential.

In conclusion, the results indicate that there has been an increase in the degree of financial market integration during the 1980s compared to the 1970s, both versus U.S. and versus Japan. U.S. continues, however, to play a more dominant role than Japan in Singapore, Hong Kong and Taiwan Province of China. The above analysis does not tell us, however, which real interest rate adjusts to restore the real interest rate differential to its long-run equilibrium. More information about the adjustment is obtained through the error correction models presented in Tables 8 and 9. Only estimates of the coefficient of the error correction term, which in effect is the long-run real interest rate differential, are reported. Constraining the coefficients on the lagged levels to be equal, reflects the results of the unit root tests of the real interest rate differential. The lag structure of the differences of the real interest rates was determined by the usual diagnostic tests for model specification.

Let us take first, Table 8 which presents the results versus U.S. Several points can be made. First, the error correction term is significant in at least one of the equations in all the countries, as implied in the Granger Representation Theorem. Secondly, the error correction term is statistically significant in all the countries when the dependent variable is the real interest rate of the Pacific Basin country, implying that the latter adjusts to short-run deviations from long-run equilibrium. In addition, the term is positive implying that if a real interest rate differential develops in favor of U.S., the interest rate in the Pacific Basin country will rise to eliminate it. These results highlight the dominant role of U.S. in the Pacific Basin countries and that profit arbitrage opportunities take some time to be eliminated. The error correction term which measures the single period response of the dependent variable to departures from equilibrium and takes into account short-run dynamics as well shows that the response is greatest in Singapore, Hong Kong and Taiwan Province of China. A similar conclusion was given in the previous exercise which disregarded short-run dynamics.

In Table 9 we report the results of the error correction models when comparisons are made with Japan. As with comparisons with U.S., the error correction term is significant in at least one of the equations in all the countries. In all the cases, the error correction term is positive and statistically significant when the dependent variable is the real interest rate of the Pacific Basin country. In the three out of the five countries, however, namely, Taiwan Province of China, Singapore and Hong Kong, the error correction term is also statistically significant when the dependent variable is the Japanese real interest rate. That implies that if there is a real interest rate differential favoring Japan, the interest rate in Japan will respond and in fact will fall as implied by the negative coefficient. These results indicate that Japan does not play a dominating role in the Pacific Basin area. Furthermore, the size of the error correction term when the dependent variable is the Pacific Basin country is on the whole smaller than with comparisons with U.S. confirming the slower response to real interest rate differentials and the lower degree of financial market integration. In addition, the size of the coefficients is bigger in

Table 6. Unit Root for the Real Interest Rate Differential between the U.S. and Selected Pacific Basin Countries

Market	ADF test	d	90 Percent adjustment (months)
Singapore			
1973.08 - 80.12	-4.512	0.273	7.2
1981.01 - 93.12	-5.676	0.875	1.1
Japan			
1974.01 - 80.12	-3.270	0.240	8.4
1981.01 - 93.12	-2.900	0.273	7.3
Korea			
1972.1 - 80.4	-3.169	0.881	3.3 (1.1 quarter)
1981.1 - 93.4	-5.052	0.682	6.0 (2.0 quarter)
Malaysia			
1982.01 - 93.12	-3.917	0.316	6.1
Hong Kong			
1976.01 - 93.12	-3.637	0.553	2.9
1981.01 - 93.12	-3.379	0.567	2.9
Taiwan			
1972.01 - 80.12	-3.108	0.213	9.6
1981.01 - 93.12	-4.897	0.551	2.9

Notes: See notes to Table 2. d is the speed of adjustment of the real interest rate differential to its equilibrium value following a shock, and is equal to one minus the sum of the autoregressive coefficients.

Table 7. Unit Root for the Real Interest Rate Differential between Japan and selected Pacific Basin Countries

Market	ADF test	d	90 Percent adjustment (months)
Singapore			
1973.08 - 80.12	-4.319	0.408	4.4
1981.01 - 93.12	-4.625	0.522	3.1
Korea			
1972.1 - 80.4	-3.757	0.881	7.5 (2.5 quarters)
1981.1 - 93.4	-5.207	0.682	5.4 (1.8 quarters)
Malaysia			
1982.01 -93.12	-3.720	0.381	4.8
Hong Kong			
1976.01 - 93.12	-3.202	0.376	4.9
1981.01 - 93.12	-3.486	0.412	4.4
Taiwan			
1972.01 -80.12	-2.961	0.256	7.8
1981.01 -93.12	-3.997	0.418	4.3

Notes: See notes to Tables 2 and 5.

Table 8. Error Correction Models: Comparisons with U.S. Real Interest Rates

Market	Error correction coefficients	
	ρ_1	ρ_2
Singapore	0.682*	-0.123
	(5.289)	(-1.063)
Japan	0.245*	-0.071
	(3.266)	(-1.036)
Korea	0.624*	-0.058
	(4.658)	(-1.106)
Malaysia	0.204*	0.002
	(2.278)	(0.040)
Hong Kong	0.505*	-0.028
	(3.340)	(-0.393)
Taiwan	0.396*	-0.007
	(3.215)	(-0.160)

Notes: ρ_1 and ρ_2 are the coefficients of the error correction terms in Equations 2 and 3 respectively. Figures in parentheses are t-ratios. The sample period is 1981.01 - 93.12 apart from the case of Malaysia where it is 1982.01 - 93.12. The frequency of data for the case of Korea is quarterly.

* Denotes significance at the 5 percent level.

Table 9. Error Correction Models: Comparisons with Japanese Real Rates

Market	Error Correction coefficients	
	ρ_1	ρ_2
Singapore	0.240*	-0.160*
	(2.919)	(-2.043)
Korea	0.493*	-0.004
	(4.029)	(-0.059)
Malaysia	0.202*	-0.090
	(2.463)	(-1.203)
Hong Kong	0.206*	-0.108*
	(2.055)	(-2.255)
Taiwan	0.351*	-0.094*
	(3.238)	(-2.299)

Notes: See notes to Table 7.

Singapore, Taiwan Province of China and Hong Kong, indicating once again that these countries are more integrated than the rest.

One key issue is whether these estimated relationships have been stable over the time period of examination e.g. 1981- 1993. We have applied the cusum test statistic developed by Brown et. al., (1975), which is designed to detect instability in the parameter estimates. The cusum test does not lead to the rejection of the hypothesis of parameter stability (at the 5 percent confidence level) for any of the countries (figures can be made available on request by the author).

V. Summary and Conclusion

In this paper, we examine capital market integration in a group of Pacific Basin countries. There are two main approaches to capital market integration. The first focuses on the sensitivity of capital flows to interest rate differentials. The second approach focuses on the degree of integration between markets as evidenced by interest rates. There are two different ways of measuring market integration using this latter approach. The convergence of interest rates approach which examines the level of interest rates among several countries; and the covariability of interest rates approach, which examines whether prices of financial assets in countries move in conjunction, but do not necessarily have the same level. Different interest-rate levels may prevail because of different levels of risk. In this paper, we have used the latter approach and concentrated on real interest rates.

We have used the methodology of cointegration which examines whether there is a long-run relationship between the rates in two different markets and allows the interest rate differential to move within a band defined by the costs involved in relocating funds. Those include transaction costs in securities and foreign exchange markets, taxes including the implicit tax relating to capital controls, and the political premium relating to future controls. That is, there will be no profitable arbitrage opportunities if interest rate movements are within this band. We have also examined the speed of adjustment of real interest rates in the aftermath of a shock. We examine how long it will take to eliminate a differential which is greater than that defined by the band and whether interest rates in both markets will respond to the disequilibrium.

Using the above approach, we have arrived at the following conclusions:

1. The ex post real interest rates of the Pacific countries in our sample have been moving together since the 1970s both versus U.S. and versus Japan.

2. When looking at the speed of adjustment following a shock the differences in the degree of market integration in pre- and post-liberalization sub-periods emerge. The capital market integration is

greater in the latter sub-period for comparisons with both U.S. and Japan. For example, in Singapore the real interest rate differential adjusts 90 percent to its long-run value following a shock in one month in the second subperiod compared with seven months during the 1970s. Similarly, in the case of Taiwan Province of China, the adjustment speeded up from ten months during the 1970s to only three months in the second subperiod.

3. The speed of adjustment is on the whole slower versus Japan than versus U.S. (apart possibly for the case of Malaysia). Japan has not overtaken U.S. in dominating the financial markets of these countries. In fact, for three of the five countries (Singapore, Hong Kong and Taiwan Province of China) if a differential develops following a shock which is different from the long-run differential, real interest rates in Japan (as well as in each of the other countries) will adjust to eliminate it.

4. Capital market integration is greater in Singapore, Hong Kong and Taiwan Province of China. On the other hand, Japan is the least integrated country with U.S.

In this paper we have established that there are extensive real interest rate linkages with world financial markets even in countries like Taiwan Province of China and to a lesser degree Korea, where there are still extensive foreign exchange controls. In our view the following explanation can be given. In these countries the degree of protectionism is much less on current account transactions than on capital account transactions. That has created a variety of channels for disguised capital flows e.g., under- and over-invoicing export and import contracts, and leads and lags in the settlement of commercial transactions. In an interesting paper on the experience of industrial and developing countries with capital controls, Mathieson and Rojas-Suarez (1993) point out that capital controls were most effective when they were combined with trade controls. In addition, the highly open character of the Pacific Basin economies has created more opportunities for evading controls. 1/

Furthermore, in some of these countries there is illicit trade in drugs and other goods. As Mathieson and Rojas-Suarez (1993) say "channels which were developed to move funds derived from illicit activities could just as readily be used to move funds derived from other activities". In Korea and Taiwan Province of China there is a substantial black market for dollars as manifested by the high and variable black market premium (see Phylaktis and Kasimmatis (1994b).

1/ This high degree of openness could also be the reason for the favorable evidence found for Purchasing Power Parity in the Pacific Basin countries (see Phylaktis and Kasimmatis, 1994a), which is an important assumption in the derivation of the real interest rate parity.

The results of this paper have important policy implications. The very rapid response of real interest rates to establish long-run real interest rate differential in the Pacific Basin countries highlight the limited effectiveness of stabilization policies to the extent that these work through real interest rate changes.

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