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Stock market linkages in emerging markets: implications for international portfolio diversification

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Abstract

This paper examines stock market linkages of a group of Pacific-Basin countries with US and Japan by estimating the multivariate cointegration model in both the autoregressive (AR) and moving average (MA) forms over the period 1980–1998. Recursive estimation helps identify the evolution of the linkages. The results for the 1980s indicate that the relaxation of foreign ownership restrictions was not sufficient to attract foreign investors' attention and that other factors must have affected the portfolio diversification decision. The results of the 1990s suggest that the relaxation of the restrictions might have strengthened international market interrelations. Country Funds have provided access to highly regulated capital markets.

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1. Introduction

There has been a considerable increase in interest on the interaction of international stock markets following the abolition of foreign exchange controls in both mature and emerging markets, the technological developments in communications and trading systems, and the introduction of innovative financial products, such as Country Funds and American Depository Receipts, which have created more opportunities for global international investments. Various approaches have been applied by the studies on international stock market linkages. For example, Longin and Solnik (1995) used cross-country correlations and found evidence of significant linkages between stock markets around the world. Bekaert and Harvey (1995) examined the conditional means and variances of stock returns by applying a one factor asset pricing model where expected returns in a country are affected by their covariance with a world benchmark portfolio when the market is perfectly integrated and by the variance of the country returns when it is completely segmented. Phylaktis and Ravazzolo (2002) measured financial linkages by analysing the covariance of excess returns on national stock markets of emerging economies.

Another group of studies has concentrated on examining financial links amongst stock markets by using either bivariate or multivariate cointegration methodology. Kasa (1992) was the first to apply multivariate cointegration to five well-established financial markets in order to examine the existence of a single common stochastic trend as a driver of the cointegrated system. A single common stochastic trend in a group of markets means that they are perfectly correlated over long horizons and limiting the gains from international diversification.

In the current study, we apply Kasa's (1992) approach and examine the potential inter-relationships amongst the trending behaviour of the stock price indices of a group of Pacific-Basin countries, Japan and the US. These Pacific-Basin markets have attracted a substantial proportion of international capital flows to emerging markets in recent years. Earlier work, which has examined long-run comovements between these markets and the more developed ones, has found weak financial linkages e.g. Chung and Lin (1994) on Japan, US, Taiwan, Hong Kong and Singapore over the period 1985–92; Corhay et al. (1995) on Australia, Hong Kong, Japan, Singapore and New Zealand over the period 1972–92; and Masih and Masih (1999) on US, Japan, UK, Germany, Singapore, Malaysia, Hong Kong and Thailand over the period 1992–97. The above studies, however, suffer from two weaknesses. First, they assume that all Pacific-Basin Countries are at the same stage of integration with the world market; and secondly, they did not take care to select the correct order of VAR system.

Our analysis attempts to remedy these weaknesses and generally contributes to the literature in the following ways. First, it examines the financial links of these markets by estimating the multivariate cointegration model not only in the autoregressive (AR) form used in the previous studies but also in the moving average (MA) form, which allows one to examine the relative importance of each market to the common trend. In estimating the common stochastic trend we use the technique suggested by Gonzalo and Granger (1995), which makes possible the estimation of the transitory component of each market and highlights additional implications for international portfolio diversification to those of the autoregressive form.

Secondly, we apply the recursive analysis to the cointegrating system developed by Hansen and Johansen (1998) in order to identify the evolution of linkages of these capital markets during the 1980s and 1990s and examine whether they are related to the existence of foreign exchange restrictions. That constitutes a novel approach to examining this issue. The same technique allows us to examine the effects of the Asian crisis of mid 1997 on the financial linkages of the region.

Finally, in our study we follow Richards' (1995) suggestion regarding the criteria for the selection of the correct order VAR system. Richards (1995) highlights the importance of using the correct criteria in selecting the lag structure in his criticisms of Kasa's (1992) work.

The analysis in the paper has implications for international portfolio diversification. If stock markets share a common trend, that implies that there is a common force, such as arbitrage activity, that brings the stock markets together in the long-term and anyone market will be representative of the behaviour of that group of markets. Thus, testing for cointegration provides information of the degree of arbitrage activity in the long-term. If markets are interdependent and driven by common shocks, which have a permanent effect, they will provide limited possibilities of gaining abnormal profits by diversifying investment portfolios since they will be arbitrated away in the long-term. If, however, there are persistent deviations from the common trend, then international investors might make short-term speculative investments based on the forecast that the market will revert to its long-term relationship with the world market. The methodology used in this paper, that is, the moving average representation of the multivariate cointegration model, allows us to estimate the transitory component of each market and explore possible short-term diversification benefits.

The paper is structured as follows. Section 2 deals with methodological issues. Section 3 reports the empirical results of the analysis of the cointegration space and the complementary common trend system. The final section summarises the main findings and offers some concluding remarks.

2. Methodology

2.1. The autoregressive (AR) representation of a cointegrating system

In the current study, we apply the multivariate cointegration analysis of Johansen (1991) to investigate the linkages amongst a group of stock price levels by looking for the existence of potential linear combinations amongst them. Thus, in our analysis the cointegrating vector Y_t is composed of p elements, which represent the stock price indices of a selected group of financial markets.

We next apply recursive estimation of cointegrated VAR models as suggested by Hansen and Johansen (1998) using estimates from the Johansen FIML technique under two VAR representations in order to identify when financial links strengthened and whether that coincided with events of liberalisation. In the "Z-representation" all the parameters of VECM are re-estimated during the recursions, while under the "R-representation" the short-run parameters are kept fixed to their full sample values and only the long-run parameters

are re-estimated. Convergence of stock markets should show up in an increasing number of cointegration vectors being accepted as the system is being increasingly driven by the same common stochastic trends. In addition, the recursive estimation will show whether the Asian financial crisis in mid 1997 temporarily affected the links amongst international stock markets, as previously verified by work on the 1987 stock market crash (see e.g. Roll, 1989).

2.2. The moving average (MA) representation of cointegrated systems

While the AR form is informative about the long-run relationships amongst the stock markets, which is useful in identifying if a group of financial markets is linked together, the MA form is informative about the underlying stochastic and deterministic trends and helpful in recognizing the components driving the system of markets. The MA representation is explained below as it is less well known in the literature.

The MA representation of the error correction form of a cointegrating system is given by:

$$\Delta Y_t = C(L)(\varepsilon_t + \mu + \phi D_t), \quad (1)$$

where $C(L)$ can be developed as $C(L) = C(1) + (1 - L)\tilde{C}(L)$. In integrated form (1) is given by:

$$Y_t = Y_0 + C \sum_{i=1}^t \varepsilon_i + C\mu t + C \sum_{i=1}^t \phi D_i + \tilde{C}(L)(\varepsilon_t + \phi D_t), \quad (2)$$

where $C = C(1)$ and $\tilde{C}(L) = (1 - L)^{-1}[C(L) - C(1)]$.

As shown in Johansen (1991) the link to the AR form of the model is given by

$$C = \beta_{\perp}(\alpha'_{\perp}(-I + \Gamma_1)\beta_{\perp})^{-1}\alpha'_{\perp}, \quad (3)$$

where α_{\perp} and β_{\perp} are the orthogonal complements of α and β , respectively. The matrix α_{\perp} , of order $p \times (p - r)$, reports the coefficients of the common trends indicating the contribution of each component to the stochastic vector; and the matrix β_{\perp} , of order $p \times (p - r)$, includes the loading factors indicating the effect of each common trend on each variable. The matrix C determines how the non-stationary part of the process Y_t is generated from the underlying stochastic and deterministic trends.

Gonzalo and Granger (1995) show that the matrix C also identifies the permanent component of a system. A simple decomposition of Y_t into its transitory and common trend components based on the estimators from the cointegration tests, is

$$Y_t = \alpha(\beta'\alpha)^{-1}X_t + \beta_{\perp}(\alpha'_{\perp}\beta_{\perp})^{-1}Z_t, \quad (4)$$

where $X_t = \beta'Y_t$ is defined as the stationary or transitory process (which is actually the deviation from the cointegration relationship) and $Z_t = \alpha'_{\perp}Y_t$ is defined as the non-stationary permanent component. Gonzalo and Granger (1995) demonstrated that this non-stationary permanent component in the decomposition (4) corresponds to the common trend of the

Stock–Watson decomposition through the Wold representation of ΔY_t ,

$$\Delta Y_t = C(L)\varepsilon_t = C(1)\varepsilon_t + \Delta\tilde{C}(L)\varepsilon_t, \quad (5)$$

where $C(1)$ is defined as in Eq. (3) and $\tilde{C}(L)$ is defined as in Eq. (2).

In our analysis, we estimate the MA representation of the cointegrated system in order to investigate the non-stationary or permanent component, which drives the set of capital markets in the long-run.

3. Empirical results

3.1. Data

The sample of countries examined in the paper includes: Japan, US, Hong Kong, South Korea, Malaysia, Singapore, Taiwan and Thailand. The sample period covers January 1980 to December 1998. The data are obtained from *Datastream* and consist of end of month observations of stock market index prices (1990 = 100) expressed in local currency.

We use various criteria to select the groups of countries to examine the presence of linkages. We examine markets, which have high degree of openness and expected to have strong links. We also look at groups of equity markets, which have foreign ownership restrictions but have alternative financial vehicles, which allow foreign investors to invest in their markets. For example, [Bekaert and Harvey \(2000\)](#), [Bekaert \(1995\)](#) suggest Country Funds as an alternative channel for entering restricted capital markets.

Information regarding the date of official liberalisation of each market as reported by the International Finance Corporation (IFC) and the date of the First Country Fund (FCF) and American Depository Receipts (ADRs) is given in [Table 1](#). What is clear is that all countries had either liberalised or started the process of liberalisation by the beginning of the 1990s. We, thus, examine the effect of stock market liberalisation on financial links between the countries by dividing the sample period into two sub-periods, the pre-liberalisation sub-period 1980–89, and the post-liberalisation sub-period 1990–1998. It should be noted that in the case of favourable results to close financial linkages the application of recursive estimation will provide us with further details of their evolution over time.

3.2. The analysis of the cointegration space

We first test for cointegration for the selected group of Pacific Basin stock markets and the financial markets of Japan and the US for the period 1980–89.¹ We use the Johansen trace statistic, which is corrected for small sample bias (see [Reimers, 1992](#)).² The lag length is one and was chosen by applying the (AIC) and (SIC) on the undifferenced VAR models as suggested by [Richards \(1995\)](#).

¹ All stock market indices in levels were found to be I(1).

² The trace test appears to be more robust to nonnormality of errors compared to the maximal eigenvalue (see [Cheung and Lai, 1993](#)).

Table 1

(A) Different signals of liberalisation

Country	IFC official liberalisation	First country fund	First ADR introduction
Hong Kong	01.73	–	–
Korea	01.92	08.84	11.90
Malaysia	12.88	12.87	08.92
Singapore	06.78	–	–
Taiwan	01.91	05.86	12.91
Thailand	09.87	07.85	01.91

(B) Emerging stock markets—direct and indirect barriers for institutional investors (end-1989)

	Foreign ownership limit	Dividends repatriation	Capital repatriation	Withholding taxes on dividend	Taxes on capital gains
Hong Kong	100%	Free	Free	0%	0%
Japan	100% (25%) ^a	Free	Free	20% (0–15%)	0%
Korea	10% (8%) ^b	Some Restrictions	Some Restrictions	25% (10–21.5%)	0% (11–27%) ^c
Malaysia	100%	Free	Free	35%(0%)	0%
Singapore	100%	Free	Free	0.0%	0%
Taiwan	Special Funds only ^c	Free	Free	20%	0.6%
Thailand	49% (25%) ^d	Free	Free	20%(10)	25%(10)

Notes: Information is based on the International Financial Corporation's (IFC) Factbook, the Euromoney annual report, the Exchange Arrangements and Restrictions, IMF and Bekaert and Harvey (2000). Percentages shown in brackets apply only to approved new Country Funds, where these may be different from normal treatment. The IFC official liberalisation date is based on the investibility index, which represents the ratio of the market capitalisation of stocks that foreigners can legally hold to total market capitalisation. A large jump in the index is taken as evidence of an official liberalisation.

^a The limit is 25% in case of "national interest" companies such as mining and agriculture.

^b Foreign ownership restriction of up to 10% of market capitalisation for "non-limited" industries and of up to 8% of market capitalisation for "limited" industries.

^c Foreign investors who open an account in a local brokerage house may only invest in four listed funds—Kwang Hua Growth Fund, NITC Fuyuan Fund and Citizen Fund. Domestic residents are allowed to remit outwards up to US\$5 million per annum.

^d Foreign investors are allowed to hold up to 49% of companies listed on the SET with the exception of the commercial banks and finance companies, where foreign ownership is restricted to 25% of the capital.

Although the results indicate that in some of the cases the series are cointegrated (see Panel A of Table 2), the results of the exclusion tests (see Panel B) show that not all markets are participating in the cointegration space.³ Thus, the findings indicate lack of linkages amongst this group of Pacific Basin capital markets and the developed equity markets of Japan and US.

We proceed the analysis by selecting smaller groups of capital markets. We test first to see whether the open equity markets of Hong Kong, Malaysia, and Singapore are cointegrated with Japan and US (see Panel A of Table 3). The results show lack of cointegration. When we repeat the exercise by excluding Malaysia as its capital market only opened in the late

³ The results are for stock price indices expressed in US dollars and thus, give the perspective of the US investor. The findings for alternative definitions, i.e. in local currency and real terms, are qualitatively the same.

Table 2

Multivariate cointegration, all countries 1980–1989

Panel A: Johansen trace test statistics									
Countries in the group	$H_0: r=0$	$H_1: r \leq 1$	$H_2: r \leq 2$	$H_3: r \leq 3$	$H_4: r \leq 4$	$H_5: r \leq 5$	$H_6: r \leq 6$	$H_7: r \leq 7$	
HK KO MA SG TA TH JP US	162.1**	105.2**	70.3	24.7	24.7	11.4	4.2	0.7	
Panel B: Exclusion test									
Countries in the group		HK	KO	MA	SG	TA	TH	JP	US
HK KO MA SG TA TH JP US	$\chi^2(2)$	4.6	5.1**	2.2	7.1**	9.4**	4.4	12.7**	7.5**

Notes: The following abbreviations have been used for the countries: HK: Hong Kong; KO: Korea; MA: Malaysia; SG: Singapore; TA: Taiwan; TH: Thailand; JP: Japan; and US: United States. The Johansen trace statistic tests the hypothesis that there are at most r cointegrating vectors $0 \leq r \leq p$ where p is the number of stock markets in each case. The critical values have been obtained from Osterwald-Lenum (1992). The statistics include a finite sample correction (see Reimers, 1992). (*) and (**) denote significance at 10 and 5% level, respectively. The exclusion statistic tests the null hypothesis that the coefficients of the cointegrating vectors relating to each market are zero. The test statistic is χ^2 distributed with r degrees of freedom.

Table 3

Multivariate cointegration, open markets 1980–1989

Panel A: Johansen trace test statistics						
Countries in the group	$H_0: r=0$	$H_1: r \leq 1$	$H_2: r \leq 2$	$H_3: r \leq 3$	$H_4: r \leq 4$	
HK MA SG JP US	51.2	18.4	9.0	1.6	0.0	
HK SG JP US	38.1*	6.3	2.1	0.0		
SG JP US	28.23**	1.14	0.23			
Panel B: Exclusion test						
		HK	MA	SG	JP	US
HK MA SG JP US		–	–	–	–	–
HK SG JP US	$\chi^2(1)$	2.34		15.3**	4.9**	19.5**
SG JP US	$\chi^2(1)$			18.66**	5.21**	19.93**

Notes: see notes to Table 2.

eighties, we find one cointegrating vector. The exclusion tests however reported in Panel B show that Hong Kong does not enter into the cointegration space implying that the lack of foreign exchange restrictions might not be a sufficient condition for stock markets to be linked together.⁴ De facto barriers may often discourage foreign investors from entering financial markets e.g. lack of sufficient information, as suggested by Levine and Zervos (1996), or the existence of specific country risks, such as the liquidity, political, economic policy and currency risks, and macroeconomic instability, as noted by Bekaert (1995). In our opinion the most relevant factor for Hong Kong is the political risk. Hong Kong suffered from frequent political shocks since the early 1980s, which related to the question of its democracy after 1997, to China's human rights developments and political reforms, as well as to China's most favoured-nation trade status. Kim and Mei (2001) demonstrated that unexpected return jumps and changes in stock market volatility were associated with political news relating to the above events.

However, such factors could not have applied to the case of Singapore. For this reason we tested for the presence of cointegration in the group of markets consisting of Singapore, Japan and the US. The results show the existence of one cointegrating vector and that all markets participate in the cointegration space, thus, confirming that the three stock markets are linked (see Table 3).

We next adopt an alternative criterion in the selection of potential countries for stock market linkages as discussed in Section 3.1. We select the countries of Korea, Taiwan and Thailand as potential candidates for close linkages because they had Country Funds from the middle of the eighties, which allowed foreigners to invest in their markets. For example, by the early 1990s Korea had 17 US dollar denominated Country Funds and 17 non-US dollar Country Funds, while Thailand had 26 closed-end and 11 open-end Thai funds trading worldwide. Taiwan, on the other hand, had 9 open-end funds and 4 investment trusts.⁵

⁴ This result for Hong Kong was rather surprising for its currency board arrangements established in 1983 should have increased the transmission mechanism of shocks between the countries and should have influenced positively their financial links.

⁵ See Bekaert and Harvey (1995). UK investment trusts are the equivalent of US closed-end funds.

Table 4
Multivariate cointegration, semi-open markets 1980–1989

Panel A: Johansen trace test statistics						
Countries	$H_0: r=0$	$H_1: r \leq 1$	$H_2: r \leq 2$	$H_3: r \leq 3$	$H_4: r \leq 4$	
KO TA TH JP US	90.5**	34.2	20.8	8.5	0.5	
TA TH JP US	57.3**	16.6	7.8	0.5		

Panel B: Exclusion test						
		KO	TA	TH	JP	US
KO TA TH JP US	$\chi^2(1)$	0.5	16.0**	3.5**	3.4**	5.0**
TA TH JP US	$\chi^2(1)$		17.5**	9.8**	16.1**	17.7**

Notes: see notes to Table 2.

According to Kaminsky et al., (2001) in 1995 holdings of dedicated Emerging Funds in Korea were 10.3 billion US dollars and had 6% of the market capitalisation. The respective figures for Taiwan were 4.6 and 2 and for Thailand 9.8 and 7. These figures are only indicative because they exclude holdings of global funds, which account for a substantially larger share of the stock market capitalisation of the emerging market. What should be noted, however, is that although the typical size of a country fund may be very small relative to the total market capitalisation of the emerging market, its introduction may drive up the prices of local companies reducing the cost of capital and essentially rendering the local market partially integrated with global markets (see e.g. Errunza et al., 1998).

The results of the trace statistics, when Korea, Taiwan, Thailand, Japan and the US are considered, show the presence of one cointegrating vector (see Panel A, Table 4) but the exclusion tests show that the Korean stock market does not participate in the cointegration space (see Panel B). Excluding Korea and repeating the test we find one cointegrating vector and all four countries participating in the cointegration space. Therefore, the capital markets of Taiwan, Thailand, Japan and US were linked during the eighties. On the one hand, these findings underline the importance of Country Funds as a channel for international investors to enter highly regulated capital markets, and on the other hand, the exclusion of Korea from that group of markets highlights that other factors might influence investors' decisions whether to invest in a particular market. Thus, we explored whether various types of risk existed at the time, which put Korea apart from Thailand and Taiwan (see Table 5). The information shown in the Table indicates that all three markets gave the same company stock information to investors, however, Korea suffered greater macroeconomic instability and had a less liquid market.

We next examine financial linkages during the 1990s for the same groups of countries, which were considered for the 1980s. While for this period also there is lack of cointegration amongst the group of all countries (see Table 6), we find cointegration for the group of open countries (see Table 7), which were found not to be cointegrated during the eighties, and for the group consisting of the semi-open countries (see Table 8). Furthermore, there is a general increase in the number of cointegrating vectors in all cases, especially for the group of semi-open economies. The capital markets of Taiwan, Thailand, Japan and US share three cointegrating vectors (one common trend) compared to one cointegrating vector (three common trends) during the 1980s. This indicates an increase in the

Table 5

Information on emerging market specific risks (end-1989)

Panel A: Emerging markets information and investor protection							
	Securities exchange publications (1)	Regular publication of price/earnings and price/dividends (2)	Market commentaries in English (3)	Company brokerage reports (4)	Interim statement (5)	Accounting standards (6)	Investor protection (7)
Korea	AMWD	C	LR, IR	LR, IR	S	G	GS
Thailand	AQMWD	C	LR, IR	LR, IR	Q	A	AS
Taiwan	AMWD	C	LR, IR	LR, IR	Q	P	PS

Panel B: Stock market turnover ratios			
	1984	1987	1990
Korea	62.17	75.73	68.67
Thailand	25.23	93.59	95.90
Taiwan	82.86	172.95	709.96

Panel C: Macroeconomic indicators						
	Real economic growth (%)		Inflation rate (%)		Exchange rate volatility (standard deviation)	
	1981–84	1985–89	1981–84	1985–89	1981–84	1985–89
Korea	8.98	9.40	2.85	4.22	71.72	84.75
Thailand	5.68	9.02	2.30	3.18	1.41	0.69
Taiwan	10.20	11.95	0.40	1.38	1.71	5.38

Notes: Emerging Stock Markets Factbook published by International Finance Corporation. (1) A = annual, Q = quarterly, M = monthly, W = weekly, D = daily. (2) P = published, C = comprehensive and published internationally. (3 and 4) LR = prepared by local broker or analysts; IR = prepared by international brokers or analysts. (5) Q = quarterly results must be published, S = semiannual results must be published. (6 and 7) G = good of international acceptable quality; A = adequate; P = poor, requires reform; S = Functioning Securities Commission or similar government agency concentrating on regulating market activity.

degree of linkages of these stock markets during the recent period of more open capital markets.

Based on this evidence, we continue our analysis and perform the recursive estimation of the group of countries presenting the highest degree of international comovements since the early eighties, namely that consisting of Taiwan, Thailand, Japan and the US.

Table 6

Multivariate cointegration, all countries 1990–1998

Panel A: Johansen trace test statistics								
Countries in the group	$H_0: r=0$	$H_1: r \leq 1$	$H_2: r \leq 2$	$H_3: r \leq 3$	$H_4: r \leq 4$	$H_5: r \leq 5$	$H_6: r \leq 6$	$H_7: r \leq 7$
HK KO MA SG TA TH JP US	155.4**	102.2	69.2	42.9	23.1	12.7	5.4	0.1

Panel B: Exclusion test									
Countries in the group	HK	KO	MA	SG	TA	TH	JP	US	
HK KO MA SG TA TH JP US	$\chi^2(1)$	0.0	13.2**	4.9**	2.0	2.2	0.8	0.6	3.2*

Notes: see notes to Table 2.

Table 7
Multivariate cointegration, open markets 1990–1998

Panel A: Johansen trace test statistics					
Countries in the group	$H_0: r=0$	$H_1: r \leq 1$	$H_2: r \leq 2$	$H_3: r \leq 3$	$H_4: r \leq 4$
HK MA SG JP US	73.6**	40.1**	16.7	7.1	0.0
HK SG JP US	49.7**	27.4**	7.4	0.0	
SG JP US	36.06**	13.5	0.11		

Panel B: Exclusion test						
		HK	MA	SG	JP	US
HK MA SG JP US	$\chi^2(2)$	10.5**	13.3**	18.9**	15.8**	9.7**
HK SG JP US	$\chi^2(2)$	16.1**		20.3**	22.9**	5.0*
SG JP US	$\chi^2(1)$			7.7**	5.62**	7.5**

Notes: see notes to Table 2.

3.3. The recursive trace test statistics

We examine the time path of the trace statistics recursively estimated to find when exactly the stock markets of Taiwan, Thailand, Japan and the US started to be linked together. In doing so each trace statistics is scaled by the 90% quantile of the trace distribution derived for the model. The number of trace statistics showing an upward behaviour and above the critical value of one, indicates the number r of cointegrating vectors shared by the cointegrated system.

Fig. 1a reports these statistics for the period 1980–1989. Only one trace statistic presents an upward trend in the period of the analysis and that assumes a value just above one at the end of the 1985, beginning of 1986. It considerably increased in the second half of 1986. This indicates that the linkages of these stock markets started between the end of 1985 and the middle of 1986. This period corresponds to the introduction of the First Country Fund for Thailand (July 1985) and of the three Country Funds for Taiwan (May 1986). Thus, the analysis indicates that financial links with world markets increased with the introduction of a vehicle of investment, which was accessible to foreign investors.

Looking now at the recursive estimation during the nineties we observe one statistic to be above one for the full period of the nineties and another two statistics to have an up-

Table 8
Multivariate cointegration, semi-open markets 1990–1998

Panel A: Johansen trace test statistics					
Countries in the group	$H_0: r=0$	$H_1: r \leq 1$	$H_2: r \leq 2$	$H_3: r \leq 3$	$H_4: r \leq 4$
KO TA TH JP US	100.0**	55.8**	30.6	14	3.8
TA TH JP US	58.3**	28.0**	12.2**	0.03	

Panel B: Exclusion test						
	χ^2	KO	TA	TH	JP	US
KO TA TH JP US	$\chi^2(2)$	17.0**	6.0**	11.0**	5.2**	6.7**
TA TH JP US	$\chi^2(3)$		21.0**	16.0**	17.3**	19.6**

Notes: see notes to Table 2.

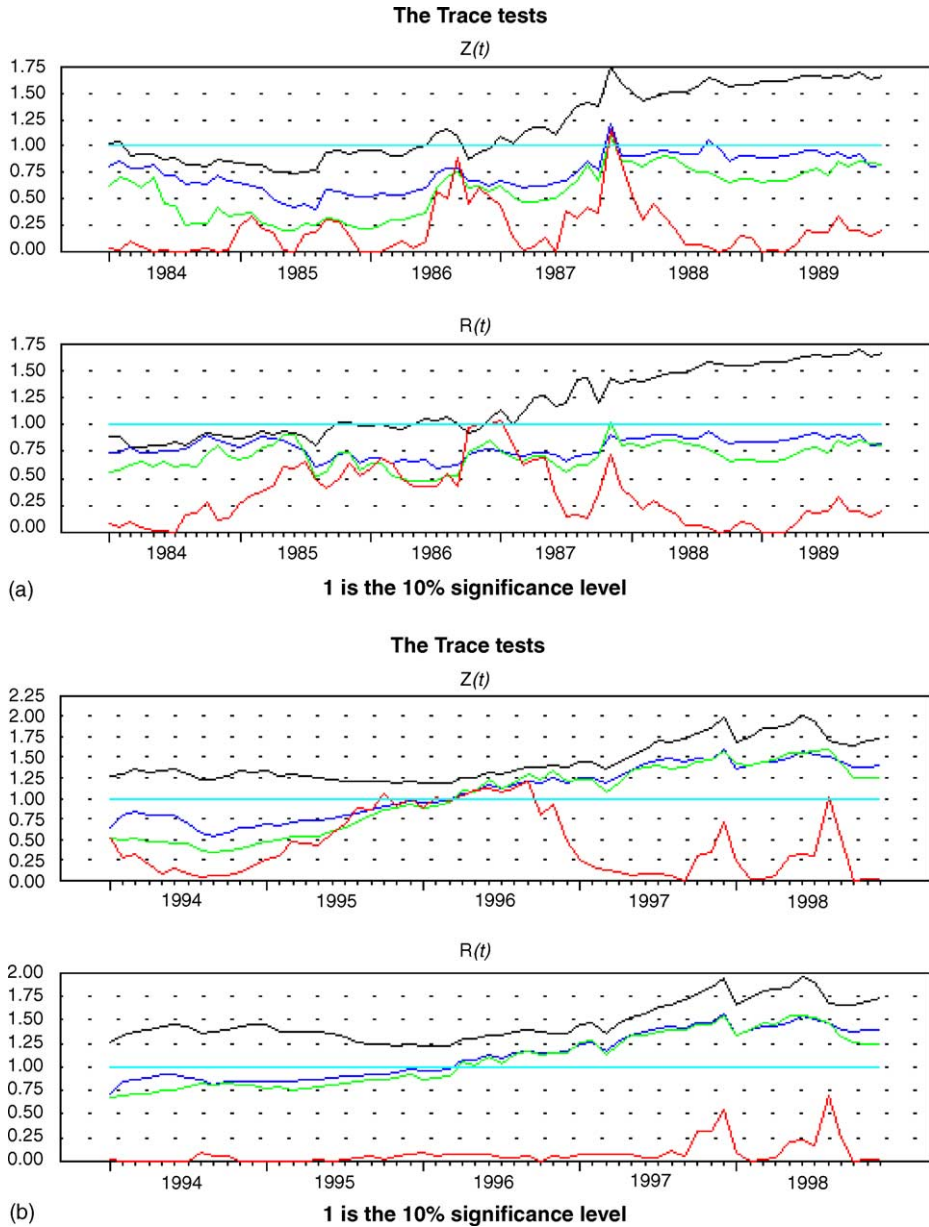


Fig. 1. (a) Recursive estimation of the trace statistics for the system composed of Taiwan, Thailand, Japan and the United States during 1980–1989. (b) Recursive estimation of the trace statistics for the system composed of Taiwan, Thailand, Japan and the United States during 1990–1998. *Notes:* The number of Trace test statistics above unity corresponds to the cointegration rank at 10% significance level. All the parameters of the VAR are re-estimated during the recursions under the Z-representation; the short-run parameters are kept fixed to their full sample values and only the long-run parameters are re-estimated under the R-representation.

Table 9

Orthogonal complement of the cointegration space with one cointegrating vector for the group of Taiwan, Thailand, Japan and US during 1980–89

Panel A: Estimates of the common trend matrix (α_{\perp})				
Common trend	Taiwan	Thailand	Japan	United States
1	-0.137	0.889	-0.407	-0.160
2	0.110	-0.123	0.080	-0.983
3	0.435	-0.315	-0.843	0.019
Panel B: Estimates of the matrix (β_{\perp})				
1	5.154	3.645	1.407	0.419
2	-4.192	-2.073	-1.791	-1.506
3	-6.454	-3.831	-3.442	-0.734

Notes: The elements of α_{\perp} indicate the weight of each market to the trend; β_{\perp} gives the relative importance of the trend to each market.

ward behaviour and reach the line of one at the beginning of 1996 (see Fig. 1b). The three statistics continued to show an upward trend until the end of 1997. This evidence suggests that the stock markets of these countries were strongly linked in the period preceding the Asian crisis of mid 1997. The Asian crisis might have fostered these links but does not seem to have had a substantial effect. This is confirmed by looking at the $R(t)$ representation, which keeps short-run dynamics constant and presents a similar behaviour to $Z(t)$ representation. Unlike other crises, which have been found to cause an increase in market links, the Asian crisis concerned a group of countries, which was already integrated prior to the crisis, not only financially but economically as well (see Phylaktis and Ravazzolo, 2002).

In conclusion, the recursive analysis suggests that First Country Funds have been an important channel for international investors to enter equity markets, in which foreign ownership restrictions are still in existence. In particular, it shows that stock market started in the period of the introduction of the First Country Funds. Furthermore, it shows that the Asian crisis of mid 1997 did not have a substantial effect on the financial links of these countries.

3.4. The analysis of common trends

We estimate the moving average process of a cointegrated system in order to investigate the non-stationary common trend or permanent component, which drives our set of capital markets. The analysis is conducted for the two subperiods of 1980–1989 and 1990–1998 in order to investigate possible changes in the potential driver of the system.

The system of the capital markets of Taiwan, Thailand, Japan and US share one cointegrating vector and three common trends during the first sub-period (see Table 9). Panel A indicates the estimated coefficients of each common trend and Panel B the loading factors for each common trend. Looking at Panel A, we can identify that the Thai stock market provides the major contribution to the first common trend, while the United States and Japan to the second and third common trends, respectively. In Panel B, we can note that for

Table 10

Orthogonal complement of the cointegration space with three cointegrating vectors for the group of Taiwan, Thailand, Japan and US during 1990–98

Panel A: Estimates of the common trend matrix (α_{\perp})				
	Taiwan	Thailand	Japan	United States
Common trend 1	0.025	-0.675	-0.681	-0.282
Panel B: Estimates of the matrix (β_{\perp})				
	-0.998	-0.672	-0.391	-0.679

Notes: see notes to Table 9.

all common trends, the Taiwanese stock market reacts most to common trend movements followed by the Thai and the Japanese stock markets. In contrast, the stock price index of the US is the least affected by common trend comovements.

For the period 1990–1998 the same group of countries share three cointegrating vectors and one common trend (see Table 10). Panel A indicates that the only common trend shared by the group of countries is dominated equally by the Thai and Japanese stock markets. In contrast, Taiwan is the stock market most affected by this common stochastic trend. If we make the normalisation that the sum of the common trend coefficients is unity then we see that the Thai and Japanese stock markets receive a weight of about 41%, while the US market has a share of only 17%. These results are somewhat surprising because they do not reflect relative market capitalisation. For instance, at the end of 1995 the market capitalisation was 1,87,206 US\$ million for Taiwan; 1,41,507 US\$ million for Thailand; 3,667,292 US\$ million for Japan and 6,857,622 US\$ million for US. The results could have been influenced by persistent movements in real exchange rates.

A different approach to investigate the relative importance of the trend to the various markets during this period is to compare the plots of the permanent component of each market, which corresponds to the common trend as shown by [Gonzalo and Granger \(1995\)](#), and the actual stock price behaviour. As it is suggested by the weights in the common trend, the trend or permanent component tracks closely the stock market behaviour in Thailand and Japan throughout the period (plots not reported). In contrast, the trend tracks closely the stock markets of Taiwan and US only up to the beginning of 1996, i.e. before the onset of the Asian crisis. Subsequently, the transitory component becomes important. This confirms the fact that both markets were not affected as much by the Asian crisis as the other two countries.

Thus, the results show that the stock market of Taiwan has not been a driver of our set of capital markets and has been responding to the common trend. On the other hand, Thailand and Japan have been the main drivers, while US contribution has remained small.

4. Conclusion

In this paper, we have investigated the linkages and dynamic interactions amongst a group of Pacific-Basin stock markets, Japan and the US. Our main objective was to examine whether these financial linkages were affected by the existence of foreign exchange restrictions. Furthermore, we wanted to investigate, whether alternative financial vehicles,

such as Country Funds, provide a channel through which international investors access capital markets.

We have examined these issues by estimating the multivariate cointegration model in the AR and MA forms. We also performed the recursive-based estimation to identify the evolution of these linkages. Our main findings are as follows.

First, we find that all the stock markets under investigation are not linked together for either the 80s or the 90s. Similar results are found for the open markets of Hong Kong and Malaysia for the 80s. This evidence suggests that the relaxation of foreign exchange restrictions is not sufficient to attract international investors' attention and strengthen international market interrelations. There exist other factors, possibly related to information availability, accounting standards, or liquidity and political risk, which may affect the portfolio diversification decision. On the other hand, the increase in financial links for open and semi-open markets in the second sub-period suggests that the relaxation of foreign ownership restrictions might have enhanced links with world markets.

Secondly, we find close financial links for Taiwan and Thailand with both Japan and US, during the first sub-period in which foreign ownership and other restrictions were in place. The results of the recursive analysis detect that the first forms of linkages correspond to the period of the introduction of First Country Funds. That can be explained by the fact that Country Funds in advanced markets are linked to their component assets traded in the Emerging Markets. The pricing efficiency, however, depends on the nature of the market segmentation of the Emerging Market and arbitrage restrictions. For example, in the case where the Country Fund is a perfect substitute for the underlying assets traded in the Emerging Market and foreign investors are prevented from accessing the Emerging Market from which the Country Fund originates, the component securities in the Emerging will be driven up to match the Country Fund by the unimpeded arbitrage of local investors from the Emerging Market.

Thirdly, the recursive analysis for the most recent period indicates that the Asian crisis did not have a substantial effect on the degree of linkages of these markets.

Finally, the estimated common trends mechanisms show that neither Japan, nor the US has a unique influence in the Pacific Rim. US plays a role, but small in magnitude, while Japan plays a more significant role, but is equally important as that of Thailand. Plotting the permanent component of each market, which corresponds to the common trend, and the actual stock price behaviour, we find that the difference of the two—the transitory component - to be substantial for Taiwan and US in the post 1996 period, thus, offering short-run diversification opportunities to international investors.

The analysis in the paper of stock market linkages in these emerging markets has indicated that international investors have opportunities for portfolio diversification by investing in most of the Pacific Basin countries. On the one hand, the results for the open economies show that although the linkages have increased in recent years, they do not seem to respond to a common world growth factor, but to be affected by national factors, leaving room for long-term gains by investing in these markets. On the other hand, the results for the semi-open economies show that although long-term diversification benefits from exposure to these markets might be limited, short-run benefits might exist due to substantial transitory fluctuations.

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