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AN EMPIRICAL ANALYSIS OF STOCK MARKET INTEGRATION: COMPARISON STUDY OF SINGAPORE AND MALAYSIA

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Using a GARCH (1, 1) model, this paper compares the extent to which financial sector liberalization in Singapore and Malaysia each has led to integration of its domestic equity market with external markets. The results show that the level of integration of the domestic markets with the external markets is higher when MSCI regional and global data are used, as compared to when individual country data are used to proxy regional and global markets. Inferences are made about the preferred pace of liberalization in Singapore, as well as, the impact of the Asian financial crisis and capital control measures imposed in Malaysia on financial integration, in the respective countries under study.

Keywords: Financial market liberalization; stock market integration; GARCH model; systematic risks; specific risks.

1. Introduction

This paper measures the extent to which the process of financial sector liberalization in a country can lead to integration of its domestic equity market with external markets in the region and the major economies. The respective markets of Singapore and Malaysia are used as case studies.

Both countries have a rich history of financial sector reforms. Interest rates settings were liberalized in the early 1970s, and in the 1980s, the governments in both countries pursued diversification of various financial instruments and automation of financial services. The governments relaxed rules and regulations in the equity, foreign exchange, and derivatives markets as well as fund management in order to encourage greater foreign participation. Broadly, the path of financial sector reforms for both countries seemed similar, but in reality, Singapore was widely recognized to be ahead of Malaysia in terms of progress and reforms.

By late 1980s, Singapore was already ranked the third most important financial centre in Asia, after Tokyo and Hong Kong. By late 1990s, Singapore further stepped up its reforms in the banking sector. Several domestic banks in Singapore were merged and foreign banks

were awarded special licenses that granted them greater freedom to operate in the domestic retail market to heighten rivalry in the retail markets. In 1999, the central bank of Singapore, the Monetary Authority of Singapore (MAS) had granted Qualifying Full Banks (QFBs) licenses to a number of foreign banks. Initially, a total of four foreign banks were awarded the license, and two years later, the number of licenses awarded was raised to six. In view of rising competition and declining market share in the domestic market, the local banks responded by expanding their operations in the region fairly aggressively.[1] The investment arm of Singapore, i.e., Temasek Holdings, was also investing widely in banks in the region.[2] Such a scale of acquisitions and investment activities was not seen in Malaysia.

One would therefore argue that in Singapore, its financial sector would have a greater level of integration with external markets, as compared to Malaysia. To verify, in our framework, we follow a one-factor risk decomposition model (as given in Akdogan (1996)) but modify it into a two-factor model, and with the residuals specified to follow a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) process (see Bekaert and Harvey, 1997). In our model, we specify the external markets to comprise of equity markets in the Asian economies (excluding Japan) and equity markets in developed major economies. We study the spill-over effects of the volatility of equity returns from these external markets on the domestic market (Singapore and Malaysia, separately). We use the results to analyze the degree of integration between the markets as well as its evolution over time. We experiment with different sources of datasets for regional and developed equity markets (MSCI-sourced versus local-sourced market indices), and arrive at some interesting results which we find will be useful for empirical type of work of this kind.

In general, our results show that the equity market in Singapore has a higher level of integration with the external markets as compared to Malaysia. We use the results to make inference about the preferred pace of liberalization in Singapore: in particular, we determine whether there is a preference for a "mini-bang" or "large bang" style of liberalization. In the case of Malaysia, the results show that the country-specific (or, idiosyncratic) factor explains a significant part of volatility of its stock market return, specifically during the Asian financial crisis and when capital control measures were imposed. We make inference that crises/shocks are causes of segmentation of the Malaysian equity market from the rest of the world.

[1] We give examples of acquisitions of Singapore domestic banks in the region. Singapore's largest domestic bank, Development Bank of Singapore (DBS), acquired, in Hong Kong, its fourth largest bank Dao Heng Bank in 2001. In Thailand, it acquired Thai Danu in 1998, and Thai Military Bank, and The Industrial Finance Corporation of Thailand in 2004. In the Philippines, it invested in the Bank of Philippines Islands in 2000. Singapore's second largest domestic bank, United Overseas Bank (UOB) acquired in the Philippines, the Westmont Bank, in 1999; in Thailand, it acquired Radanasin Bank in 1999 as well as Bank of Asia Public Company Limited in 2004; and in Indonesia, it acquired P.T. Bank Buana in 2004.

[2] We give examples of investment activities by Temasek Holdings. In Malaysia, it invested in the holding company of Alliance Bank Malaysia, Malaysian Plantations in 2005; in Pakistan, it invested in NDLC-IFIC Bank in 2005; in Thailand, it invested in Siam Commercial Bank in 2004; and in Indonesia, it acquired PT Bank Danamon Indonesia through a consortium with Deutsche Bank in 2003, and PT Bank International Indonesia through a consortium with Kookmin Bank, ICF Financial Group Holdings, and Barclays Bank in 2004. It recently acquired a 12% stake in Standard Chartered Bank in 2006.

Section 2 reviews the literature on stock market integration, with a focus on the economies within the Asian region. Section 3 discusses the methodology used in this paper. Discussions on model diagnostics are provided in Section 4 with empirical findings in Section 5. Our conclusions are provided in the last section.

2. Literature Review

Studies on financial sector interdependence between South East Asian markets (ASEAN) and the developed markets proliferated the research scene in the early 1990s. This was the period when regional economies were opening up their financial markets aggressively. Much of the attention of the research was on the degree of interdependence among ASEAN markets, and also the degree of interdependence between ASEAN or East Asia markets and major developed markets. Some of the recent work has covered the extent to which integrations are affected by external factors, such as financial liberalization and financial crisis. The results in these papers vary, depending on factors such as the period of estimation or testing, the types of data used, and the model and methodology employed. There have been no conclusive findings in the empirical studies.

The methodological applications range from simple correlations and covariance VAR based approaches, such as Granger causality for the short-run analysis, to tests for co-integration in long run analysis. An earlier study by Kasa (1992) used the Johansen co-integration technique for stock prices to assess integration of the stock markets. Kasa examined market indices of capital markets in US, UK, Japan, Germany, and Canada and found a single common trend in these markets, which imply that the returns in all of these markets are highly integrated. Another study by Cheung and Liu (1994) employed co-integration technique on Asian countries data. Using data for the US, Japan, Hong Kong, Singapore, Taiwan, and Korea, Cheung and Liu discovered two co-integration relationships and four common trends.

Other papers that used the statistical method of co-integration analysis as a test of integration with focus on ASEAN markets included Roca, Selvanathan and Shepherd (1998), Ng (2000), as well as, Azman-Saini and Azali (2002). Roca, Selvanathan and Shepherd (1998) found that there were no strong co-movement relationships among the five ASEAN markets as a group (namely the markets in Indonesia, Malaysia, Philippines, Singapore and Thailand) for the period studied 1988 and 1995. This result indicated a low level of integration among ASEAN markets. Likewise, Ng (2000) reported non-existence of long-run relationship between the equity markets of the same five ASEAN countries for the period between 1988 and 1997. In contrast, Azman-Saini and Azali (2002) found partial evidence of co-integration in the same five ASEAN equity markets for the period between 1988 and 1999. This indicates that the Singapore equity market has not been affected by other markets in the region, except by the Philippines in the long run. (See Kanas, 1998; Olienyk, Schwebach and Zumwalt, 1999; Phylaktis and Ravazzolo, 2002; and Barari and Sengupta, 2003 for related works).

A great deal of attention has also been given to studying the linkages between Asian equity markets and the US and Japan markets. Many studies found strong dominance of the US market in the Asian-Pacific region. These include those undertaken by Park and Fatemi

(1993), Masih and Masih (1997), Cha and Oh (2000) as well as, Anoruo and Ramchander (2003). Of the others, Phylaktis (1999) provided evidence to suggest the increasing influence of Japan in the Asian region. Similar results were shown by Johnson and Soenen (2002) who observed that the equity markets of Australia, China, Hong Kong, Malaysia, New Zealand, and Singapore are highly integrated with the Japanese equity market. In contrast, Cho, Eun and Senbet (1986) and Harvey (1991) found evidence that the Japanese and other Asian markets are not well integrated in the world markets. Studies by Cheung and Mak (1992) as well as Alexakis and Siriopoulos (1999) also concluded that the Japanese market was found to play a less important role in the region. Similarly, Ghosh, Saidi and Johnson (1999) argued that neither Japan nor the US drives the Asia-Pacific stock markets.

Of interest is also the study of the impact of external events, namely liberalization and financial crisis, on integration of equity markets. Works by Bertero and Mayer (1989), Lee and Kim (1993) as well as Bracker and Koch (1999) suggest that correlation among equity markets tends to increase during periods of market crises. Fang (2002), Chatterjee, Ayadi and Maniam (2003) and Daly (2003) confirmed an increase in the convergence of returns among the Asian markets since the start of the 1997 Asian financial crisis. Yang, Kolari and Min (2003) examined the long- and short-run relationships among the US, Japanese, and ten Asian stock markets. Their empirical results revealed that long-run relationships among these markets were strengthened during the crisis and that these markets were more integrated after the crisis. Sheng and Tu (2000) reported no co-integration in the US and Asian equity markets in the year prior to the Asian crisis, but found that the US and Asian equity markets to be integrated during the crisis. One important implication of the above findings was that the degree of integration among countries tended to change over time, especially around periods marked by financial crises.

Bekaert and Harvey (1995) measured capital integration using conditional regime-switching model. Their model allows conditionally expected returns in any country to be affected by their covariance with a world benchmark portfolio and by the variance of the country returns. Using this method, the degree of market integration is allowed to change over time. In contrast to the general perception and findings that markets are becoming more integrated with the world market, their results suggest that some countries are becoming less integrated. Following Bekaert and Harvey (1995), many research studies have emerged which use similar time-varying methods to examine the behavior and correlation of international financial markets. (See Bekaert and Harvey (1997), Ng (2000) and Carrieri, Errunza and Ked (2001)).

Another strand of research tests for financial integration using asset pricing models. Earlier studies include those by Sharpe (1964), Lintner (1965), Black (1972), Solnik (1974), Lessard (1976), and Errunza and Losq (1985), while recent ones are by Bekaert and Harvey (1995), Akdogan (1996), De Santis and Imrohoroglu (1997), Henry (2000), and Bekaert and Harvey (2002).

3. Methodology

We measure the extent to which Singapore and Malaysia stock markets are influenced by external factors and local country-specific factors, following the framework used by Akdogan

(1996). External shocks are divided into two components: shocks coming from markets in the region, and shocks from markets in the developed economies (see Ng (2000)).[3] Following Bekaert and Harvey (1997), the conditional variances of the equity returns are specified to be time variant, while the spillover effects as captured by β_m and β_r are assumed to be constant over time. Tests for non-linear dependency in the data are carried out based on the ARCH family of models developed by Engle (1982) and generalized by Bollerslev (1986). All parameters are estimated using maximum likelihood method.

This section expands on the methodology, and the subsequent sections give the analysis and interpretations of the results. Akdogan (1996) expressed his model as: $\mathrm{Var}(R_i) = \beta_i^2 \mathrm{Var}(R_w) + \mathrm{Var}(\varepsilon_i)$, where R_i is the return of country i portfolio, R_w is the return of benchmark world index, and $\beta_i = \frac{\mathrm{cov}(R_i, R_w)}{\mathrm{var}(R_w)}$. The component ε_i is residual of country i assumed to be normally distributed with mean zero and constant variance. The relevant measure of integration, by taking the ratio of variance of return of benchmark world index to total variance of return of country i portfolio, adjusted by squared of country i beta is: $p_i = \frac{\beta_i^2 \mathrm{var}(R_w)}{\mathrm{var}(R_i)}$, where p_i denotes systematic risk of country i portfolio.

It measures the extent that country i portfolio participates in general global market moves. What this means is that the higher (or lower) the proportion of systematic risk, the greater (or lesser) is the degree of integration with (or segmentation from) the benchmark world market. The ratio of variance of the idiosyncratic component to total variance of return of country i portfolio is: $q_i = \frac{\mathrm{var}(\varepsilon_i)}{\mathrm{var}(R_i)}$, where q_i denotes specific risk, which is the risk unique or peculiar to the country i.

Unlike systematic risk, it represents that component of an asset's return which is uncorrelated with general global market moves.

We extend Akdogan's model to a two-factor analysis, and model the mean return on country i as:

$$R_{i,t} = c + \beta_i R_{i,t-1} + \beta_m R_{m,t} + \beta_r U_{r,t} + \varepsilon_{i.t} \tag{1}$$

$R_{i,t}$ is the contemporaneous logarithmic return of country i equity price index and $R_{i,t-1}$ is the logarithmic return of country i for the previous period. $R_{m,t}$ and $U_{r,t}$ are contemporaneous logarithmic return of major developed market and regional market, respectively. The error term is $\varepsilon_{i,t} = \delta_{i,t} z_{i,t}$ where $\varepsilon_{i,t} | I_{t-1} \sim N(0, \delta_{i,t}^2)$ and $z_{i,t}$ is an i.i.d process with zero mean and constant variance. The variance of the error $\varepsilon_{i,t}$ follows a univariate GARCH (1, 1) process[4]:

$$\delta_{i,t}^2 = c + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i \delta_{i,t-1}^2 \tag{2}$$

The conditional variance of the error is defined to be dependent on its own forecasted variance from the last period, $\delta_{i,t-1}^2$ and previous period squared error $\varepsilon_{i,t-1}^2$. Stationarity of the GARCH process requires that $\alpha_i + \beta_i \leq 1$, according to Bollerslev's (1986) Theorem 1.

[3] One interesting aspect of Ng's (2000) paper is that she focused on how volatility in a Pacific-Basin market can be influenced by foreign shocks, by separating these external shocks into those influenced by regional or by world market factors.

[4] For the sake of simplicity, we have specified the residual process to follow a univariate GARCH model, instead of a multivariate GARCH process. We thank Jun Yu for this suggestion which we would like to incorporate into the paper as our future work.

By construction, the term $U_{r,t}$ in (1) captures stock market shocks in the region that are unrelated to shocks in the major global markets. Since there is the possibility of common news driving both regional and major markets, thus some correlation is expected between these stock market indices. This means that if the standard market indices are used directly in the Equation (1), the problem with multi-collinearity can lead to unreliable assessments of the relative strength of explanatory variables. To overcome this, the indices are orthogonalized using:

$$R_{r,t} = c + \gamma R_{m,t} + U_{r,t}$$

$R_{r,t}$ represents regional market influence, and by construction, $U_{r,t}$ represents the part of variation in regional markets equity index that cannot be explained by $R_{m,t}$. Similarly, the variance of the residual in the regression $U_{r,t} = c + \alpha U_{r,t-1} + \varepsilon_{r,t}$ is specified to have a univariate GARCH (1, 1) process:

$$\delta^2_{r,t} = c + \alpha_r \varepsilon^2_{r,t-1} + \beta_r \delta^2_{r,t-1} \tag{3}$$

The error term $\varepsilon_{r,t} = \delta_{r,t} z_{r,t}$ where $\varepsilon_{r,t}|I_{t-1} \sim N(0, \delta^2_{r,t})$ and $z_{r,t}$ is an i.i.d process with zero mean and constant variance. Similarly, the variance of the residuals in the regression $R_{m,t} = c + \alpha R_{m,t-1} + \varepsilon_{m,t}$ is specified to have a univariate GARCH (1, 1) process:

$$\delta^2_{m,t} = c + \alpha_m \varepsilon^2_{m,t-1} + \beta_m \delta^2_{m,t-1}, \tag{4}$$

where $\varepsilon_{m,t} = \delta_{m,t} z_{m,t}$ where $\varepsilon_{m,t}|I_{t-1} \sim N(0, \delta^2_{m,t})$ and $z_{m,t}$ is an i.i.d process with zero mean and constant variance.

Following Akdogan (1996), we express the variance of returns of market portfolio i as:

$$\begin{aligned} \text{var}(R_{i,t}|I_{t-1}) &= \beta^2_m \text{var}(R_{m,t}|I_{t-1}) + \beta^2_r \text{var}(U_{r,t}|I_{t-1}) + \text{var}(\varepsilon_{i,t}|I_{t-1}) \\ \delta^2_{c,t} &= \beta^2_m \delta^2_{m,t} + \beta^2_r \delta^2_{r,t} + \delta^2_{i,t}. \end{aligned} \tag{5}$$

Equation (5) says the variance of index return series for country i can be decomposed into outer sources of volatility shocks (from neighboring regional economies and developed markets), and internal idiosyncratic shocks specific to the country. Bear in mind that the parameters β_m and β_r are the maximum likelihood estimates that can be obtained from (3) and (4). Likewise, the variance terms $\delta^2_{i,t}$, $\delta^2_{r,t}$ and $\delta^2_{m,t}$ can be obtained from previous steps in Equations (2), (3), and (4) respectively. Dividing both sides of (5) by $\delta^2_{c,t}$, the total risk associated with market i portfolio is broken into three parts, A, B, and C:

$$A = \beta^2_m \delta^2_{m,t} / \delta^2_{c,t}, \quad B = \beta^2_r \delta^2_{r,t} / \delta^2_{c,t}, \quad \text{and} \quad C = \delta^2_{i,t} / \delta^2_{c,t}$$

By construction, A, B, and C sum up to unity with A and B representing systematic risk in the market portfolio i (or, the category of risks due to external market influences coming from the major and regional economies, respectively), and C representing specific risks (or the category of risks due to internal influences that are unique to the market i itself). The higher (or lower) the proportion of systematic risk A, the greater (or lesser) is the degree of integration with (or segmentation from) the benchmark major equity markets. Similarly, the higher (or lower) the proportion of systematic risk B, the greater (or lesser) is the degree of integration with (or segmentation from) the benchmark regional equity markets. In this paper, we use the computation of C for doing cross-country comparison study of idiosyncratic factors affecting the volatility of market returns.

4. Model Diagnostics

The data used in our paper are weekly equity indices (in terms of US dollars) compiled by Datastream from the period January 1985 to December 2004. Weekly returns are obtained as logarithmic first differences of equity market index using Friday-to-Friday data. By choosing weekly frequency data, problems of day-of-the-week effects of daily frequency data are avoided, as is the problem of January/December effect of monthly frequency data. Moreover, by computing the Friday-to-Friday data, it is possible for weekly data on equity returns in different national markets to overlap, which allows sharing among countries of market information affecting the equity market.

To capture Singapore and Malaysia local equity markets, we use the MSCI Singapore and MSCI Malaysia, as representation; and we also use the respective local stock market indices — the Singapore Straits Times Index and the Malaysia Kuala Lumpur Composite Index. To represent equity markets in regional and major developed economies, we use the MSCI All Country Far East excluding Japan index and the MCSI World index data.[5] We also experiment with country indices, namely United States' S&P 500 Composite Index to proxy major developed stock market, and Japan's Nikkei 225 Stock Average to proxy regional stock market, followed Ng's (2000) paper, and found some interesting results, or pitfalls, of using single-country index as proxy for global or regional stock market behavior. The MSCI World index represents selected market comprising only major developed economies, which is what we want to capture. The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The MSCI AC Far East excluding Japan index includes the nine developed and emerging market country indices: China, Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore Free, Taiwan, and Thailand.

Summary statistics of stock returns, such as the means, standard deviations, and first-order autocorrelation of stock market returns as well as its squared returns are presented in Table 1. Over the sample period January 1985 to December 2004, the first-order autocorrelation of weekly returns is seen to range from -0.049 (US market) to 0.072 (Singapore market), with the Ljung-Box (LB) tests showing persistent linear dependency of all stock indices. For squared returns data, statistics on first-order autocorrelations vary from 0.097 (Japan market) to 0.292 (US market), with the LB tests showing strong dependence of non-linear dependency in returns of all stock indices. The non-linear dependency in the returns suggests the presence of GARCH structure in the residuals.

Tables 2(A) and 2(B) tabulate the coefficients of the parameters for Equations (1) and (2), respectively, together with the corresponding p-values, using the datasets S&P 500 and Nikkei 225 as explanatory variables. Tables 3(A) and 3(B) tabulate the values for datasets MSCI World and MSCI Far East ex-Japan.

[5]The MSCI World index is recommended over the MSCI All Country (AC) World index because the latter covers not only developed markets but also emerging ones. This broad definition makes it unsuitable for our purpose of focusing on purely developed markets.

Table 1. Basic Statistics of Stock Returns

	Mean	Standard Deviation	$\rho 1(-1)$	LB (10)	$\rho \mathbf{2}(-\mathbf{1})$	LB2 (10)
MSCI Singapore	0.001	0.030	0.072	0.007***	0.188	0.000***
MSCI Malaysia	0.0007	0.042	0.048	0.000***	0.134	0.000***
S&P 500	0.001	0.022	−0.049	0.014**	0.292	0.000***
Nikkei 225	0.0008	0.032	0.016	0.632	0.097	0.000***
MSCI World	0.001	0.019	0.050	0.227	0.231	0.000***
MSCI AC Fareast ex Japan	3.10E-19	0.025	0.022	0.000***	0.117	0.000***

All weekly log returns are calculated in US dollars. The columns $\rho 1(-1)$ and $\rho 2(-1)$ are the first-order serial correlations of returns and squared returns, respectively. The columns LB(10) and LB2(10) are the p-values of the Ljung-Box statistics with 10 lags. The p-values are small, which means there is overwhelming rejection of the null hypothesis of no serial correlation. According to the standard deviation statistics, the most volatile asset is Malaysia's KLCI and the least volatile is the MSCI World.

Table 2. Models Using S&P 500 and Nikkei 225 Data as Explanatory Variables

(A) Mean Process

	β_m	β_r
STI Singapore	0.607 (0.00***)	0.254 (0.00***)
KLCI Malaysia	0.366 (0.00***)	0.172 (0.00***)

Figures in brackets are p-values. The p-values are small, which means there is overwhelming rejection of the null hypothesis that the parameters are insignificant.

(B) Conditional Variance Process

	STI Singapore	KLCI Malaysia	S&P 500	Nikkei 225
α's	0.130 (0.00***)	0.145 (0.00***)	0.101 (0.00***)	0.097 (0.00***)
β's	0.862 (0.00***)	0.858 (0.00***)	0.882 (0.00***)	0.846 (0.00***)

Figures in brackets are p-values. The p-values are small, which means overwhelming rejection of the null that the parameters are insignificant.

(C) Diagnostic Test

	Test			
	White Noise Test (Ljung-Box)		GARCH Effect Test (Ljung-Box)	
Series	Statistic	p-Value	Statistic	p-Value
STI Singapore	12.153	0.433	1.363	1.000
KLCI Malaysia	17.119	0.145	10.056	0.611

Tests were conducted to test for fitness of the mean Equation (1) and to test for fitness of the variance Equation (2). The p-values are large, which suggests there is overwhelming acceptance of null hypothesis of no serial correlation in the series. It can be said that the models are seen to be correctly specified.

Table 3. Models Using MSCI World and MSCI Far East Ex-Japan Data as Explanatory Variables

(A) Mean Process

	β_m	β_r
MSCI Singapore	0.743 (0.00***)	0.707 (0.00***)
MSCI Malaysia	0.616 (0.00***)	0.829 (0.00***)

Figures in brackets are *p*-values. The *p*-values are small, which means there is overwhelming rejection of the null hypothesis that the parameters are insignificant.

(B) Conditional Variance Process

	MSCI Singapore	MSCI Malaysia	MSCI World	MSCI AC Fareast Ex Japan
α's	0.060 (0.00***)	0.138 (0.00***)	0.085 (0.00***)	0.167 (0.00***)
β's	0.927 (0.00***)	0.859 (0.00***)	0.897 (0.00***)	0.797 (0.00***)

Figures in brackets are *p*-values. The *p*-values are small, which means overwhelming rejection of the null that the parameters are insignificant.

(C) Diagnostic Analysis

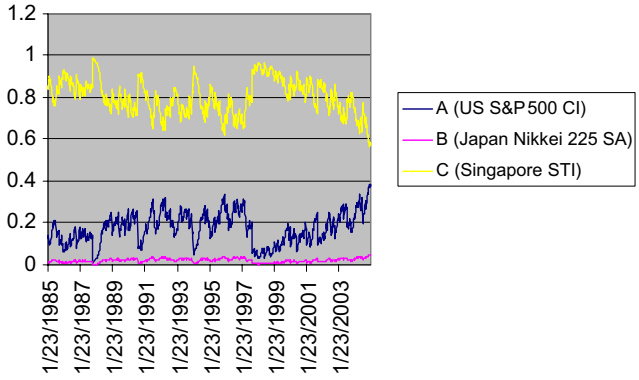
	Test			
	White Noise Test (Ljung-Box)		GARCH Effect Test (Ljung-Box)	
Series, *i*	Statistic	*p*-Value	Statistic	*p*-Value
MSCI Singapore	12.907	0.376	27.480	0.122
MSCI Malaysia	8.852	0.715	14.008	0.300

Tests were conducted to test the fitness of the mean Equation (1) and to test the fitness of the variance Equation (2). The *p*-values are large, which suggests there is overwhelming acceptance of null hypothesis of no serial correlation in the series. It can be said that the models are seen to be correctly specified.

The Ljung-Box tests of white noise have been applied to the standardized residuals and squared standardized residuals in both instances to test for serial correlation. The test statistics follow a Chi-square distribution with 10 degrees of freedom, given the same number of lags employed in the Ljung-Box tests. In all cases, the parameters β_i, β_m, β_r and the corresponding α's are significant at conventional significance levels. For the purpose of assessing the fit of the model (see Part C of Tables 2 and 3), a diagnostic test using LB statistics performed on both the standardized residuals and the squared standardized residual confirmed the mean and volatility processes to be correctly specified.

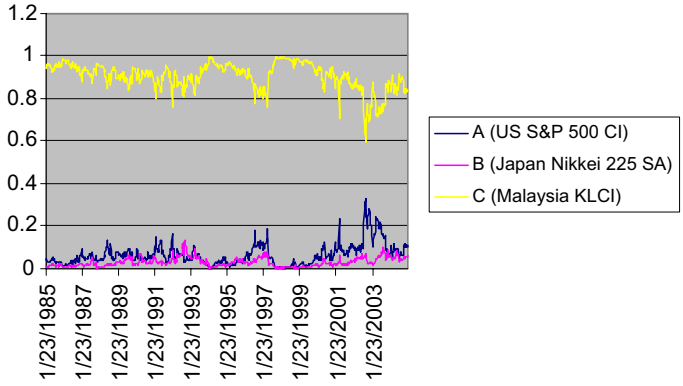
5. Empirical Evidence

We initially followed Ng's (2000) approach of using the United States S&P 500 Composite Index and the Japan Nikkei 225 Stock Average data as single-country proxies to



Integration of Singapore equity market to the region (as proxied using Japan Nikkei 225 index) is shown to be very small over the period 1985 to 2004. Integration of Singapore equity market to the developed economies region (as proxied using US S&P index) is shown to be fairly constant, in the range of 0.2 to 0.4. Country-specific effect is shown to dominate.

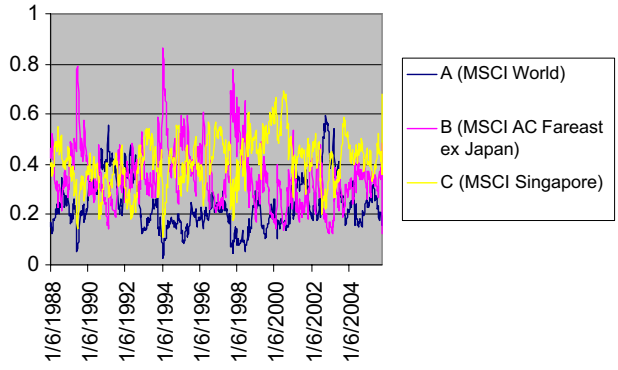
Figure 1. Singapore — Systematic and Specific Risks (1985 to 2004)



Integration of Malaysia equity market to the region (as proxied using Japan Nikkei 225 index) and the developed economies region (as proxied using US S&P index) is shown to be fairly small over the period 1985 to 2004. Country-specific effect is shown to dominate very strongly throughout the period.

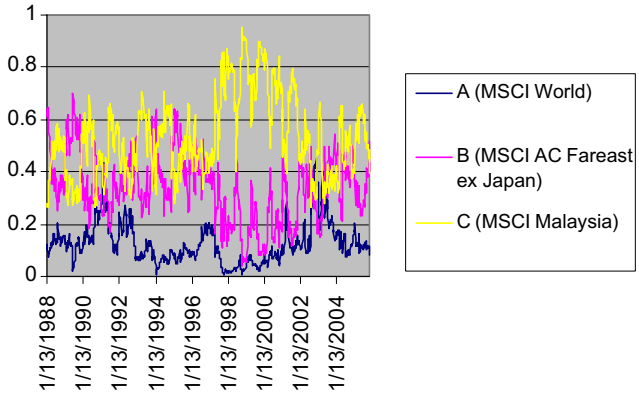
Figure 2. Malaysia — Systematic and Specific Risks (1985 to 2004)

represent market influences in major developed economies and regional economies respectively. Ng (2000) measured the integration for six Pacific Basin equity markets (Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand). Her results showed the spillover effect from the region to be small, or in other words, resulting in large country-specific spill-over effects. Similar to Ng's (2000) findings, we found the integration of Singapore and Malaysia equity markets to the region to be small (see Figures 1 and 2). The results were obtained using



Integration of Singapore equity market to the region (as proxied using MSCI AC Fareast ex Japan index) and to the developed economies region (as proxied using US S&P index) is shown to be fairly large over the period 1985 to 2004.

Figure 3. Singapore — Systematic and Specific Risks (1988 to 2004)



Integration of Malaysia equity market to the developed economies region (as proxied using US S&P index) is shown to be relatively small over the period 1985 to 2004. Country-specific effect is shown to dominate, particularly during the period of the Asian Financial Crisis.

Figure 4. Malaysia — Systematic and Specific Risks (1988 to 2004)

the following datasets — MSCI AC Far East index, MSCI Singapore, and MSCI Malaysia, and since the results are similar to Figures 1 and 2, they are not shown here.

Then we experimented with the MSCI All Country Far East excluding Japan index and the MCSI World index as proxies to represent influences from regional and major developed economies, respectively. In contrast to previous results, we found the regional contributions to the Singapore and Malaysia equity markets volatility to be large (see Figures 3 and 4, respectively).

Our explanation is that the MSCI All Country Far East excluding Japan data captures regional shocks better than either the Nikkei 225 Stock Average, or the MSCI AC Far East

index data. Similarly, when the MCSI World index data was used, the model estimates that the domestic equity market integrations of Singapore and Malaysia with the developed markets is higher, as compared to using the United States' S&P 500 Composite Index dataset. The results are not surprising. By construction, the sub-indices in the MSCI dataset give a more thorough representation of regional effects and major developed market effects. Our finding of the pitfall of using single-country indices as proxies, serves as a useful reminder for future empirical work of similar type.

There are a few interesting comparisons that one can draw from the results shown in Figures 3 and 4. First, we can use the results to show that Singapore equity market is more integrated with the major developed markets, as compared to the results for Malaysia. However, the country-specific effects for Malaysia are higher, when compared with Singapore. This was evident during the Asian financial crisis where the country-specific component constitutes an overriding factor in explaining the volatility in Malaysia stock return. From Figure 4, we notice substantial declines in both major and regional fractions in the period following September 1998. At that time, the Malaysian government imposed capital controls and caused uncertainties among many foreign investors' about the economic direction and management[6] of the country. We infer that events constitute one of the few causes of segmentation of the Malaysian equity market from the rest of the world.

In May 2001, the government of Malaysia announced the abolition of the 10% exit levy on the repatriation of profits from portfolio investments held for less than one year. The results in Figure 3 show that there were no significant increases in both regional and global fractions until end 2002 and early 2003. We infer that it took more than a year for the Malaysian market to be integrated back into the major and regional equity markets.

Second, we can use the results of the empirical study to compare the pace of equity market integrations in Singapore and Malaysia *vis-a-vis* the rest of the world between 1988 and 2004. Focusing on Singapore, the results in Figure 3 show that the pace of increase in the financial integration scores has been gradual. The Singapore government has explicitly stated a preference for a gradualist (or "mini-bang") liberalization program that does not compromise the soundness of the domestic financial system, the conduct of monetary policy, or the stability of the economy.[7] Examples of the gradualist approach can be seen in the government's limited relaxation of the policy of non-internationalization of the Singapore dollar and the five-year banking reform program, which took place in two phases between 1999 and 2004.[8] One may use the findings to arrive at the conclusion that a gradualist, pragmatic, interventionist policy to liberalization in the case of Singapore has enabled the nation to register strong growth, as opposed to a free market policy that calls for rapid liberalization with minimum government intervention. At this stage, of course, a cautious stance is in order, and further investigation is necessary before a firm view of policy implications can be given.

[6]Comments by Malaysia's Prime Minister had raised investors' concern about the country's management of the economy. The removal of his pro-reformist, pro-IMF Deputy Prime Minister further aggravated investors' concerns.

[7]See Lee (2000, 2001, 2002 and 2004).

[8]For more discussions on process of financial sector liberalization in Singapore, see Tan (2005).

6. Conclusions and Future Work

This paper provides a framework to compute the integrations of domestic equity markets in Singapore and Malaysia each, with equity markets in the regional and developed economies. The purpose is to demonstrate empirically, how the experience of varying degree stock market liberalization of each country, can affect its integration with external markets, i.e., the region and global markets.

We discussed the effects of country-specific factors on the volatility of domestic equity markets during the Asian financial crisis. Different datasets were tested on the model and the results showed that using the MSCI All Country Far East excluding Japan index and MSCI World index datasets, these datasets captured a higher level of regional and developed market integrations, respectively, as compared to the results using single-country indices such as the Nikkei 225 or S&P 500 index datasets as proxies. The findings imply greater regional and global integration than what the Nikkei 225 or S&P 500 index would suggest.

One extension that can be made to this paper is to extend the univariate GARCH models in Equations (2), (3), and (4) into a multivariate GARCH ones. This will allow us to do a comparison of the financial sector linkages between the two countries, if we are interested in examining the information spillover between Singapore and Malaysia markets. In the extended version of Equation (2), a multivariate GARCH model will allow us to capture the spill-over effects of volatility from regional and developed market on domestic market. While in the extended version for Equation (3), a multivariate GARCH model will allow us to capture the spill-over effects of volatility from developed markets into the regional markets. Lastly in Equation (4), a multivariate GARCH model will allow us to capture the spill-over effects of volatility from regional markets into the major markets.

Explanatory variables that should be included into the model (but were not) can technically, result in estimates of the parameters that are biased. However, if the effect of the explanatory variables is perceived to be insignificant, then the degree of bias is negligible. For example, in the case of Equation (4), we can expect the spill-over effects of volatility from regional markets into the major markets to be small. Such work will be interesting and warrant more research, a new project that we can do in the future.

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