ASIAN ACADEMY *of*
MANAGEMENT JOURNAL
of ACCOUNTING
and FINANCE

AAMJAF, Vol. 6, No. 2, 1–17, 2010

TIME-VARYING WORLD INTEGRATION OF THE MALAYSIAN STOCK MARKET: A KALMAN FILTER APPROACH

Bit-Kun Yeoh[1], Chee-Wooi Hooy[2*] and Zainudin Arsad[1]

[1]*School of Mathematical Sciences,* [2]*School of Management,*
Universiti Sains Malaysia, 11800 USM Pulau Pinang, Malaysia

[*]Corresponding author: cwhooy@usm.my

ABSTRACT

This paper estimates the time-varying world integration of the Malaysian stock market and examines if the paths of the time-varying integration match the economic events of the country. We employed weekly time series data for the period between February 1988 and September 2009 to coincide with the liberalisation of the Malaysian market since the late 1980s. To capture the time-varying degree of market integration, we employed the Kalman Filter technique, which produces time-varying coefficients in estimating International Capital Asset Pricing Model (ICAPM). The changes in the level of market integration coincide with the economic events that took place in the country and provide some evidence to the practical application and suitability of the Kalman Filter technique in studying stock market integration.

Keywords: ICAPM, Kalman Filter, integration, time varying coefficient

INTRODUCTION

Global financial integration has increased substantially in recent decades. In the aftermath of the Bretton Woods era, globalisation has manifested itself among the developed countries in increasing flows of cross border capital. Globalisation has promoted the emergence of global financial centres (US, UK, and Tokyo) in the 1980s. In response to the reduction of various trade and financial barriers, financial integration subsequently spread to the emerging markets in the early 1990s. Malaysia was one of the beneficiaries.

The Malaysian stock market, known today as Bursa Malaysia (it was previously known as the Kuala Lumpur Stock Exchange, or KLSE), has gained the fast momentum of globalisation due to Malaysia's small but open economy. The Malaysian stock market is one of the biggest markets in Southeast Asia, with a history stretching back about 50 years. Before the 1990s, the Malaysian stock market remained relatively small in terms of market capitalisation. Due to the country's successful industrial transformation in the late 1980s, the Malaysian economy experienced tremendous growth in the early 1990s. Since then, the Malaysian stock market has grown tremendously thanks to many liberal financial policies aimed to attract foreign capital to promote further growth.

Bursa Malaysia has experienced high growth in terms of market capitalisation and trading value since the early 1990s. In 1990, there were only 271 companies listed in the exchange with a total market capitalisation of USD 47.87 billion and USD10.70 billion in total traded stock value. In 1996, just before the Asian financial crisis, the number of listed companies was 618 with a USD306.17 billion market capitalisation; the total value of traded stocks was USD178.01 billion. The tremendous growth of the market within the six-year period (1990 to 1996) involved a 639% increase in market capitalisation; the traded stock value in 1996 was 1664% of the equivalent in 1990. Given that Malaysia was one of the hardest hit countries in the 1997 to 1998 Asian financial crisis, the number of listed companies in 1998 was 731 with only USD95.56 billion in market capitalisation and USD26.839 billion in traded stock value. Although the crisis caused a significant decrease in the value of companies as well as depreciations in the ringgit exchange rate, the growth of Bursa Malaysia has remained significant since 1990.

In 2007, the performance of Bursa Malaysia was about the same as during the pre-Asian crisis period, with an obvious increase in the number of listed companies (986 listed companies, USD325.29 billion in market capitalisation, and USD169.72 billion in shares traded). However, the performance of the market was affected by the global financial crisis in 2008. There were 976 listed companies, USD189.09 billion in market capitalisation, and USD93.78 billion share traded in 2008, representing a sharp decrease in growth compared to 2007 (World Federation of Exchanges, 2009).

This study was motivated by a number of reasons. First, the Malaysian economy has undergone profound structural changes over the last few decades, evolving from a primary producer into an increasingly diversified and broad-based economy. Malaysia can be considered one of the typical emerging markets in the developing world. Thus, it is interesting to see how Malaysia has integrated with the world market ever since the period of liberalisation. Secondly, most studies on inter-relationships between stock markets examine market correlation, long-run cointegration or volatility transmission to indirectly infer the stock market integration hypothesis. These approaches do not really comply with the definition of market integration as implied by Bekaert and Harvey (1995). Accordingly, market integration has to be defined using an asset pricing model. We followed Korajczyk (1996) and Levine and Zervos (1998) to define pricing errors as the degree of market integration. Thirdly, a weakness of many previous studies was a focus on static models that did not consider the time-varying nature of equity risk premiums. For this reason, this paper employs the Kalman Filter methodology that allows time-varying coefficients of the model and hence is able to investigate the varying degree of the Malaysian stock market's integration with the rest of the world. Last but not least, we would like to see if this measure can establish a link with economic events to confirm the practical application of the Kalman Filter approach in studying stock market integration.

The rest of the paper is organised as follows. In Section 2, a brief review is provided on the issues related to stock market integration worldwide and the approaches of assessing the level of integration in the literature. Section 3 presents the model, the estimation method and the data used in this study. The estimation results are presented in Section 4, and Section 5 provides a conclusion.

LITERATURE REVIEW

Bekaert and Harvey (1995) point out that a market is completely integrated with the world if its assets have the same expected return as the assets with identical risk levels listed in major global markets. In other words, in an integrated world, the cross section reward to risk is not important, as it is common to all integrated markets. However, the reward to risk is different for a segmented market due to different risk exposures for each country. In other words, the law of one price can definitely work as a behaviour of stock market integration. The nature and extent of financial market integration is therefore prominent for investors, as they influence international asset allocation potential and portfolio diversification decisions.

The issue of inter-relationships between stock markets worldwide has been examined extensively using different measures and methodologies. In the literature, there are two broad categories of financial integration measures: price-based measures and quantity-based measures.[1] A price-based measure is more desirable for regulators and researchers as they prefer to refer to indicators that are quantitatively available. Under the price-based measure, cointegration analysis is today's standard method in examining the long-run relationships between different equity indices. By definition, cointegrated markets exhibit

[1] See Adam, Jappelli, Menichini, Padula & Pagano (2002) and Baele, Ferrando, Hordahl, Krylova & Monnet (2004) for a detailed survey of the market integration research literature.

common stochastic trends and in turn limit the amount of independent variation and diversification opportunities between these markets.[2] However, cointegration analysis fails to take into account that convergence is a gradual and on-going process. It only tests for convergence over the whole period under consideration rather than investigating the degree of convergence that increased more recently than earlier in time. Rangvid (2001) takes the effort to detect time-varying cointegration using a recursive method, but Pascual (2003) points out that the increasing convergence shown by Rangvid (2001) may be due to an increasing sample size over time. Pascual (2003), by conducting a rolling cointegration test with a fixed sample size and report, reports no evidence of increasing cointegration among the markets.

Another school of thought in the research literature focuses on the linkages between international market indices, which includes tests on the correlation, lead-lag and volatility transmissions between markets. However, most of the efforts in this area focus on static integration. Only a few have placed significant emphasis on the dynamics of integration over time. Among these, Fraser, Helliar and Power (1994), Serletis and King (1997) and Manning (2002) imply the methodology proposed by Haldane and Hall (1991) for measuring the convergence of European equity markets. In testing for integration, an external market (to which the markets under study are assumed to be converging) and a dominant local market need to be identified. The principle involved in this approach is that the coefficient of the model should approach zero if convergence with a local market has occurred. Bekaert and Harvey (1995) were perhaps the first to explicitly model time variation in expected stock returns induced by a changing covariance with a single world factor. However, they assumed that the markets were perfectly integrated, perfectly segmented or partially integrated, although the extent of integration was constant over time.

There are some empirical studies that recognise that coefficients of asset pricing models should change over time; these studies employ rolling regression to fix this problem. Rolling regression is a very common method among practitioners in producing time-varying coefficients. The rolling window that covers a period of five years using monthly data is the most frequently used

[2] Kasa (1992) is one of the pioneers in using Johansen's (1988) multivariate technique to study long-run relationships among the major developed markets, i.e., the US, UK, Japan, Canada and Germany markets. By using similar methodologies, Chou, Ng and Pi (1994) found evidence of increased integration in the latter period under study for G7 countries, and Hung and Cheung (1995) provide similar findings for the Asian markets. In addition, de Fusco, Geppert and Tsetsekos (1996) found that no cointegrating vectors exist among emerging markets like Korea, the Philippines, Taiwan, Malaysia and Thailand over the time period from 1989 to 1993; a weak cointegration result is also highlighted in a later study by Click and Plummer (2005). For the ASEAN-5 stock market, Janor, Ali and Shaharudin (2007) found that these stock markets are both regionally and globally integrated. In short, there is hardly a consensus on market integration using the cointegration approach.

window size. Korajczyk (1996), Franzoni (2001) and Hooy and Goh (2006) are among the researchers that have used rolling regression to produce time-varying coefficients. However, there are few points that should be highlighted in the suitability of the use of rolling regression. First, rolling regression is considered an unconditional technique because the coefficients are assumed to be constant over a fixed window period that moves forward month by month. In reality, the market integration level may change substantially over a shorter period of time, and it is essential that the new information is used to update the coefficients. Furthermore, by employing Ordinary Least Square (OLS) rolling regression, one single abnormal observation in the series will affect the estimated coefficients over the entire window length. In other words, if the data are rolled for a period of five years, one abnormal observation will have the same distorting impact on all five years of the estimated coefficients.

METHODOLOGY

The Measure for Market Integration

The Capital Asset Pricing Model (CAPM), largely due to the work of Sharpe (1964) and Lintner (1965), has become a standard model in finance. The CAPM postulates a stable linear relationship between the expected excess return and the non-diversifiable risk of holding a financial asset. Under the hypothesis of stock market integration, the domestic CAPM has been extended to international settings, and a single factor international CAPM (ICAPM) can be written as

$$R_{i,t} - R_{F,t} = \alpha_i + \beta_i (R_{W,t} - R_{F,t}) + \varepsilon_{i,t} \qquad t = 1, 2, ..., N \tag{1}$$

where $R_{i,t}$, $R_{F,t}$ and $R_{W,t}$ refer to the returns for the market portfolio, world portfolio and international risk free rate, respectively; t represents the time period with sample size N; i refers to the stock markets being studied and $\varepsilon_{i,t}$ is the residual. The above mentioned ICAPM assumes that the purchasing power parity holds, that is, an environment where investors bear no currency risk and the risk-return relationship is unaffected by the choice of the reference currency.

While the intercept term of the CAPM is often used as a measure to asses the stock selection skills and market timing abilities at mutual fund managers; for examples see Abdullah and Abdullah (2009) and Prather, Bertin and Henker (2004), the intercept term may also be used to examine the intergration level of stock markets. In essence, according to Korajczyk (1996) and Levine and Zervos (1998), if a stock market is perfectly integrated with the world, then the intercept

(α_i) that represents the pricing error should be equal to zero. Levine and Zervos (1998) proposed that the estimates of stock market integration can be represented by the absolute value of α_i and multiply this value with negative one. In other words, the adjusted market integration index can be expressed as

$$MII_i = -\left|\hat{\alpha}_i\right|. \tag{2}$$

This index is designed to be positively correlated with the degree of market integration. The index can take any value with the upper bound equal to zero, and a zero index is interpreted as stock market *i* that is perfectly integrated with the world market.

OLS estimation of Equation (1) is straightforward; in practice, however, it is unreasonable to allow the level of integration to be constant as the risk is usually found to vary over time. The estimation of the ICAPM coefficients using the OLS regression may be less desirable from economic and financial points of view, which limits researchers in matching the levels of market integration with the economic or financial events that have taken place over the same period. In this study, we employed a time-varying coefficient technique to capture the time-varying market integration process.

Estimating Time-Varying Integration with the Kalman Filter Technique

The Kalman Filter technique allows for the estimation of both a time-varying intercept and a coefficient of ICAPM. It is a recursive procedure that progresses through the data and yields at each time t a minimum mean-square linear estimate of the state variables and a covariance matrix of the estimate. The Kalman Filter approach makes use of a state space model of ($N \times 1$) vector of Y_t as a function of X_t, which is expressed by the following system of equations:

$$Y_t = \alpha_t + \beta_t X_t + \varepsilon_t \quad t = 1, 2, ..., N \tag{3}$$

$$\alpha_t = \alpha_{t-1} + n_t \tag{4}$$

$$\beta_t = \beta_{t-1} + v_t \tag{5}$$

Equation (3) is known as the observation equation, while Equation (4) and Equation (5) are called state equations. The equations above can be rewritten in vector form as

$$Y_t = \delta' Z_t + \varepsilon_t \tag{6}$$

$$Z_t = AZ_{t-1} + w_t \, , \tag{7}$$

Where Z_t is a vector of time-varying parameters (α_t, β_t), δ is a vector of the constant and A is an identity matrix. The ε_t and w_t are error terms that are assumed to be independently distributed as

$$\varepsilon_t \sim IID(0,\sigma^2) \text{ and } w_t \sim IID(0,Q) \, . \tag{8}$$

From Equations (4) and (5), it can be noted that both α_t and β_t are allowed to vary over time according to a random walk process. The random walk model is quite general in nature because it covers a large number of time paths of gradual coefficient variation reasonably well. It also allows a gradual level shift in the parameters.[3] In this model, there are three unknown parameters (hyperparameters) that must be estimated: the diagonal elements of Q and the variance of the observation equation, σ^2.

The Kalman Filter equations are obtained by defining Z_t as the vector of the state variables at time t and P_t as the covariance matrix of the state vector. Besides that, $Z_{t|t-1}$ is the best estimate of Z_t based on information up to time t–1, while $P_{t|t-1}$ is the covariance matrix of $Z_{t|t-1}$. The prediction equations are expressed as

$$Z_{t|t-1} = AZ_{t-1} \tag{9}$$

$$P_{t|t-1} = AP_{t-1}A' + Q \, . \tag{10}$$

In Equation (9), the one-step-ahead prediction of the state is formed by taking the last known value of the variables and multiplying it by the transition matrix A. Similarly, the estimate of the covariance matrix of the state prediction in Equation (10) also utilises past data. By having the two estimates above, the one-step-ahead prediction error, e_t, and its covariance, f_t, can be calculated as below:

---

[3] Well (1994) shows the random walk model to be superior to alternative specifications such as $Z_t = \overline{Z}_{t-1} + w_t$ in which the coefficients are restricted to some mean values denoted by Z; hence, the model does not allow for any level shifts.

$$e_t = Y_t - \delta' Z_{t|t-1} \tag{11}$$

$$f_t = \delta P_{t|t-1} \delta' + \sigma^2 . \tag{12}$$

The e_t contains new information about Z_t beyond that contained in $Z_{t|t-1}$. Therefore, after observing Y_t, the one-step-ahead of the state may be improved by incorporating this new information. The updated equations for the estimates of the state and its covariance matrix are expressed as

$$Z_t = Z_{t|t-1} + P_{t|t-1} \delta' f_t^{-1} e_t \tag{13}$$

$$P_t = P_{t|t-1} - P_{t|t-1} \delta' f_t^{-1} \delta P_{t|t-1} \; . \tag{14}$$

Then the process returns to Equation (9) for the next iteration.

From the discussion above, it can been seen that the hyperparameters of Equation (8) are unknown and thus need to be estimated. Under the assumption that ε_t and w_t are normally distributed, the sample log likelihood can be expressed as below to estimate the unknown parameters of the system equations:

$$\log L = -\frac{nT}{2} \log 2\pi \sum_{t=1}^{T} \log | f_t | - \frac{1}{2} \sum_{t=1}^{T} e_t ' f_t^{-1} e_t . \tag{15}$$

The likelihood is evaluated using the Kalman Filter estimates and must be maximised with respect to the unknown parameters.

By employing the Kalman Filter methodology mentioned above, the time-invariant ICAPM of Equation (1) can be expressed as a time-varying ICAPM, as follows:

$$R_{i,t} - R_{F,t} = \alpha_{i,t} + \beta_{i,t} (R_{W,t} - R_{F,t}) + \varepsilon_{i,t} . \tag{16}$$

Hence, the static *MII* of Equation (2) attempts to be expressed via time-series behavior as

$$MII_{i,t} = - \left| \hat{\alpha}_{i,t} \right| . \tag{17}$$

As can be seen in Section 4.2, the Kalman Filter technique that allows for time-varying integration is more economically tractable. The estimated time-varying market integration allows one to match data to the changing economic environment in both the domestic and international financial markets.

DATA

The data employed in this study are the weekly indices for the Malaysian stock market from Morgan Stanley Capital International (MSCI). The MSCI All-Country World Index is used as a proxy for the global portfolio, and the weekly yields on the US three-month treasury bill rate are used as the international risk free rate. These series are in common currency, that is, the US dollar, to alleviate any exchange rate noise. The data covered a time period between February 1988 and September 2009. The weekly returns are calculated from Wednesday to Wednesday to avoid any contaminating effects from Mondays and weekends, as mentioned by Bartholdy and Peare (2005). The compounded returns of the indices, R_t, is calculated as follows:

$$R_t = \log\left({CP_t}/{CP_{t-1}} \right) \times 100 \tag{16}$$

where CP_t is the Wednesday closing price on week t.

RESULTS AND DISCUSSION

Descriptive Statistics and Unit Root tests

Table 1 summarises some statistical properties for the returns for the Malaysian and world stock markets. From Table 1, it can be noted that the mean returns for Malaysia are slightly higher than the returns for the world market. However, the standard deviation that measures the risk of a stock market shows that the risk for Malaysia is about two times higher than that of the world market. This is no surprise because the emerging market is expected to be more unstable and volatile compared to the world market, which includes the developed stock markets. Furthermore, the difference between the minimum and maximum values of the returns for the Malaysian stock market is much larger than that of the world market. On top of that, both Malaysian and global returns show a negative sign of skewness, indicating that the return series are skewed to the left; therefore, the probability of obtaining a profit in each trading week is higher. The kurtosis values for both series are larger than the value for the normal distribution of three, suggesting that the unconditional distribution of the return is not normally distributed. The distributions are leptokurtic relative to the normal distribution.

Table 1
Descriptive Statistics

	Minimum	Maximum	Mean	Std. Dev.	Skewness	Kurtosis
Malaysia	–37.052	29.692	0.103	4.086	–0.720	14.850
World	–17.470	9.033	0.092	2.1697	–0.860	5.580

Prior to modelling the data, the Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) tests were carried out to determine the unit root property of the data. Both tests were performed on the excess returns of the Malaysian portfolio, $R_{i,t} - R_{F,t}$ and excess returns of the world portfolio, $R_{W,t} - R_{F,t}$ because the ICAPM is expressed in term of excess returns. The unit root tests were performed with intercepts and two alternatives of trend assumptions, that is, with and without trend. From the tabulated results in Table 2, it can be noted that the series are stationary due to the rejection of the null hypothesis of unit root at a 5% significant level for both the ADF and PP tests. Thus, the series can be used for subsequent analysis.

Table 2
ADF and PP Unit Root Tests of Excess Returns of the Malaysian and World Portfolios

Series	ADF				PP			
	Lag	Without trend	Lag	Trend	Lag	Without trend	Lag	Trend
$R_{i,t} - R_{F,t}$	12	–8.282[1]	12	–8.284[1]	9	–30.592[1]	9	–30.582[1]
$R_{W,t} - R_{F,t}$	6	–11.913[1]	6	–11.909[1]	12	–32.719[1]	12	–32.705[1]

Note: [1] denotes significance at the 5% level

Estimation of Market Integration

Before we proceed to the time-varying Kalman Filter model, we first estimate the static coefficients from the OLS regression, which could serve as a useful benchmark for the average value of the dynamic time-varying coefficient produced by the Kalman Filter. The result from estimating Equation (1) by OLS is reported in Table 3. It can be noted that the intercept term α is not significantly different from zero at the 5% level. This result implies that the ICAPM is well-specified for the dataset. When converting the data according to the market integration index formula $(MII = -|\hat{\alpha}|)$, the Malaysian stock market is shown to be quite integrated with the world markets, with the converted *MII* value equalling –0.0156. However, this time-invariant assumption might be invalid as the risk premium of equities is indeed time-varying, and therefore, the degree of market integration will also be time-varying in nature.

Table 3
Results from the Ordinary Least Square estimation

Variable	Coefficient	*t*-Statistic
α [1]	0.0156	0.1364 (0.1145)
$R_{W,t} - R_{F,t}$	0.6348	12.0222[2] (0.0528)

Notes: [1] the value of *MII* is given by $-\left|\alpha\right|$, that is, –0.0156
[2] denotes significance at the 5% level; standard errors are given in parentheses

We proceeded to employ the Kalman Filter approach to examine the time-varying nature of the market integration index. The time-varying coefficient MII_t from the Kalman Filter model is plotted in Figure 1, accompanied by the *MII* value obtained from OLS and the corresponding OLS confidence intervals.[4] From Figure 1, we can see that the OLS confidence intervals fail to indicate the presence of strong variations of the market integration index as suggested by the state-space model. Furthermore, looking at the estimated *MII* from both methods, the value of *MII* from the OLS estimation, i.e., –0.0156, is very different from the average of MII_t, i.e., –0.2940. Hence, it is no surprise that the dynamics of MII_t are not captured by the OLS confidence intervals.

The time-varying MII_t generally fluctuated around zero, except for a distortion during the 1997 to 1998 Asian financial crisis. The state of integration is obviously affected by economic events. In many occasions, the fluctuation of MII_t is quite consistent with the world and regional crises and the chronology of the development of the Malaysian stock market. In the subsequent discussion, we provide a detailed analysis of the consistency of the dynamics of MII_t with the development of Bursa Malaysia over the last two decades.

[4] In line with Brooks, Faff and Mckenzie (1998) and Hearn (in press), the first two years of the estimated *MII* values were not taken into consideration in the results that are reported in this paper due to the nature of the Kalman Filter approach that generates a very large (and some cases negative) estimation at the initial stages. The exclusion of first two year estimations can avoid any biases due to this start-up problem.

The Chronology of Market Integration

The liberalisation of the early 1990s

It is obvious that the values of *MII* have an increasing trend from 1990 to 1992. This result indicates that the Malaysian equity market was becoming more integrated with the world market during this period, which was actually the starting point of stock market liberalisation in Malaysia. In the past, Malaysia has been reluctant to relax foreign ownership restrictions in the financial sector. However, with the view that opening the financial sector to foreign institutions will introduce international standards of best practices and also increase competitiveness, Malaysia gradually recognised the importance of opening up the domestic financial sector to foreign competition.

In the late 1980s to 1990, the Malaysian government took some action to reform the capital markets. Their initiations included easing the entry barriers to the brokering activities of foreign institutions, increasing the number of mutual funds and allowing foreign stock brokerage firms to increase their equity share in local brokerage firms from 30% to 49%. On top of that, in March 1991, Malaysia issued RM190 million in bonds that were convertible into shares of state-owned communications firms. This action marked the first placement of a convertible sovereign bond in the international market. Additionally, a Malaysias fund was launched on the New York Stock Exchange (NYSE) in December 1987, with a net asset value of USD98.3 million in December 1991. These factors may explain the fast integration of the Malaysian equity market with the world market in this early period.

The capital control in 1994

Starting from January of 1994, the Malaysian government adopted some capital control measures to curb short-term capital inflows. The government announced that residents were prohibited from selling certain kinds of Malaysian securities to nonresidents. Examples of these instruments were negotiable instruments of deposit, Bank Negara bills, Malaysian government treasury bills and Malaysian government securities with a remaining maturity of one year or less. Furthermore, in February of 1994, British firms were prevented from participating in public sector contract bidding, and residents were prohibited from selling any form of private debt securities with a remaining maturity of one year or less to non-residents. The restrictions on the sale of Malaysian securities to nonresidents were extended to both the initial issue of the relevant security and the subsequent secondary market trade. Figure 1 shows that the *MII* started to decrease even before the announcement of capital control measures and achieved its lowest point when such controls started to be implemented in January of 1994.

The restriction on the sale of Malaysian securities was lifted and residents were permitted to sell any Malaysian securities to non-residents in August of 1994. In addition, the Malaysian cabinet lifted its seven-month ban preventing British firms from participating in public sector contract bidding. As expected, the degree of integration of the Malaysian market with the world market increased after this abolition of capital inflow. According to the model, the Malaysian market began to be particularly integrated with world market from February of 1995 to April of 1997, as the *MII* is close to zero during this time period.

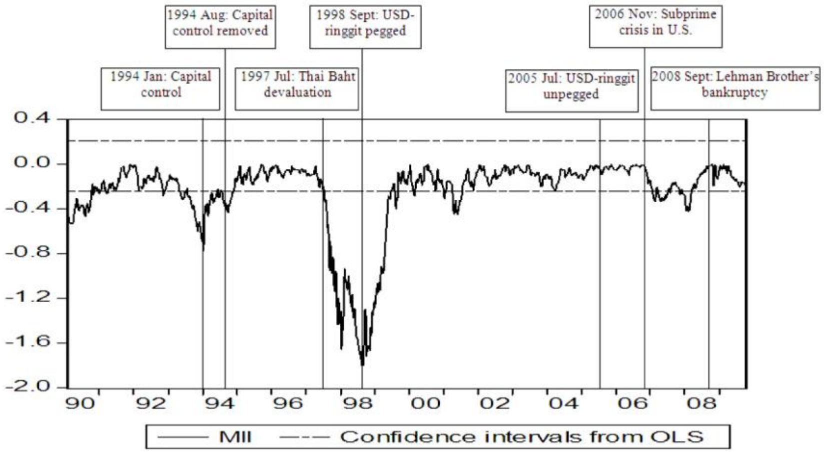

Figure 1. Time-varying Market Integration Index using the Kalman Filter Approach and Confidence Intervals of OLS estimation.[5]

Asian financial crisis in the late 1990s

In May of 1997, speculators attacked the Thai Baht, and the devaluation of the Thai Baht on July 2, 1997, set off a massive meltdown of the foreign currency markets in the region. The exchange rate crisis led to the collapse of the stock markets in the ASEAN 5, Korea, Japan and Hong Kong. The foreign direct investment (FDI) in Malaysia fell at an alarming rate, and the ringgit depreciated substantially from MYR 2.50 per USD to a much lower level (up to MYR 4.80 per USD at its lowest point) as significant capital flowed out. Although the Asian crisis spilled into the global market as well, the extent of vulnerability for the rest of the world was much lower compared to the eight aforementioned countries most affected by the crisis. This explains why the Malaysian stock market was significantly segmented from the world market from July of 1997 to August of

[5] At a 95% confidence level, the OLS confidence intervals are written as (*MII* $\pm$ 1.96* standard error). Hence, the OLS confidence intervals in Figure 1 are given by: OLS CI = (–0.0156 $\pm$ 1.96*0.1145) = (–0.2400, 0.2088)

1998. The level of integration of Malaysia to world markets tumbled to an all-time low in August of 1998.

On September 1, 1998, the exchange rate of the ringgit to the US dollar was fixed at 3.8 RM/USD, and a wide range of currency and capital controls were instituted. Foreign investors were prohibited from withdrawing funds from Malaysia for a one-year period starting in September of 1998. However, they were allowed to withdraw starting from mid-February of 1999 after paying a scaled exit tax that favoured long-term investors. The capital control measures have contributed to the recovery of the stock market. Many foreign portfolio investors were attracted to Malaysia by these very capital controls, although they may once have condemned them soon after they were first introduced in September of 1998. From the foreign investors' point of view, Malaysia offers a portfolio investment haven that is relatively sheltered from the volatility of global capital markets. Additionally, foreigners locked in until September 1, 1999, have withdrawn their funds from the banks that offered low interest rates to take advantage of the stock market's upturn after the great depth to which the Malaysian stock market fell during the Asian financial crisis. This clarifies why the *MII* rose sharply after the ringgit was pegged against the US dollar.

Post Asian financial crisis era and the world financial crisis of the late 2000s

According to the statistics in Masud et al. (2008), Malaysia remained a favourable economy to foreign investors as implied by the FDI position that grew from MYR129.1 billion in 2001 to MYR253.8 in 2007. The continuous reinvestment, as well as new capital injection among the existing foreign companies, indicated their confidence in the investment climate of Malaysia. It can be noted that the abandonment of the fixed exchange rate regime in July 2005 did not have any obvious impact on the level of integration. The US market experienced a subprime crisis at the end of 2006 and 2007, and the crisis started to spread to the developed European countries. During that period, the financial markets in Malaysia were less affected due to the small direct exposure to the subprime-related markets. Therefore, the *MII* in 2007 was slightly lower compared to the previous year.

However, the downside pressures on the US economy and further downturns in the US housing sector have started to develop into global economic shocks. The rising uncertainty and concerns over the problems in the global financial markets and the health of the global economy led to increased volatility in the regional equity markets, especially towards the end of the year. Starting from January of 2008, the increase in *MII* towards zero indicates Malaysia's high degree of integration with the world markets. Malaysia, as an emerging country, is inevitably influenced by this global crisis. This phenomenon is very different from the 1997/98 Asian financial crisis, in which the Malaysian stock market was obviously segmented from the world market during the crisis.

CONCLUSION

This study examines the degree of stock market integration of the Malaysian stock market with the world markets over the time period ranging from February 1988 to September 2009. The time-varying Kalman Filter technique was employed to capture the dynamic degree of the stock market integration. Unlike prior studies that only showed the degree of integration among countries that changes over time, this paper attempted to explain the varying degrees of integration with the economic events that have taken place. Generally, the findings show that the capital reform and capital control measures that were imposed by the Malaysian government have affected the levels of integration of the Malaysian stock market with the global market. Furthermore, the results show that the Malaysian stock market was segmented from the world market during the 1997 to 1998 Asian financial crisis but is now more closely integrated with the world market during a time of global crisis.

ACKNOWLEDGMENT

We are grateful for the financial support from Universiti Sains Malaysia Fellowship and the Research University Postgraduate Research Grant (Grant number: 1001/PMATHS/832059).

REFERENCES

Abdullah, N. A., & Abdullah, N. A. H. (2009). The performance of Malaysian Unit Trust investing in domestic versus international markets. *Asian Academy of Management Journal of Accounting and Finance, 5*(2), 77–100.

Adam, K., Jappelli, T., Menichini, A., Padula, M. & Pagano, M. (2002). *Analyse, compare, and apply alternative indicators and monitoring methodologies to measure the evolution of capital market integration in the European Union*. Italy: University of Salerno.

Baele, L., Ferrando, A., Hordahl, P., Krylova, E. & Monnet, C. (2004). Measuring financial integration in the Euro Area. *European Central Bank Occasional Paper*, no. 14. Frankfurt am Main: European Central Bank.

Bartholdy, J., & Peare, P. (2005). Estimation of expected return: CAPM vs. Fama and French. *International Review of Financial Analysis*, *14*(4), 407–427.

Bekaert, G., & Harvey, C. R. (1995). Time varying world market integration. *Journal of Finance*, *50*(2), 403–444.

Brooks, R. D., Faff, R. W., & Mckenzie, M. D. (1998). Time-varying beta risk of Australian industry portfolios: A comparison of modeling techniques. *Australian Journal of Management*, *23*(1), 1–22.

Chou, R., Ng, V., & Pi, L. (1994). *Cointegration of International stock market indices* (IMF Working Papers, no. 94/94). Washington: International Monetary Fund.

Click, R. W., & Plummer, M. G. (2005). Stock market integration in ASEAN after the Asian financial crisis. *Journal of Asian Economics*, *16*(1), 5–28.

de Fusco, R., Geppert, J., & Tsetsekos, G. (1996). Long run diversification potential in emerging stock markets. *The Financial Review*, *31*(2), 343–363.

Franzoni, F. (2006). *Where is Beta Going? The riskiness of value and small stocks* (MIT Working Paper, no. 829). Paris: Les Cahiers de Recherche 829, HEC.

Fraser, P., Helliar , C. V. , & Power, D. M. (1994). An empirical investigation of convergence among European equity markets. *Applied Financial Economics*, *4*(2), 149–157.

Haldane, A., & Hall, S. (1991). Sterling's relationship with the Dollar and the Deutschemark 1976–1989. *Economic Journal*, *101*, 436–443.

Hearn, B. A. (in press). Development strategy in offshore markets: Evidence from the channel islands. *Journal of Economic Studies*.

Hooy, C. W., & Goh, K. L. (2006). Regionalism and stock market integration in International asset pricing. *Chulalongkorn Journal of Economics*, *18*(2), 89–107.

Hung, B., & Cheung, Y. (1995). Interdependence of Asian equity markets. *Journal of Business, Finance and Accounting*, *22*(2), 281–288.

Janor, H., Ali, R., & Shaharudin, R. S. (2007). Financial integration through equity markets and the role of exchange rate: Evidence from ASEAN-5 countries. *Asian Academy of Management Journal of Accounting and Finance*, *3*(1), 77–92.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2&3), 231–254.

Kasa, K. (1992). Common stochastic trends in International stock markets. *Journal of Monetary Economics*, *29*(1), 95–104.

Korajczyk, R. A. (1996). A measure of stock market integration for developed and emerging markets. *World Bank Economic Review*, *10*(2), 267–289.

Levine, R., & Zervos, S. (1998). Stock markets, banks, and economic growth. *American Economic Review*, *88*(3), 537–558.

Lintner J. (1965). The valuation of risky assets and the selection of the risky investments in stock portfolios and capital budget. *Reviews of Economics and Statistics*, *47*(1), 13–37.

Manning, N. (2002). Common trends and convergence? South East Asian equity markets, 1988–1999. *Journal of International Money and Finance*, *21*(2), 183–202.

Masud, M. R., Yusoff, Z. M., Hamid, H. A., & Yahya, N. (2008). Foreign Direct Investment in Malaysia – Findings of the quarterly survey of International Investment and Services. *Journal of the Department of Statistics, Malaysia*, 1, 1–9.

Pascual, A. G. (2003). Assessing European stock markets (Co) integration. *Economics Letters*, *78*(2), 197–203.

Prather, L., Bertin, W. J., & Henker, T. (2004). Mutual fund characteristics, managerial attributes and fund performance. *Review of Financial Economics*, *13*(4), 305–326.

Rangvid, J. (2001). Increasing convergence among European stock markets? A recursive common stochastic trends analysis. *Economics Letters*, *71*(3), 383–389.

Serletis, A., & King, M. (1997). Common stochastic trends and convergence of European Union stock markets. *The Manchester School*, *65*(1), 44–57.

Sharpe, W. (1964). Capital asset prices: A Theory of market equilibrium under conditions of risk. *Journal of Finance*, *19*(3), 425–442.

Well, C. (1994). Variable betas on the Stockholm exchange 1971–1989. *Applied Economics*, *4*, 75–92.

World Federation of Exchanges (2009). Retrieve December 4, 2009, from http://www.world-exchanges.org/statistics.