Regional Stock Market Integration in Singapore: A Multivariate Analysis

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Regional Stock Market Integration in Singapore: A Multivariate Analysis

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Abstract
This paper evaluates the time-varying integration of the Singapore stock market in the ASEAN-5 region based on a conditional version of the International Capital Asset Pricing Model (ICAPM) with c-DCC-FIAPARCH parameters. This model allows for dynamic changes in the degree of market integration, regional market risk premium, regional exchange-rate risk premium, and domestic market risk premium. Our findings show several interesting facts. First, the time-varying degree of integration in the Singapore market is satisfactorily explained by the level of trade openness and the term premium of US interest rates, which have recently tended to increase, however these markets remain substantially segmented from the world market. Second, the local market risk premium is found to explain a significant proportion of the total risk premium for emerging market returns. Our findings illustrate several important implications for portfolio hedgers for making optimal portfolio allocations, engaging in risk management and forecasting future volatility in equity markets. Our results are also of interest for both policymakers and investors, with respect to regional development policies and dedicated portfolio investment strategies in the ASEAN-5 region.

JEL classification: C32, F36, G11.
Keywords: time-varying integration, emerging markets, ICAPM, risk premium, c-DCC-FIAPARCH.

1. Introduction
Over the last 10 years, emergent capital markets have attracted substantial capital flows in the context of relaxation of foreign investment restrictions. The integration of the emerging markets of Asia in global finance has become an important element in the overall portfolio decision. We investigate the issue through a longitudinal study of a single stock market. Singapore is one of the countries with greater political stability in Asia, but this economy has been shaken by the turbulence associated with sharp increases in the prices of oil and raw materials and the financial turmoil from the subprime crisis triggered by the mortgage market in the United States.
Within the limits of defining integration as the weight of the South Asia factor premium in emerging markets members’ expected returns, we argue that integration in general is influenced by regional as much as by local events and does not necessarily start immediately after local capital markets are liberalised.

Our study differs from previous contributions in that we test the hypothesis of the time-varying regional integration of Singapore in the ASEAN-5 region (Indonesia, Malaysia, Thailand, Philippines and Singapore). The international asset-pricing model we use is built so that it characterizes the changes in market integration through time owing to the impacts of the gradual removal of direct and indirect barriers to emerging market investments. We also examine the proportions of the returns explained by regional and domestic risk factors, by carrying out a decomposition of the total risk premium.

This paper contributes to the existing literature by developing a dynamic international capital asset pricing model (ICAPM) that allows for the smooth transition between different integration regimes. Specifically, expected returns may move from a perfectly-segmented regime to a perfectly-integrated one, or vice versa, depending on a certain number of national and regional factors that are likely to drive the process of regional integration. Although the proposed model was developed in the spirit of that presented by Bekaert and Harvey (1995), it allows for dynamic conditional correlations between stock returns by using the multivariate corrected Dynamic Conditional Correlation Fractionally integrated (c-DCC-FIAPARCH) model of Engle (2002). It also enables an examination of the relevance of the dynamic measure of financial integration over risk premiums, very frequently used in the literature when referring to the level of integration. Lastly, our study differs from past studies in that we investigate the integration of the Singapore market into the regional market by using an actual real effective exchange rate (REER) index as a common source of risk, in addition to regional and national sources of risk.

The remainder of the article is organised as follows. Section 2 presents a review of the literature on financial integration in emerging markets. Section 3 presents the asset-pricing model and methodology used to test it. Section 4 presents and discusses the results obtained. Section 5 provides concluding remarks.

2. Review of the literature

The literature on the integration of emerging countries in global finance has become abundant since these countries have dismantled some of the regulations that prevented the flow of capital. International Capital Asset Pricing models can be differentiated according to the type of risk considered in the price of expected returns: namely models of segmented markets, integrated market models and partially segmented market models:

i) Models of market segmentation evaluate expected equity returns as a function of only the country-specific risk represented by stock returns variance. This is the approach taken by Sharpe (1964), Lintner (1965) and Black (1972) for a single country;

ii) Integrated market models assume that the international financial market is fully globalised and thus that the conceptualisation of risk is from the covariance of local stock market returns...
with the world market portfolio. This corresponds to the classical models of Solnik (1983) and Bekaert and Hodrick (1992);

iii) An alternative asset pricing model provides a framework in which the polar segmented/integrated cases are replaced by a mild segmentation pricing structure. Thus in the models of Errunza and Losq (1985) and Errunza, Losq, and Padmanabhan (1992) access to the various asset classes is not equal for two types of investors: investors that are not subject to legal restrictions on holding assets have access to all securities, while investors subject to reference restrictions are able to conduct transactions on only a subset of assets. Their empirical results show that emerging markets are neither strictly segmented nor perfectly integrated.

2.1. The canonical model of Bekaert and Harvey

Bekaert and Harvey (1995) consider a one-factor asset-pricing model that allows the conditional expected returns of a country to be affected by their covariance with a world benchmark portfolio and by the variance of country returns. If the market is perfectly integrated then only the covariance counted; while if the market is completely segmented then variance is a relevant measure of market risk. These authors use a conditional regime-switching model to account for periods when national markets are segmented from the global capital market and when they become integrated in other periods. This analysis was borrowed by De Santis and Imrohoroglu (1997).

In the spirit of the current literature following the model of Bekaert and Harvey (1995), Adler and Qi (2003) investigate the evolution of the process of integration between the Mexican and North American equity markets between 1991 and 2002. They use a model that combines the domestic and international versions of the capital asset pricing model. This model tests the power of local factors relative to that of common factors to explain expected returns and empirically infer segmentation when the weight of the local factors is high. They show that the degree of market integration is higher at the end of the period than it is at the beginning but that it exhibits wide swings related to both global and local events. They also discover that Mexico’s currency risk is priced. Further, the currency returns process shows strongly significant asymmetric volatility that is strongly related to the asymmetric volatility of the Mexican equity market returns process.

Guesmi and Nguyen (2012) extend the model of Bekaert and Harvey (1995) to evaluate the dynamics of the global integration process of four emerging market regions (Latin America, Asia, Southeastern Europe, and the Middle East) into the world market based on a conditional version of the ICAPM. Their results show that the integration degree in these four emerging market regions varied widely over the period 1996–2008, because of regional factors.

2.2. Extensions

Carrieri et al. (2007) generalise the model of Errunza and Losq (1985) to assess the integration levels of eight emerging markets using an aggregated measure of financial asset substitution over the period 1977–2000. The results obtained indicate that local pricing continues to be relevant in the valuation of emerging market assets, but that none of the markets considered is completely segmented from the world market.
In a different way, Claessens and Rhee (1994) apply the methodological procedure of Stehle (1977) to study the risk-/return linkages in 16 emerging markets. Their empirical evidence contradicts the hypothesis of integration in most markets, whereas the segmentation hypothesis cannot be rejected in any of the markets.

Phylaktis and Ravazzolo (2002) derive the covariance of excess returns on the stock market for 1980 and 1998 using Asset Pricing Models. They establish expressions for the excess returns of local and foreign stock markets as a function of the real interest rate, dividends paid and other variables such as lagged returns and the exchange rate. These expressions find the determinants of returns in each country. The next step is to derive the variances and covariances of excess returns. The principal idea is to find variables that help explain movements in stock markets. The countries included in the sample are Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand. The authors find that variations in dividends paid are a significant source of variance in stock returns. An interesting result that arises is that co-movements in output growth are directly related to stock prices, indicating a connection between real and financial sectors. The paper also unearths a close connection between Thailand and the US and a high degree of integration between Korea, Taiwan and Japan.

Berger and Pozzi (2013) suggest a measure of financial integration based on the conditional variances of country-specific and common international risk premiums in equity excess returns. The inspection of the time profile of the proposed measure of integration for Germany, France, the UK, the US, and Japan over the period 1970–2011 show that all countries exhibit several shorter periods of disintegration. The authors conclude that stock market integration is measured as a dynamic process that fluctuates in the short run while gradually increasing in the long run.

### 3. Model and econometric specification

#### 3.1. The model

The model of Bekaert and Harvey (1995) is the point of departure of our methodology. This model combines the domestic and international versions of the ICAPM. It tests the power of domestic factors relative to that of common factors to explain expected returns and empirically infers segmentation when the weight of the domestic factors is high. In this paper we use a conditional version of the International Capital Asset Pricing Model (ICAPM) with multivariate cDCC-FIAPARCH parameters. The advantage of the DCC-FIAPARCH technique is that it allows for dynamic changes in the degree of market integration and risk premium. This framework incorporates the features of asymmetries and persistence, typically observed in stock markets. This choice has the following advantages: (i) it nests other GARCH processes that exist in the literature; and (ii) it is relatively parsimonious compared with other multivariate models.

De Santis et al. (2003), Carrieri et al. (2007) and Tai (2007) all find evidence to support the partial integration hypothesis and time-varying world market integration for most individual markets. Exchange rate risk is also found to be priced in the context of both developed and emerging markets. In this study, we also adopt a partially integrated conditional ICAPM with three sources of systematic risk that globally reflect fluctuations in regional stock markets, national stock markets and exchange rates.
Our model is expressed as:

\[
E_{t-1}(R_{\text{Singapore}} / \pi_{t-1}) = \Theta_{t-1} \left[ \eta_{\text{reg},t-1} \text{Cov}(R_{\text{Singapore}}, R_{\text{reg},t} / \pi_{t-1}) + \sum_{k=1}^{l} \eta_{k,t-1} \text{Cov}(R_{\text{Singapore}}, R_{k,t} / \pi_{t-1}) \right] \\
+ (1-\Theta_{t-1}) \text{Var}(R_{\text{Singapore}} / \pi_{t-1})
\]  

(1)

The notation should be interpreted as follows:

\[ R_{\text{Singapore},t}, R_{\text{reg},t}, \text{ and } R_{k,t} \] are respectively expected excess returns on the local market portfolio, the excess return on \text{ASEAN-5 region (ASEAN + Australia, Korea, China, India and Japan)} and the rate of return on the real exchange rate index. Any investment in a foreign asset is a combination of an investment in the performance of the foreign asset and an investment in the performance of the domestic currency relative to the foreign currency. \[ R_{k,t} \] corresponds to the geometric weighted average of the real exchange rates for the states comprising a region, where the weights are the share of each country in the foreign trade with the rest of the world.

\[ \pi_{t-1} \] is the available information to investors up to time \( t-1 \).

\[ \eta_{\text{reg},t-1}, \eta_{k,t-1}, \text{ and } \eta_{i,t-1} \] denote respectively the expected prices of a unit of risk, related to the regional market, the local market and the currency risk, respectively.

\[ \Theta_{t-1} \] is the conditional probability of transition between segmentation and integration states, which falls within the interval \([0,1]\) and can be thus interpreted as a conditional measure of integration of market \( i \) into the regional one.

At the empirical stage, the pricing formula in Equation (1) will be simultaneously estimated for the regional market, Currency return and for Singaporean market. That is, we have a system of equations where the expected return on the regional market portfolio is given by:

\[
E_{t-1}(R_{\text{reg},t} / \pi_{t-1}) = \eta_{\text{reg},t-1} \text{Var}(R_{\text{reg},t} / \pi_{t-1}) + \eta_{k,t-1} \text{Cov}(R_{\text{Singapore},t}, R_{k,t} / \pi_{t-1})
\]  

(2)

The rate of return on the real exchange rate index is expressed as follows:

\[
E_{t-1}(R_{k,t} / \pi_{t-1}) = \eta_{\text{reg},t-1} \text{Var}(R_{k,t} / \pi_{t-1}) + \eta_{k,t-1} \text{Cov}(R_{\text{reg},t}, R_{k,t} / \pi_{t-1})
\]  

(3)

Specifically the evolution of the conditional prices of risk are expressed as:

\[
\begin{aligned}
\eta_{\text{reg},t-1} &= \text{Exp}(\delta_{\text{reg}}' G_{t-1}) \\
\eta_{i,t-1} &= \text{Exp}(\gamma_i' D_{t-1}) \\
\eta_{k,t-1} &= \text{Exp}(\delta_k' G_{t-1}) \\
\Theta_{t-1} &= \text{Exp}(-\alpha' F_{t-1})
\end{aligned}
\]  

(4)

with \( G_{t-1} \) (regional information variables), \( D_{t-1} \) (local information variables) and \( F_{t-1} \) (integration variables)
denote three vectors available at time \( t \). The degree of integration of region \( i \) into the regional market, \( \Theta_{i,t-1} \), is modeled by using an exponential function in system (4) satisfies the condition \( 0 \leq \Theta_{i,t-1} \leq 1 \). \( F_{t-1} \) is the vector of information variables available at time \( t-1 \) that are susceptible to drive the integration degree.

### 3.2. Econometric specification

We employ the multivariate generalised autoregressive conditional heteroskedasticity (MGARCH) methodology to estimate the international asset pricing model described by Equations (1), (2), (3) and (4). More specifically, we adopt the multivariate cDCC-FIAPARCH model to gauge the time-variations of the variance-covariance matrix and conditional correlations. The econometric specification of the model to be estimated is characterized by the following system of equations:

\[
\begin{align*}
    r_{\text{Singapore},t} & = \Theta_{1,t-1} \left( \eta_{\text{reg},i,t} h_{\text{Singapore},i} + \eta_{k,i,t} h_{\text{reg},k,i} \right) + (1 - \Theta_{1,t-1}) \eta_{1,t-1} h_{\text{Singapore},i} + \varepsilon_{\text{Singapore},i} \\
    r_{\text{reg},i,t} & = \eta_{\text{reg},i,t} h_{\text{reg},i,t} + \eta_{k,i,t} h_{\text{reg},k,i} + \varepsilon_{\text{reg},i,t} \\
    \varepsilon_{i,t} & = \left( \varepsilon_{\text{Singapore},i,t}, \varepsilon_{\text{reg},i,t}, \varepsilon_{k,i,t} / \Pi_{i,t-1} \right) \sim \mathcal{N}(0, H_{i,t})
\end{align*}
\]

where \( r_{\text{reg},i,t} \), \( r_{\text{Singapore},t} \) and \( \bar{r}_{\text{Singapore},t} \) refer to the vector of excess returns on regional market, exchange rate and local market. These returns are expressed in the currency of reference country in order to compare results across markets.

\( h_{\text{Singapore},reg,t}, h_{\text{Singapore},k,t}, h_{\text{reg},i,t}, h_{\text{reg},k,t} \) and \( h_{\text{reg},k,t} \) are, respectively, the conditional covariance between Singaporean market return and regional market return, the conditional covariance between Singaporean market return and exchange rate \( k \)'s return, the conditional covariance between regional market return and exchange rate \( k \)'s return, the conditional variance of Singaporean market return, the conditional variance of regional market return, and the conditional variance of rate \( k \)'s return, all being issued from the \((3 \times 3)\) variance-covariance matrix \( H_{i,t} \).

\( D_{i,t} = (d_{ij}) \) is a \((3 \times 3)\) diagonal matrix of time-varying standard deviation from univariate FIAPARCH models which generates long memory properties in both the first and the second conditional moments.

In this framework, the conditional variance equation is expressed as a power transformation of the standard deviation and is given formally by:

\[
\begin{align*}
    h_{i,t}^{\delta_i/2} & = \omega_i + \left\{ 1 - \left( 1 - \psi_i \left( L \right) \right)^{-1} \phi_i \left( L \right) \left( 1 - L \right)^{d_i} \right\} \left\{ \left| \varepsilon_{i,t} \right| - \gamma_i \varepsilon_{i,t} \right\}^\delta_i
\end{align*}
\]

\( h_{i,t} \) is the conditional variance of \( x_{i,t} \), \( \omega_i \) is the mean of the process, \( d_i \) is the fractional degree of integration of \( h_{i,t} \) and \( \psi_i \left( L \right) \) and \( \phi_i \left( L \right) \) are lag polynomials of respective orders \( P \) and \( K \). Where \(-1 < \gamma_i < 1 \) and \( \delta_i > 0 \). Here the power term \( \delta_i \) plays the role of a Box-Cox transformation of the conditional standard deviation \( h_{i,t}^{\delta_i/2} \), while \( \gamma_i \) denotes the asymmetry coefficient accounting for the leverage effect.
When $\gamma_i > 0$, negative shocks give rise to higher volatility than positive shocks. The reverse applies if $\gamma_i < 0$; the magnitude of the shocks being captured by the term $\left( C_{i,t} - \gamma_{i,t} \right)$.

The DCC correlation specification as follows:

$$R_t = \text{diag} \left( q_{i1,t}^{-1/2}, \ldots, q_{ik,t}^{-1/2} \right) Q_t \text{ diag} \left( q_{11,t}^{-1/2}, \ldots, q_{kk,t}^{-1/2} \right)$$

where $Q_t = \left( q_{\eta,t} \right)$ is a symmetric positive define matrix. Aielli (2008) proposed the corrected Dynamic Conditional Correlation (cDCC) to evaluate the impact of both the lack of consistency and the existence of bias in the estimated parameters of the DCC model of Engle (2002). In order to resolve this issue, Aielli introduces the cDCC models, which have the same specification as the DCC model of Engle (2002), except of the correlation process $Q_t$ is reformulated as follows:

$$Q_t = \left( 1 - \theta_1 - \theta_2 \right) \bar{Q} + \theta_1 \eta_{t-1}^* \eta_{t-1}^* + \theta_2 Q_{t-1}$$

where $\eta_t^* = \text{diag} \left\{ Q_t \right\}^{1/2} \eta_t$.

The parameters $\theta_1$ and $\theta_2$ are scalar parameters to capture the effects of previous shocks and previous dynamic conditional correlation on current dynamic conditional correlation. $\bar{Q}$ is a $k \times k$ unconditional variance matrix of standardized residuals $\eta_{i,t}$.

The parameters are estimated by maximum likelihood, assuming conditional normally distributed errors. To avoid problems due to non-normality in excess returns, we provide quasi-maximum likelihood (QML) estimates, as proposed by Bollerslev and Wooldridge (1992), which are robust to departures from normality. Given the highly nonlinear structure of the model and the large number of parameters involved in estimation. Following Bekaert and Harvey (1995), Hardouvelis et al. (2006) and Guesmi and Nguyen (2011), we adopt a two-stage procedure to estimate the pricing system (6) since the simultaneous estimation of the full model is not feasible given a large number of unknown parameters. We first estimate a subsystem of equations for excess returns on regional market and real exchange rate indice. This stage allows us to obtain the conditional variance of regional market and real exchange rate indice, their conditional covariances as well as the prices of regional market and exchange rate risk. In the second stage, we estimate the price of local market risk and the time varying level of integration in the system (6) by imposing the estimators obtained from the first stage. Note that by doing so we explicitly maintain the same prices of regional market and exchange rate risk.

Generally, the dynamic ICAPM described above is manifestly subject to critics since it is, just like the traditional CAPM, built on a set of strong assumptions that do not reflect the real region where investment decisions are made by companies and individuals. Among these assumptions, the most questionable ones are the existence of a market portfolio and of a perfect capital market. The former requires the market index to be a good proxy of the “true” market portfolio, while the latter means that assets are correctly valued by investors. Both conditions are indeed not verified in the empirical implementation of the model since the market index.
only reflects a small proportion of available securities and there often exist trading costs, taxes, and asymmetric information. Meanwhile our model is flexible enough to capture the stylised facts of stock returns in ASEAN-5 markets as indicated by the diagnostic tests on the standardised residuals and has a practical interest in the estimation of the cost of capital in partially integrated markets. A similar model was implemented in Hardouvelis et al. (2006) and found to successfully account for the effects of the economic and monetary union on the financial integration of European countries. This shows, in particular, that the launch of a single currency leads to higher stock market integration, which in turn results in a reduction in the equity cost of capital. Further, for a particular country experiencing an increase in its degree of financial integration the country-specific effects on the determination of equity risk premia are becoming less important.

4. Data and results

This study investigates the regional integration process of the Singapore stock market. Monthly data are collected for the stock market index, regional stock market index, and REER index over the period from March 31, 1996 to March 31, 2010.

4.1 Stock market return

Returns on the regional market and on the Singapore index are computed by taking the difference in logarithm between two consecutive index prices. All returns are expressed in US dollars and are converted into excess returns by subtracting the one-month Eurodollar interest rate, taken as the risk-free rate in our study. The Eurodollar rate is obtained from Datastream International database.

4.2 REER indices

We use REER indices to represent exchange rate risk since variations in the inflation rates of emerging countries are much more significant in comparison to those in exchange rates. For the ASEAN-5 region, the REER index is measured as the geometric weighted average of all individual countries’ exchange rates against the US dollar, where the weights are the share of each country in foreign trade with the rest of the world. These indices are calculated monthly by using exchange rate and trade data from Datastream International, the Federal Reserve Bank of St Louis, and the IMF’s International Financial Statistics. Their returns are computed by taking the difference in logarithm between two consecutive index values. By construction, the REER index also allows for cross-country comparisons of changes in trade competitiveness.

4.3 Regional and local information variables

Regional instrumental variables are used to explain changes in the prices of regional market and foreign exchange risks. Following Hardouvelis et al. (2006) and Carrieri et al. (2007), we employ the following variables: the dividend yield of the region in excess of the 30-day Eurodollar interest rate (RIDY), the returns on the regional market index (RRENT) and the region term premium (RPRM).

As local instrumental variables, we consider the dividend yield of a market portfolio (DDIV), the return on the stock market index in excess of the 30-day Eurodollar interest rate (RSRI), and the variation in the inflation rate
(DINF). Data on these information variables are obtained from MSCI and the IMF’s International Financial Statistics databases.

4.4 Instruments for the dynamic measure of financial integration

Fluctuations in the regional stock market constitute a source of systematic risk in the context of an ICAPM model with partial integration. Theory suggests that this risk is relevant and priced; so thus we hint at the number of instrumental variables that may help describe risk prices. Two information variables are used in this study to capture the evolution of regional market integration. We use the variation in the U.S. term premium (UPRM) and the level of market openness (MOPN).

UPRM has significant impacts on the formation of the total risk premium (Fama and French, 1992), and can reflect variations in investors’ average risk aversion (Avramov, 2002). Moreover, Chinn and Forbes (2003), and Kose et al. (2008), among others, show that international interest rates have substantial effects on valuation and on financial asset allocation in the international context. For their part, Adler and Qi (2003) use the interest rate spread as a factor of financial integration, and find that this variable affects the mobility of international capital flows which, in turn, leads to changes in the level of market integration.

The degree of market openness is measured by the ratio of imports plus exports to GDP. This variable is computed using data from MSCI, the International Finance Corporation, and Datastream International. Trade liberalisation is commonly considered to be factor of convergence between markets as well as a key element for the elaboration of international development strategy. This liberalisation process sharply accelerated in a number of emerging market countries during the early 1980s in order to deal with the lack of resources, available to finance economic growth and to remedy the poor performances of their financial markets. Bekaert and Harvey (2000), Bhattacharya and Daouk (2002), and Rajan and Zingales (2001) document that a higher degree of market openness increases the exposure of national markets to global risk factors. Thus, as markets become more open to foreign trade and capital flows, their level of economic integration rises, and asset exchanges become significant. Accordingly, the degree of market openness can be a potential factor in promoting financial integration.

4.5 Stochastic properties of the data

Table 1 presents the descriptive statistics for the stock market and REER. The average stock return is negative with a negative skewness coefficient, denoting that returns distributions are skewed to the left and that the probability of observing extreme negative returns is higher than that of a normal distribution. The kurtosis coefficient is significant, and greater than three, showing the leptokurtic behavior of returns distributions. Altogether, the non-normality of returns series is clearly confirmed by the Jarque-Bera test. Further, the Engle (1982) test highlights the existence of ARCH effects in all returns series, which obviously supports our decision to model the conditional volatility of returns by using a GARCH-type process.
Table 1 - Descriptive Statistics of Return Series

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>J.B</th>
<th>Q(12)</th>
<th>ARCH(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excess Returns</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.009</td>
<td>0.113</td>
<td>-0.075</td>
<td>6.660</td>
<td>79.957</td>
<td>101.97++</td>
<td>0.016+++</td>
</tr>
<tr>
<td><strong>Exchange Rate Return</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.269</td>
<td>0.038</td>
<td>1.109</td>
<td>3.594</td>
<td>31.689</td>
<td>55.55+++</td>
<td>0.169+++</td>
</tr>
</tbody>
</table>

Note: This table shows the basic statistics and the stochastic properties for stock returns in excess of the Eurodollar rates at 1 month and the exchange rate. ‘’, ‘’’, and ‘’’’’ indicate that the null hypothesis of normality, of no autocorrelation, and of no ARCH effect is rejected at the 10%, 5% and 1% rate, respectively.

4.6 Prices of regional market and foreign exchange risk

As discussed above, we first estimate system (6) for excess returns in regional markets, and returns on the REER index.

Table 2 - Determinants of the price of exchange rate and regional market risk

<table>
<thead>
<tr>
<th></th>
<th>Constant</th>
<th>RDIY</th>
<th>RRENT</th>
<th>RPRM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A - Price of exchange rate risk</strong></td>
<td>0.113***</td>
<td>0.0022</td>
<td>-0.022***</td>
<td>0.012***</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.0054)</td>
<td>(0.005)</td>
<td>(0.001)</td>
</tr>
<tr>
<td><strong>Panel B - Price of regional market risk</strong></td>
<td>0.090***</td>
<td>0.091**</td>
<td>0.009***</td>
<td>0.007***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.070)</td>
<td>(0.000)</td>
<td>(0.002)</td>
</tr>
</tbody>
</table>

Panel C - Specification tests for the relevance of prices of regional market and exchange rate risk

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the price of regional market risk null? $H_0: \eta_{reg} = 0$</td>
<td>117.13+++</td>
<td>0.000</td>
</tr>
<tr>
<td>Is the price of regional market risk constant? $H_0: \eta_{reg} = 1$</td>
<td>220.78+++</td>
<td>0.000</td>
</tr>
<tr>
<td>Is the price of exchange rate index risk in Singapore zero? $H_0: \eta_k = 0$</td>
<td>111.122+++</td>
<td>0.000</td>
</tr>
<tr>
<td>Is the price of exchange rate index risk in Singapore constant? $H_0: \eta_k = 1$</td>
<td>117.661+++</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Notes: This table shows the determinants of exchange rate and regional market risk prices. Constant, RDIY, RRENT and RPRM represent the constant term, dividend yield, regional market returns and interest rate spread. The numbers in parentheses are the associated standard deviations. $\chi^2$ is the empirical statistics of the Wald test examining the null hypotheses of nullity and constant coefficients. ‘’, ‘’’, and ‘’’’’’ indicate significance at the 10%, 5% and 1% rate respectively. ‘’, ‘’’, and ‘’’’’’ indicate rejection of the null hypotheses at the 10%, 5% and 1% rate respectively.
The estimation results are reported in Table 2. Panel A presents the estimated parameters for the price of regional market risk. Accordingly, the coefficients associated with the returns on the regional market index and the region term premium are significant at the 1% level. These variables have, however, an insignificant effect on the evolution of the price of regional market risk. The results of the Wald tests of nullity and constancy restrictions on the price of regional market risk, reported in Panel C, clearly reject the null hypotheses that the latter is equal to zero and constant, which confirms the findings of previous studies including Bekaert and Harvey (1995) and Carrieri et al. (2007).

Turning to the analysis of the prices of foreign exchange risk, we first observe that they are mainly driven by the dividend yield of the region in excess of the 30-day Eurodollar interest rate, the returns on the regional market index and the region term premium because the associated coefficients are statistically significant at conventional levels (Panel B). Second, we employ the Wald test to investigate the null hypotheses that the price of exchange risk is zero and constant respectively. The obtained results, reported in Panel D of Table 3, indicate the rejection of these null hypotheses at the 1% level. These findings are effectively in agreement with those of previous studies, including Carrieri et al. (2007) and Tai (2007), in that exchange rate risk is a relevant factor of risk for asset pricing in emerging markets, and that they change over time.

Table 3 presents a detailed analysis of the model’s standardised residuals. Normality is rejected at the 1% level for the four currency returns. The departure from normality decreases substantially for regional returns, but it remains significant at the 10% level. The Ljung-Box test shows that the first-order autocorrelations of standardised residuals are no longer significant and that their values decrease substantially. The Engle (1982)’s test for the conditional heteroscedasticity of the standardised residuals indicates that ARCH effects no longer exist in all cases, thus revealing the suitability of the GARCH approach. Although all the coefficients in the multivariate DCC-FIAPARCH process for conditional variances and covariances are not reported, most are significant at the 1% level. Overall, this confirms the time-variation in both the prices and the quantities of risk as found based on the Wald tests.

<table>
<thead>
<tr>
<th>Table 3 - Analysis of residuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skewness</td>
</tr>
<tr>
<td>-0.382**</td>
</tr>
</tbody>
</table>

Note: Numbers in parenthesis are the associated standard deviations. JB, Q(6), and ARCH(6) are respectively, the empirical statistics of the Jarque-Bera test for normality, the Ljung-Box test for serial correlation of order 1, and Engle’s (1982) test for conditional heteroscedasticity. ** indicates that the coefficients are significant at the 1% level. *** indicates that the null hypothesis of normality and autocorrelation is rejected at the 1% level.

4.7 Time-varying regional market integration

Table 4 reports the descriptive statistics of our time-varying measure of market integration, which is obtained
by estimating the whole system (6), while imposing the estimates from the subsystem for the regional and the exchange rate index returns\(^1\). The Singapore markets are only weakly integrated into regional markets. The statistical significance of most coefficients associated with the degree of trade openness and US term spread suggests that they are important determinants of the degree of market integration.

### Table 4 - Dynamics of regional integration

<table>
<thead>
<tr>
<th>Panel A – Determinants of market integration</th>
<th>Constant</th>
<th>UPRM</th>
<th>MOPN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.561***</td>
<td>0.061***</td>
<td>0.117***</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.002)</td>
<td>(0.071)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B – Levels of market integration</th>
<th>(\Theta_{\text{mean}})</th>
<th>(\Theta_{\text{max}})</th>
<th>(\Theta_{\text{min}})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.601***</td>
<td>0.790</td>
<td>0.312</td>
</tr>
<tr>
<td></td>
<td>(0.115)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: This table shows the estimation results of the system (6) using degree of trade openness and US term spread as determinants of financial integration. The numbers in parentheses are standard deviations. *** indicate significance at the 1% rate.

In Figure 1 we depict the time-paths of the financial integration measure. The regional integration of financial markets has important implications for the design of the financial policies of multinational firms, the analysis of exchange rate risk and investment opportunities. The implication of the findings of cointegration among Singapore and the other countries of Asia is the benefits of international diversification for investors. Given that correlations among international financial markets are lower than those among stocks in each country, it is widely accepted that investors can obtain significant earnings from international portfolio diversification. According to modern portfolio theory (Markowitz, 1952), an investor can reduce portfolio risk simply by holding assets that are not or poorly positively correlated, thus diversifying its holdings. This allows her or him to obtain the same expected return while reducing portfolio volatility. Incentives for investing in emerging markets have been accentuated by lower return correlations between internationally-traded assets compared with those between domestic assets (see Grubel, 1968; Levy and Sarnat, 1970; Bekaert et al., 1998; Nguyen and Deora, 2013; among many works).

Financial markets are said to be segmented when returns are only affected by local factors. Such markets meet the diversification principle put forward by Markowitz (1952). The highly segmented assets traded in emerging markets should therefore provide a better fit between risk and return. Such segmentation of emerging markets is linked to a context of strong state regulations that circumscribe a large part of economic activities to national territories (Black, 1974; Claessens and Rhee, 1994). However, in the current global environment such restrictions cannot be sustained over the long term, and therefore emerging countries see their economic and financial markets aligning with international markets.

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\(^1\) Most of the estimates of the individual coefficients on the local information variables are significant, which suggests time-variation in the local prices of risk. These are available upon request to the corresponding author.
financial operations acquire an increasingly international dimension. Owing to the development of economic activity across borders, yields depend more on external factors (Chinn and Forbes, 2003). The consequence of this increasing integration of markets, formerly segmented, is to reduce the gains of diversification.

The literature on this subject (Bekaert and Harvey, 1995; Carrieri et al., 2007) shows that the expected returns of listed shares on emerging stock exchanges depend on the economies considered characteristics, as well as the degree of the integration of emerging markets in global finance. Efficient allocation strategies in emerging countries such as Singapore require a careful analysis of their risk-return trade-offs as well as their linkages with the world stock market. The interaction with the developed world makes Singapore market returns vulnerable to changes in other markets which may wipe out any portfolio diversification benefits.

Figure 1 - Dynamic integration of Singapore into the regional market

4.8 Market integration and the formation of the total risk premium

As discussed earlier, one of the advantages of our approach is that it provides direct estimates of the conditional second moments and, therefore, of the premium associated with each of the risk factors. The total risk premium can be broken down into two components. The first component, called the regional risk premium, consists of the regional market risk premium and exchange rate risk premium. It is weighted by the level of integration. The second one, referred to as the local risk premium, is weighted by the level of market segmentation.
Table 5. Decomposition of the Total Risk Premium

<table>
<thead>
<tr>
<th></th>
<th>TPRM</th>
<th>LPRM</th>
<th>RPRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>6.487</td>
<td>5.098</td>
<td>1.389</td>
</tr>
<tr>
<td></td>
<td>(0.151)</td>
<td>(0.141)</td>
<td>(0.149)</td>
</tr>
</tbody>
</table>

*Note: +++ indicates that the average risk premiums are significantly different from zero at the 1% level with respect to the two-sided Student-t test.

Table 5 reports the average values of the total, regional and local risk premiums. The two-sided Student-t test indicates that both the global and the local risk premiums are significantly different from zero at the 1% level, especially given the high risk exposure of this region’s member countries, e.g., repeated political and economic crises. For the remaining regions, the proportion of the local risk premium is larger than that of the regional one.

The time-variations of the total risk premium and its local component are shown in Figure 2. We see that the total risk premium changes considerably over time according to international and regional economic conditions, and that it is mainly composed of the local risk premium. The local risk premium seems to be particularly low during the 2000-2003 subperiod, and from 2006 onwards. This finding confirms the increase in the level of Singapore’s integration during these subperiods because stock returns depend more on global risk factors than on local risk factors. The 2006-2010 subperiod preceding the Asian crisis was also characterised by a low degree of segmentation.

Figure 2. Local versus total risk premiums
5. Conclusion

Our results show that integration degree varied widely over the period 1996-2011, and this can be satisfactorily explained by the level of trade openness and variations in the US term premium. Although the general trend is towards increasing financial integration, Singaporean stock market seems to be still significantly segmented from the global market. A breakdown of the total risk premium confirms this finding, in that it underlines the dominant role of the domestic risk factor in explaining variations in the expected returns. Finally, a close inspection of the conditional correlations indicates that they constitute a biased indicator of financial integration.

This paper presents a new approach to measuring the time-varying degree of financial market integration. We find strong support for the specification of an ICAPM with multivariate cDCC-FIAPARCH parameters. According to the empirical evidence, the decomposition of the total risk premium shows that local risk factor (i.e. the variance risk related to the local market index), explains a significant part of the total risk premium on average. Thus, the risk premium associated with global factors is the most statistically significant component of the total risk premium. In fact, the share of the premium associated with global factors has increased sharply since 2008, indicating a higher degree of market integration.

It is known that the degree of the integration of national markets into the world stock market is a question that has a decisive impact on a number of issues related to problems studied by financial theory such as asset pricing. If capital markets are fully integrated, investors face common and specific risk factors, but price only common risk factors (specific risk is fully diversified). By contrast, when capital markets are segmented, asset pricing relationships vary everywhere and domestic risk factors determine expected yields. Our results suggest that diversification into more developed emerging markets does not produce as substantial benefits as in the past.

Consistent with previous studies, such as Bekaert and Harvey (1995), our results – obtained over the period 1996:3/2010:3 – indicate that Singapore is integrated into world markets like other Pacific Basin countries such as Taiwan, Korea and Indonesia. However, the degree of Singapore stock market segmentation changes over times. In the recent period, the financial market has become less segmented as a result of liberalisation and reforms. The case of Singapore confirms that the integration of financial markets is a dynamic process that fluctuates indefinitely, but is increasing in the long term.

References


## Appendix

### Variables and Measurements

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurements</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore Market Returns (SINGRETURN)</td>
<td>( \ln\left(\frac{P_t}{P_{t-1}}\right) )</td>
<td>Bekaert and Harvey (1997, 2000) &amp; Guesmi and Nguyen (2011)</td>
</tr>
<tr>
<td>Real exchange rate index (REER)</td>
<td>Geometric weighted average of all individual countries’ exchange rates against the US dollar, where the weights are the share of each country in the foreign trade with the rest of the world.</td>
<td>Jorion (1991) &amp; Bollerslev and Wooldridge (1992) &amp; De Santis and Gerard (1998)</td>
</tr>
<tr>
<td>Singapore Dividend Differential (SINGDIV)</td>
<td>DY of Singapore - DY world; With DY = dividend/price</td>
<td>Bekaert and Harvey (1995) &amp; Hardouvelis et al. (2006)</td>
</tr>
<tr>
<td>Regional Market Returns (RRETURN)</td>
<td>( \ln\left(\frac{P_t}{P_{t-1}}\right) )</td>
<td>Bekaert and Harvey (1997, 2000) &amp; Guesmi and Nguyen (2011)</td>
</tr>
<tr>
<td>Interest rate spread (IRS)</td>
<td>( \ln \left(\frac{\text{US Treasury 10 years bond}}{\text{US risk free 30 days rate}}\right) )</td>
<td>Harvey (1995) &amp; Hardouvelis et al. (2006)</td>
</tr>
<tr>
<td>Singapore Inflation Rate (SINGINF)</td>
<td>(Consumer price index ( \tau ) Consumer price index ( \tau )) / Consumer price index ( \tau )</td>
<td>Boyd et al. (2001)</td>
</tr>
</tbody>
</table>