# “Interdependence of the Equity Markets of India, Malaysia and Singapore: Tests Based on Daily Equity Series”

# Interdependence of the Equity Markets of India, Malaysia and Singapore: Tests Based on Daily Equity Series

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## Abstract

In this paper we investigate the interdependence of the equity markets of India, Malaysia and Singapore. We have studied the long-run behavior and the Granger causality of stock price indices from July 1, 1997 through February 24, 2005 using daily equity prices. Data are collected from the Yahoo Finance and Standard & Poor's Emerging Markets Database. Applying Johansen's multivariate cointegration technique, we find equilibrium relationship among the three markets. Applying the pairwise Granger causality test, we find bidirectional causality between the Bombay Stock index and the Kuala Lumpur Stock Index, and between the Bombay Stock Index and the Singapore Straight Times. Unidirectional causality is detected from the Singapore Straight Times to the Kuala Lumpur Stock Index. The overall results suggest that there is a strong daily lagged feedback effect between the Bombay Stock Index and the Kulala Lumpur Index, and between the Bombay Stock Index and Singapore Straight Times. These findings are helpful to individual investors and portfolio managers in terms of reducing portfolio risks and enhancing the returns.


## I. Introduction

Linkages of global securities markets have generated considerable interest among academia, individual investors, and the international fund managers. In recent years emerging markets have becoming more popular among international investors who seek portfolio diversification. Most recently the emerging equity market of India has attracted many international investors because of its high GDP growth rate and large IT-related markets. The government of Malaysia did find a way to bring the economy quickly back to a rapid growth path following 1997 Asian financial crisis; its recovery has been better than other countries (except Singapore) in that region. Singapore is one of the world's most open economies and serves as a regional headquarter for more than 3,000 MNCs. Statistics indicate that the inflow of portfolio investment to these countries has shown a phenomenal growth. Privatization, reforms in financial and capital markets as well as governmental liberalization efforts have brought high growth rates of their GDP, and have encouraged global investors to enter these markets. Literature reveals that the greater part of the past research has been directed to more developed capital markets. Asprem (1989), for example, compared the effects of economic factors on the stock markets of ten European countries. While Bulmash & Trivoli (1991) did similar studies in the US market. Peiro (1996) compared such relationships in three European countries with the US. Cheng (1995) and Poon and Taylor (1991) examined the UK market; and Gjerde and Sattem (1999) researched on Norwegian data. The number of similar studies using data from Asian markets is considerably smaller. With few exceptions, the previous research has concentrated on the economy of Japan, Korea and Singapore (Hamao, 1988; Brown and Otsuki,1990; Kaneko and Lee, 1995; Mukherjee and Naka, 1995; Maysami and Koh, 2000; and Maysami and Hui, 2001). Our study aims to narrow the gap by examining the cases of three equity markets of India, Malyasia and Singapore by using high frequency daily equity series. The objective of this paper is thus to shed new light on the question of interdependence among the stock markets of these three countries. We investigate whether there are any long-run relationship and codependence among these markets. We also try to explore the degree to which their respective market price indices exhibit common long-term stochastic trends and the degree to which these common trends are influenced by one of these market indices. Since cointegration implies that nonstationary times series move stochastically together toward some long-run stable relationship, the existence of cointegrating relationships among various stock prices has a direct implication in terms of the existence of common trends among these series. In other words, if the random walk component behavior is a realistic hypothesis for the stock prices of these countries, do these components differ across them or are these markets sharing random walk components? We also investigate the Granger causality between the markets. This relationship is attractive to investors in order to enhance the diversification benefits. The remainder of this paper is organized as follows. Section II briefly discusses the macroeconomic fundamentals of each country. Section III discusses the methodology and the data. The empirical results are discussed in section IV, while section V concludes the paper.

## II. Macroeconomic Fundamentals

### *India*

Indian economy has been characterized by a diversified industrial base, a growing, world-class IT and software development sector, and a relatively large and sophisticated financial sector. India has been gradually transforming its economic base from agrarian to industrial and commercial. The agricultural sector accounts for 23.6% of GDP, the industrial sector 28.4%, and services sector 48%. Rapid economic progress has often been the precursor to political reform and liberalization. During the Persian Gulf conflict in 1991, India faced a financial crisis because of rising oil prices, which stimulated economic reforms and liberalization. These reforms removed most of the government regulations on investment, including many on foreign investment, and eliminated the quota and tariff system that had kept trade at low levels. Reforms also de-regulated a number of industries and privatized many public enterprises. GDP grew at an average of more than 6% through the year 2000. Private investment has been the fuel for India's recent economic success; domestic savings and investment now run at about 22% of GDP. While foreign direct investment reached a record high of US$3.6 billion in 1997, 20 times higher than it was before the reforms in 1991, inflows of direct and portfolio investment from abroad have been miniscule as compared to those received by China. Yet the economy still managed to grow 5% in 1997 and 1998 on the strength of consumption and domestic investment demand. The inflation rate declined to about 5% in 2001 from nearly 6% in 2000 and almost 7% in 1999. India's balance of payments has been characterized by modest current account deficits and financial account surpluses sufficient to finance the current account and allow the country to more than double its international reserves to over US$44 billion as of year-end 2001. The volume of financial flows into and out of India is also small in relation to the size of the economy. For example, India has never received more than US$3.6 billion in direct investment from abroad while both Brazil (whose GDP is about the same size as India's) and China have attracted in excess of US$30 billion of direct investment per year in recent years. Clearly, India's large population and strong democratic institutions give it outstanding potential for development, but that process will be greatly expedited if it can make itself as attractive to outside investment as other large developing nations. The economy has posted an excellent average growth rate of 6.8% since 1994. (*Sources: World Bank (www.worldbank.org) and IMF (www.imf.org*) *Ministry Of Finance( India), Reserve Bank of India and Asian Development Bank (www.adb.org).*

### *Malaysia*

Malaysia, as a middle-income country, transformed itself from a producer of raw materials into an emerging multi-sector economy. Growth was almost exclusively driven by exports, particularly electronics. As a result, Malaysia was hard hit by the global economic recession in the IT sector in 2001 and 2002. GDP in 2001 grew only 0.5% due to an estimated 11% contraction in exports, but a substantial fiscal stimulus package equal to US $1.9 billion to overcome the recession. As a result the economy rebounded in 2002 with a 4.1% increase in GDP growth rate. The economy grew 4.9% in 2003, notwithstanding a difficult first half, when external pressures from SARS and Iraq war led to exercise a caution in the business community. Growth topped 7% in 2004. Healthy foreign exchange reserves, low inflation, and a small external debt are the strengths that make it unlikely that Malaysia will experience a financial crisis similar to the one in 1997. However, the economy remains dependent on continued growth in the U.S., China, and Japan, top export destinations and the major sources of foreign investment. (*Source: The World Factbook, 2005).* Historically, Malaysia received sizable inflows of foreign direct investment. After the Asian crisis, it still does so, but it has also begun to invest some of its own excess earnings of foreign exchange (from the current account surplus) in FDI abroad. Portfolio investment and bank lending and borrowing activity have resulted in net outflows of funds from Malaysia, again a reflection of the placement of excess holdings of foreign currency in banks and investments abroad as well as the repayment of past external debt. The result of the sharp reversal in the current account balance has been a strong growth in Malaysia's gross international reserves. (*Sources: World Bank and IMF report 2004)*.

***Singapore***

Singapore is a highly developed and successful free market economy, enjoys a remarkably open and corrupt-free environment, stable prices, and a per capita GDP equal to that of the most developed West European countries. The economy depends heavily on exports, particularly in electronics and manufacturing. In 2004, the estimated contributions to GDP was 32.6% by industrial sector and 67.4% by the services sector. The economy was hard hit in 2001-03 by the global recession, by the slump in the technology sector, and by the outbreak of SARS in 2003, which curtailed tourism and consumer spending. The government plans to establish a new growth path that will be less vulnerable to the external shock and will continue efforts to establish Singapore as Southeast Asia's financial and high-tech hub. Fiscal stimulus, low interest rates, a surge in exports, and internal flexibility led to vigorous growth in 2004, with real GDP rising by 8%. (*Source: The World Factbook, 2005)*.

## III. Methodology and Hypotheses

***Unit Root***

The issue of whether stock prices are mean reverting or not has stimulated considerable empirical work in recent years (see for example, the often-quoted study of Porteba and Summers, 1988). If stock series follow a random walk, the effects of a temporary shock will not dissipate after several periods, but instead will be permanent. Several studies show that most economic time series data do appear to be random walks or at least have random walk components. Most of these studies use unit root tests introduced by Dickey and Fuller (1979). In this study we use the Augmented Dickey Fuller (ADF) test to determine whether our time series represented by daily equity prices is non-stationary (unit root). ADF requires running a regression of the first difference of the series against the series lagged once, lagged difference terms, and a constant and a time trend such as

$$\Delta \boldsymbol{x}_t = \lambda_0 + \lambda_1 X_{t\text{-}1} + \lambda_2 T + \Sigma\, \lambda_{\text{i}}\, \Delta \boldsymbol{x}_{\,t\text{-I}} + \epsilon_t \quad i = 1 \ldots\ldots\ldots\ldots\ldots k, \tag{1}$$

where $\Delta$ is the first difference operator, $\epsilon_t$ is an error term, and k, the number of lagged first difference term, is determined such that $\epsilon t$ is approaching white noise. The null hypothesis states that the series have unit root or are nonstationary ($H_o$: $\lambda_1 = 0$). Output of the ADF test consists of the t-statistic on the estimated coefficient of the lagged variable ($\lambda_1$) and the critical values for the test of a zero coefficient. If the coefficient is significantly different from zero then the null hypothesis of a unit root is rejected.

***Cointegration Test***

The theory of cointegration, first introduced by Granger (1981) and developed further by Granger (1986) and Engle and Granger (1987), integrates the short-run dynamics with long-run equilibrium relationship. A set of time-series variables is said to be cointegrated if they are integrated of the same order and a linear combination of them is stationary. Such linear combination would then point to the existence of a long-term relationship among the variables. Since our interest is in searching for long run linkages in the stock prices, we consider the three series jointly in order to investigate the presence of potential common trends among them. Thus we focus on the first order nonstationary integrated process i.e. I(1). The implications of cointegration are numerous, both from economic and statistical points of view. In particular we know if there are *r* stable long-run relationships (cointegrating equations) in $k$ dimensional vector of time series, then these $k$ series share $k$-$r$ common stochastic trends. On the other hand, given the unique relationship between cointegration and the error correction models, then there must be some Granger causality (i.e., precedence) in at least one direction. This paper exploits these relationships and investigates the presence of common stochastic trends by means of the vector autoregressive representation. We derived a maximum likelihood approach for estimating and testing the number of cointegrating relationships among the components of a $k$-vector $x_i$ of variables. Assuming a simple vector autoregressive model for $x_i$:

$$A(L)\, x_i = \epsilon_t \quad (2)$$

which can be reparametrized in a vector autoregressive ECM:

$$\Delta x_t = \Sigma_i \prod_i \Delta x_{t-1} + \prod p\boldsymbol{x}_{t-p} + \epsilon_t \quad (3)$$

where $i = 1,2, \ldots\ldots., p$-1.

$\Pi_i$ = -1+$A_1$ + $A_2$ + ……..+ $A_i$ with I=1,…….,$p$.

If rank ($\Pi_p$) = $r<k$, there are $r$-$k$ unit roots in the system and $r$ linear combinations which are stationary, that is, there are $r$ cointegrating relationships. $\Pi_p$ can be written as $\alpha\beta'$ where both α and β are ($k$ x $r$) matrices of full column rank. The first $r$ rows of $\beta'$ are the $r$ cointegrating vectors in the different equations. The maximum likelihood estimate of the cointegrating vector is given by the empirical canonical variates of $X_{t-p}$ with respect to $\Delta x_t$ corrected for the short-run dynamic and the deterministic components. The number of cointegrating relationships is given by the number of significant canonical correlations. Their significance can be tested by means of a sequence of likelihood ratio tests. Once the number of cointegrating relationships has been determined, it is possible to test particular hypothesis concerning $\alpha$ and $\beta$ using standard $\chi^2$ distributed likelihood ratio test. We consider the above three stock price indices jointly in a model such as equation (3). The specification of the lag length of the model is tested sequentially using likelihood ratio test statistics.

***The Granger Test for Causality***

The first attempt at testing for the direction of causality was by Granger (1969). The intuition behind the Granger causality is as follows. Suppose X Granger-causes Y but Y does not Granger-cause X, then the past values of X should be able to help predict future values of Y, but the past values of Y would not be helpful in forecasting X. The Granger approach to the question of whether X and Y have causality is to see how much of the current *Y* can be explained by past values of *Y* and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged values of X are statistically significant.

More specifically let us consider the following two variable VAR model:

$$Y_t = \alpha_{10} + \sum \alpha_{1i} X_{t-i} + \sum \beta_{1j} Y_{t-j} + \varepsilon_{1t} \quad (4)$$

$$X_t = \alpha_{20} + \sum \alpha_{2i} X_{t-i} + \sum \beta_{2j} Y_{t-j} + \varepsilon_{2t} \quad (5)$$

where $\varepsilon_t$ is white noise, $p$ is the order of the lag for $X$, and $q$ is the order of the lag for $Y$.

With respect to this model we can distinguish the following cases:

i. If [$\alpha_{11}, \alpha_{12}, \ldots\ldots\ldots, \alpha_{1p}$] ≠ 0 and [$\beta_{21}, \beta_{22}, \ldots\ldots, \beta_{2q}$] = 0, there exists a unidirectional causality from $X_t$ to $Y_t$, denoted as X → Y.
ii. If [$\alpha_{11}, \alpha_{12}, \ldots\ldots\ldots, \alpha_{1p}$] = 0 and [$\beta_{21}, \beta_{22}, \ldots\ldots, \beta_{2q}$] ≠ 0, there exists a unidirectional causality from $Y_t$ to $X_t$, denoted as Y → X.
iii. If [$\alpha_{11}, \alpha_{12}, \ldots\ldots\ldots, \alpha_{1p}$] ≠ 0 and [$\beta_{21}, \beta_{22}, \ldots\ldots, \beta_{2q}$] ≠ 0, there exists a bidirectional causality between $X_t$ to $Y_t$, denoted as X ↔ Y.

In order to test the hypotheses referring to the significance or not of the sets of the coefficients of the VAR model of equations (4) and (5), the usual Wald F-statistic could be applied.

The hypotheses in this test may be formulated as follows:

$H_0$: X does not Granger-cause Y, i.e. [$\alpha_{11}, \alpha_{12}, \ldots\ldots\ldots, \alpha_{1p}$] = 0, if F-statistic < critical value of F.

Ha: X does Granger-cause Y, i.e. [$\alpha_{11}, \alpha_{12}, \ldots\ldots\ldots, \alpha_{1p}$] ≠ 0, if F-statistic > critical value of F.

and

$H_0$: Y does not Granger-cause X, i.e. , $[\beta_{21}, \beta_{22, \ldots\ldots\ldots\ldots\ldots,} \beta_{2q}] = 0$ if F-statistic < critical value of F.
Ha: Y does Granger-cause X, i.e. $[\beta_{21}, \beta_{22, \ldots\ldots\ldots\ldots\ldots,} \beta_{2q}] \neq 0$, if F-statistic > critical value of F.

## IV. The Data Series

This study focuses on three markets of Southeast Asian countries which received more attention recently because of their less regulatory restrictions and other favorable factors. The national stock price indices are obtained from the S&P's Emerging Market Data Bank and Yahoo Finance. They are Bombay Stock Exchange 30 (BSE) of India, Kuala Lumpur Composite Stock index (KSE) of Malaysia, Straits Times (STI) of Singapore. Our investigation covers the daily indices from July 1, 1997 through February 24, 2005. Indices are based on closing adjusted daily prices for all countries. The series were transformed into natural logs and then the returns are calculated using the continuously compounding formula in natural logarithms as

$$R_t = \ln (P_t / P_{t-1}),$$

where $P_t$ is the price index at time $t$, $R_t$ is the return , and $ln$ is the natural logarithm.

## V. Empirical Results

Empirical results reported here are comprised of ADF stationarity tests, Johansen cointegration tests and the Granger causality tests. Results reported here are also intended to have some prior descriptive information on how the various national stock price indices behave during the study period. Figure 1 shows the random walk or nonstationary behavior of the level series. Graphs of Indian and Malaysian indices exhibit similar pattern of trends. Figure 2 shows the behavior of the series in first differences (returns series). The return series of BSE and STI are more volatile compared to Kuala Lumpur index. Panel A of Table 1 provides the statistical results for ADF unit root tests for stationarity, both in levels and first difference series. Statistical results do not lead us to reject the null hypothesis of a unit root for level series of all equity indices. However, ADF test statistics for first difference series show stationarity for all indices. Panel B of Table 1 summarizes the ADF unit root tests. The results are consistent with Figures 1 and 2.

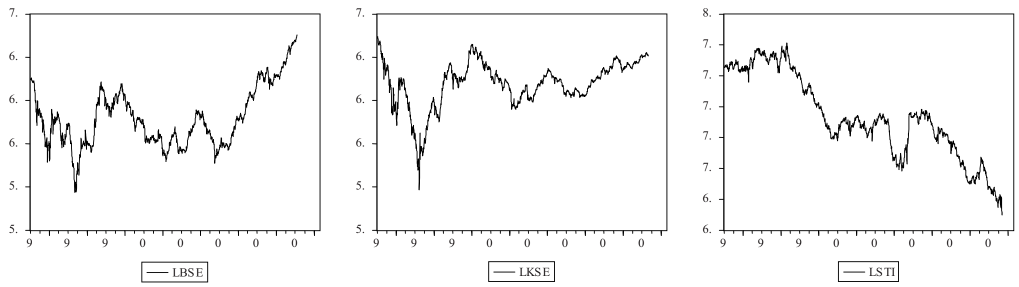


Fig.1. Random Walk of Stock Prices in India (BSE), Malaysia (KSE), and Singapore (STI) (All series are in log-scale)

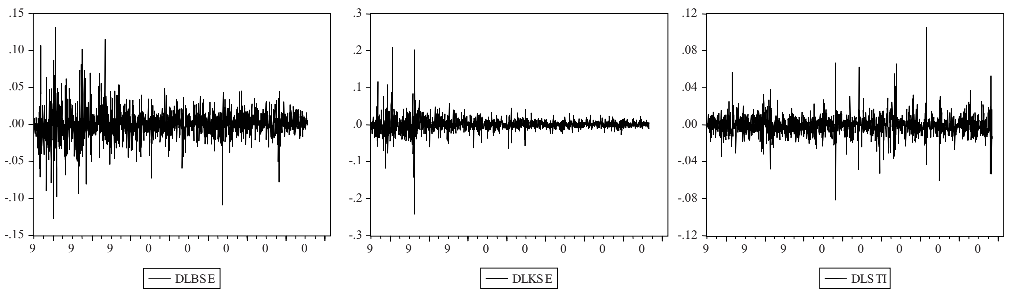


Fig. 2. Behavior of the Return Series in Logarithms

Table 1

ADF Tests: India (BSE), Malaysia (KSE), Singapore (STI) in levels and in first diffences

| | | | |
|---|---|---|---|
| Panel A | | | |
| INDIA | | | |
| Null Hypothesis: LBSE has a unit root | | | |
| Exogenous: Constant, Linear Trend | | | |
| Lag Length: 1 (Automatic based on SIC, MAXLAG=24) | | | |
| | | t-Statistic | Prob.* |
| Augmented Dickey-Fuller test statistic | | -2.033921 | 0.5817 |
| Test critical values: | 1% level | -3.963035 | |
| | 5% level | -3.412251 | |
| | 10% level | -3.128055 | |
| Null Hypothesis: D(LBSE) has a unit root | | | |
| Exogenous: None | | | |
| Lag Length: 0 (Automatic based on SIC, MAXLAG=24) | | | |
| | | t-Statistic | Prob.* |
| Augmented Dickey-Fuller test statistic | | -36.20390 | 0.0000 |
| Test critical values: | 1% level | -2.566219 | |
| | 5% level | -1.940996 | |
| | 10% level | -1.616584 | |
| MALAYSIA | | | |
| Null Hypothesis: LKSE has a unit root | | | |
| Exogenous: Constant, Linear Trend | | | |
| Lag Length: 5 (Automatic based on SIC, MAXLAG=24) | | | |
| | | t-Statistic | Prob.* |
| Augmented Dickey-Fuller test statistic | | -3.114998 | 0.1030 |
| Test critical values: | 1% level | -3.962965 | |
| | 5% level | -3.412217 | |
| | 10% level | -3.128035 | |
| Exogenous: None | | | |
| Lag Length: 4 (Automatic based on SIC, MAXLAG=24) | | | |
| | | t-Statistic | Prob.* |
| Augmented Dickey-Fuller test statistic | | -19.01653 | 0.0000 |
| Test critical values: | 1% level | -2.566201 | |
| | 5% level | -1.940993 | |
| | 10% level | -1.616585 | |
| SINGAPORE | | | |
| Null Hypothesis: LSTI has a unit root | | | |
| Lag Length: 1 (Automatic based on SIC, MAXLAG=25) | | | |
| | | t-Statistic | Prob.* |
| Augmented Dickey-Fuller test statistic | | -2.113002 | 0.5376 |
| Test critical values: | 1% level | -3.962831 | |
| | 5% level | -3.412152 | |
| | 10% level | -3.127996 | |
| Exogenous: None | | | |
| Lag Length: 0 (Automatic based on SIC, MAXLAG=25) | | | |
| | | t-Statistic | Prob.* |
| Augmented Dickey-Fuller test statistic | | -39.12523 | 0.0000 |
| Test critical values: | 1% level | -2.566168 | |
| | 5% level | -1.940989 | |
| | 10% level | -1.616588 | |

*MacKinnon (1996) one-sided p-values.

Table 1 (continuous)

Panel B: Summary of ADF Unit Root Tests

| INDEX | ADF Coefficients in levels | Mackinnon critical value | ADF Coefficients in first difference | Mackinnon critical value |
|---|---|---|---|---|
| | $\tau_\mu$ | $\tau_t$ | $\tau_\mu$ | $\tau_t$ |
| LBSE | -2.034 | -3.963 | -36.204** | -2.566 |
| LKSE | -3.114 | -3.962 | -19.016** | -2.566 |
| LSTI | -2.113 | -3.962 | -39.125** | -2.566 |

Note: ** indicate rejection of null hypothesis of unit root (non-stationary) at the 1 percent level of significance. Mackinnon critical value for rejection of hypothesis of a unit root has been applied at the 1 percent level. Optimum lag structures are determined by the Akaike and Schwarz information criteria.

### *Johansen Cointegration Tests*

We then test for cointegration by applying the Johansen likelihood ratio test to the series. We begin the investigation by assuming various stochastic trends (linear and the quadratic deterministic trends). Table 2 (Panel A) provides the statistical results of Johansen's *trace statistics* and maximum *eigen value*, statistics assuming linear deterministic trends in data with intercept, while Panel B summarizes the results for all five assumptions. Applying the trace test, the null hypothesis of no cointegration among these equity indices is rejected at the 5% level of significance, however applying the maximum *eigen value* test, the null hypothesis cannot be rejected. Sine the trace test is more powerful than the *eigen value* test, we can conclude that there exists at least one cointegrating rank. Thus our results of the Johansen cointegration tests point to the existence of a long-run relationship among the stock series of India, Malaysia, and Singapore.

Table 2

Johansen's Cointegration Tests

| | | | | |
|---|---|---|---|---|
| Sample (adjusted): 7/11/1997 7/26/2004 | | | | |
| Included observations: 1837 after adjusting endpoints | | | | |
| Trend assumption: Linear deterministic trend | | | | |
| Series: LBSE LKSE LSTI | | | | |
| Lags interval (in first differences): 1 to 5 | | | | |
| Panel A: Trace test ($\lambda_{trace}$) | | | | |
| Unrestricted Cointegration Rank Test | | | | |
| Hypothesized | | Trace | 5 Percent | 1 Percent |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Critical Value |
| None * | 0.009938 | 42.72091 | 42.44 | 48.45 |
| At most 1* | 0.007725 | 25.37423 | 24.32 | 30.45 |
| At most 2 | 0.005498 | 10.12825 | 12.25 | 16.26 |
| *(**) denotes rejection of the hypothesis at the 5% (1%) level | | | | |
| Trace test indicates 1 cointegrating equation(s) at the 5% level | | | | |
| Trace test indicates no cointegration at the 1% level | | | | |
| Maximum-Eigenvalue test ($\lambda max$) | | | | |
| Hypothesized | | Max-Eigen | 5 Percent | 1 Percent |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Critical Value |
| None | 0.009938 | 18.34668 | 25.54 | 30.34 |
| At most 1 | 0.007725 | 14.24598 | 18.96 | 23.65 |
| At most 2 | 0.005498 | 10.12825 | 12.25 | 16.26 |
| *(**) denotes rejection of the hypothesis at the 5%(1%) level | | | | |
| Max-eigenvalue test indicates no cointegration at both 5% and 1% levels | | | | |

Table 2 (continuous)

| Panel B: Summary of Cointegration Test with 5 assumptions | | | | | |
|---|---|---|---|---|---|
| Series: LBSE LKSE LSTI | | | | | |
| Lags interval: 1 to 5 | | | | | |
| Data Trend: | None | None | Linear | Linear | Quadratic |
| Rank or | No Intercept | Intercept | Intercept | Intercept | Intercept |
| No. of CEs | No Trend | No Trend | No Trend | Trend | Trend |
| Selected (5% level) Number of Cointegrating Relations by Model (columns) | | | | | |
| Trace | 0 | 0 | 0 | 1 | 3 |
| Max-Eig | 0 | 0 | 0 | 0 | 0 |

***The Granger Causality Test***

We then investigated the Granger causality among the equity series of these markets. Results of Granger causality tests are reported in Table 3. Panel A shows pair wise Granger causality, while Panel B summarizes the results. Here we test the null hypothesis that one equity market does not Granger cause another equity market at the 1% and 5% significance levels with one to five days lag intervals. Bidirectional causality has been detected between the Indian stock market and the Malaysian stock market, and between the Singapore stock market and the Malaysian stock market. We find that there is a strong daily feedback effect between the Bombay Stock Index and the Kuala Lumpur Index, and between the Singapore Straight Times and the Bombay Stock Exchange. A strong unidirectional causality is found running from the Singapore Straight Times to the Kuala Lumpur Stock Exchange.

Table 3

Panel A: Pair wise Granger Causality: Malaysia (KSE), India (BSE), Singapore (STI)

| Sample: 7/01/1997 2/24/2005 | | | |
|---|---|---|---|
| Lags: 1 day | | | |
| Null Hypothesis: | Obs | F-Statistic | Probability |
| LKSE does not Granger Cause LBSE | 1842 | 0.07121 | 0.78961 |
| LBSE does not Granger Cause LKSE | | 8.01133 | 0.00470 |
| LSTI does not Granger Cause LBSE | 1842 | 1.17902 | 0.27770 |
| LBSE does not Granger Cause LSTI | | 10.1082 | 0.00150 |
| LSTI does not Granger Cause LKSE | 1872 | 6.15657 | 0.01318 |
| LKSE does not Granger Cause LSTI | | 1.68581 | 0.19431 |
| Lags: 2 days | | | |
| Null Hypothesis: | Obs | F-Statistic | Probability |
| LKSE does not Granger Cause LBSE | 1841 | 42.2984 | 0.00000 |
| LBSE does not Granger Cause LKSE | | 28.1455 | 9.1E-13 |
| LSTI does not Granger Cause LBSE | 1841 | 2.36994 | 0.09377 |
| LBSE does not Granger Cause LSTI | | 4.56657 | 0.01051 |
| LSTI does not Granger Cause LKSE | 1871 | 3.24561 | 0.03916 |
| LKSE does not Granger Cause LSTI | | 0.84821 | 0.42835 |
| Lags: 3 days | | | |
| Null Hypothesis: | Obs | F-Statistic | Probability |
| LKSE does not Granger Cause LBSE | 1840 | 29.7829 | 0.00000 |
| LBSE does not Granger Cause LKSE | | 19.4273 | 2.1E-12 |
| LSTI does not Granger Cause LBSE | 1840 | 1.62470 | 0.18165 |
| LBSE does not Granger Cause LSTI | | 2.95473 | 0.03142 |
| LSTI does not Granger Cause LKSE | 1870 | 3.07829 | 0.02657 |
| LKSE does not Granger Cause LSTI | | 0.76336 | 0.51458 |

Table 3 (continuous)

| Lags: 4 days | | | |
|---|---|---|---|
| Null Hypothesis: | Obs | F-Statistic | Probability |
| LKSE does not Granger Cause LBSE | 1839 | 22.3733 | 0.00000 |
| LBSE does not Granger Cause LKSE | | 14.8336 | 6.2E-12 |
| LSTI does not Granger Cause LBSE | 1839 | 1.46407 | 0.21062 |
| LBSE does not Granger Cause LSTI | | 2.45295 | 0.04410 |
| LSTI does not Granger Cause LKSE | 1869 | 2.67757 | 0.03034 |
| LKSE does not Granger Cause LSTI | | 0.62727 | 0.64308 |
| Lags: 5 days | | | |
| Null Hypothesis: | Obs | F-Statistic | Probability |
| LKSE does not Granger Cause LBSE | 1838 | 17.9650 | 0.00000 |
| LBSE does not Granger Cause LKSE | | 12.2421 | 1.1E-11 |
| LSTI does not Granger Cause LBSE | 1838 | 1.38077 | 0.22845 |
| LBSE does not Granger Cause LSTI | | 2.08968 | 0.06400 |
| LSTI does not Granger Cause LKSE | 1868 | 2.19752 | 0.05210 |
| LKSE does not Granger Cause LSTI | | 0.49848 | 0.77759 |

Panel B: Summary of Granger Causality Tests

| Null Hypothesis | 1% level of Significance | 5% level of significance |
|---|---|---|
| Malaysia ≠ => India | (2,3,4,5) | --------- |
| India ≠ => Malaysia | (1,2,3,4,5) | --------- |
| Singapore ≠ => India | (1,2) | ------- |
| India ≠ => Singapore | (1,2) | (3,4) |
| Singapore ≠ => Malaysia | (1) | (2,3,4,5) |
| Malaysia ≠ => Singapore | ---------- | ________ |

Note: "≠ =>" indicates does not "Granger Cause". Numbers in parenthesis indicate the lag length in days.

## VI. Summary and Conclusions

In this paper we examined linkages and lead-lag relationships of daily stock price series for three equity markets in three Southeast Asian stock markets (India, Malaysia and Singapore) after the post Asian financial crisis. In terms of market capitalization and trading volume, these three markets are dominant in the Southeast Asian region. Empirical results comprise ADF tests of stationarity, Johansen tests of cointegration, and the Granger causality tests. The level series are supportive to unit root hypothesis for all stock series. However, first differenced (returns) series are found to be stationary for all indices. We analyzed the various stochastic properties (Linear deterministic as well as quadratic deterministic) of the data by performing vector autoregressive of lag intervals of one to five days. Trace test results show that the series are cointegrated upto five lags, as the null hypothesis of no cointegration is rejected at the conventional levels of significance. This is the case with five different assumptions about linear and quadratic trends in the data with or without intercept. We also performed Granger causality tests at the 1% and 5% significance levels upto several days intervals. Statistical results indicate that there is a strong bidirectional causality between the Bombay stock market and the Kuala Lumpur market, and between the Bombay market and the Singapore market. A strong unidirectional causality is detected running from the Singapore to the Malaysian market. These findings suggest that there is a daily feedback effect between the Bombay Stock Index and the Kuala Lumpur Composite Index, and between the Singapore Straight Times and the Bombay Stock Index. This is not surprising given the newly emerging, highly capitalized markets of India, Malaysia, and Singapore with their growing economies. These findings are helpful to international fund managers and individual investors who seek to maximize returns by portfolio diversifications.

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