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Chinese and Indian Stock Market Linkages with Developed Stock Markets

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Abstract

This study examines the linkages of the two leading emerging markets i.e. Chinese and Indian market with developed markets. Using daily data from January 2000 to December 2009, the stock market indices of China, India, United States, United Kingdom, Japan and Hong Kong are examined. The linkages are modelled using the correlation test, Granger causality and the co- integration test applying error correction model. It was found that Chinese and Indian markets are both correlated with all four major markets. Both markets have at least had a unilateral causality with all four developed markets. This suggests that the benefits of any short-term diversification, or speculative activities, are limited between them.

Keywords: Market Linkages, Co-integration, China

JEL Classifications: F3, F36, F37

1. Introduction

International stock markets have become further integrated in the recent years. Factors such as the progressive removal of restrictions and relaxation of controls on capital movements have helped further towards this and have indirectly increased the flow of funds across countries. Hence, the national stock exchanges are becoming more integrated and moving towards a single international stock exchange.

The point when the correlation between the returns of the equity markets increases, the risk exposure of the portfolio (all else being constant) will start to increase and, at a, certain point international diversification will no longer look beneficial. However this allows investors to spread their portfolio across markets which in return reduce risk when diversified effectively.

With the rapid growth in India and China, many investors would certainly consider investing in the two markets rather than in the advanced or developed markets. However, the question of whether both markets are integrated with other stock markets so that investing in India and China will provide the benefit of diversification is a major concern for investors. This lead to investigate whether, despite the growing importance and contribution of the two major emerging markets i.e., India and China to the world economy, their stock markets are interdependent with other stock markets? Therefore the aim of this paper is to present the linkages or relationship of Indian and Chinese with four other major developed markets namely United States, United Kingdom, Japan and Hong Kong using various econometric techniques.

Numerous works studying international linkages of the equity markets have contributed an in-depth understanding of the market behaviour. However, little attention has been given to both the emerging Indian and Chinese equity markets since their rapid economic growth early this decade. Therefore the paper is designed to fill the above gap by applying various robust techniques and the study is organized as follows: Section two reviews the empirical studies of this issue. The methodology is discussed in section three, while section four provides a discussion of the data as well as the empirical results. Finally, section five offers concluding remarks.

2. Literature Review

Numerous studies have been carried out to investigate stock market linkages, integration or interdependence. Stock market is said to be integrated when correlation exists between markets. However the results of these studies are mixed, inconsistent and sometimes even contradict with each other (Hilliard (1997), Aggarwal *et. al*. (2003), Abbas and Chancharat (2008)). If evidence of stock market linkage were found, it would imply that there is a common force that brings these markets together (Choudhry *et. al.* (2007)) Hence, the benefit of diversification would be limited. Apart from analyzing only the interdependencies of stock markets, many researchers have also focused on the impact of major events such as market crisis, market liberalization, etc on the stock market linkages (Tan and Tse (2002), Lim and McAleer (2004), Aggarwal *et. al.* (2008)). Since the early 1990s, most of the research on international stock market linkages has been concentrated on the mature and emerging markets.

Studies by Hilliard (1997) and Asimakopoulos *et. al.* (2002) investigated the interrelationship between daily returns generated by major stock exchanges. Evidence found that strong interdependence exists between the daily returns generated by United States and other selected major world indices. This was followed by the work of Aggarwal *et. al.* (2003) that examined the time-varying integration of European equity markets over the 1985 to 2002 period using daily data for the main EU countries. Using estimates of traditional co-integration, Haldane and Hall Kalman filter technique, and dynamic eigenvalue analysis in their study, the result shows the evidence of integration in European countries only after the establishment of EMU and the ECB during 1997-98 periods. The result also indicates that Frankfurt is the dominant market for equities in Europe.

By controlling for the exchange rate, Tan and Tse (2002) use daily data in local currencies over 1988-2000 to examine the linkages among U.S., Japan, and seven Asian stock markets including Malaysia, Philippines, Singapore, and Thailand. By truncating the data at the end of 1996 and restarting the data in mid-1998 to create a pre-crisis and post-crisis comparison, they found that markets appear to be more integrated after the crisis than before. Another interesting result is that Malaysia is less affected by the U.S. and Japan after the crisis, which can be attributed to the success of its capital and currency controls, but Singapore and Malaysia still affect each other strongly, which can be attributed to geographic proximity, economic linkages, and structural symmetry. Meanwhile Golaka *et. al*. (2003) examined the interdependence of the three major stock markets in South Asia. Using daily stock market indices of India (NSE-Nifty), Singapore (STI) and Taiwan (Taiex) from January 1994 to November 2002, employed bivariate and multivariate co-integration test. The result shows that no co-integration was found for the entire period which leads one to conclude that there is no long run equilibrium between India, Singapore and Taiwan.

Similarly by working on a list of semi-strong efficient market, Lim and McAleer (2004) conducts a study to examine the dynamic interdependencies of five ASEAN stock markets i.e. Indonesia, Malaysia, Philippines, Singapore and Thailand with the US stock market over the period of April 1990 to July 1997 using daily total market-return indices for each stock market. The result indicates higher average returns and correlations over the post crisis period. Result also indicates an increase in the integration between the ASEAN-5 markets after the financial crisis and US market returns have significant influence on the returns of all ASEAN-5 markets. Another study carried out by Click and Plummer (2005), controlling for local currency examined whether the ASEAN stock markets are integrated or segmented using co-integration technique using daily and weekly stock index quotes in local currency data from July 1998 to December 2002. The empirical result suggests that the ASEAN-5 stock markets are co-integrated. However, only one co-integrating vector is found, leaving four common trends among the five variables. Hence, the ASEAN stock markets are integrated, but the integration is still far from complete.

Later Royfaizal *et. al.* (2007) analyse the stock market interdependencies between the Asean and U.S. stock markets before, during and after Asian financial crisis by using weekly stock indices expressed in local currencies from July1997 to June 1998. Employing the Granger-causality test based on VECM to test the long run relationship among the stock markets, the study shows that the long-run relationships between ASEAN stock markets occur only for during and post-crisis period. In a similar study on the Asian markets Choudhry *et. al*. (2007) observed the changes in the long run relationship between eight Far East countries namely Thailand, Malaysia, Indonesia, Hong Kong, Singapore, the Philippines, South Korea and Taiwan around the Asian financial crisis of 1997-98. They examined the change in the influence of the U.S. and Japanese stock markets in the Far East region before, during and after the Asian financial crisis using daily stock price indices from January 1, 1998 to January 1, 2003. Correlation coefficients, multivariate co-integration, causality test and regression were conducted. Results showed significant long-run relationship and linkages between the Far East stock markets before, during and after the crisis. It was also found larger U.S. influence in all periods and some evidence of increasing Japanese influence to the eight Far East countries.

Meanwhile Abbas and Chancharat (2008) investigated the existence of co-integration and causality between the stock market price indices of Thailand and its major trading partners (Australia, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, the UK and the USA), using monthly data spanning the period from December 1987 to December 2005. They used both the Engle-Granger two-step procedure (by assuming no structural breaks) and the Gregory and Hansen test (allowing for one structural break). From the result, evidence of potential long run benefits from diversifying the investment portfolios internationally was found. Results also notice that the stock returns of Thailand and three of its neighbouring countries (Malaysia, Singapore and Taiwan) are interrelated during these periods.

Although there are continuous researches done on market integration, it has mainly focused on the developed markets. Until the late 1980s the Asian-Pacific stock markets, had grown in some importance, where a considerable amount of work was done to investigate the relationship and linkages among the markets. However, few studies concentrated on the relationship of two major emerging markets namely China and India with other major developed stock markets in the world.

In the mid twentieth century, Chi *et. al.* (2006) examined the bilateral relations between three pairs of stock markets, namely India-U.S., India-China and China-U.S. They used weekly stock index of Bombay Stock Exchange National Index for India, All Shares Index from Shanghai Stock Exchange for China, and the S&P 500 index for U.S. market from January 2, 1991 to December 29, 2004. Augmented Dickey-Fuller and Phillip-Perron unit root test were used to test the stationary of the series and subsequently employ the Fractionally Integrated Vector Error Correction Model (FIVECM) to detect the co-movement of the pairs of stock markets. Result shows that the three markets are fractionally co-integrated with each other. It was also found that U.S. market leads the Indian market in information spill-over and leads the Chinese market in return transmission. These results suggest that the two emerging markets appear to be more closely linked to each other relative to the U.S.

Similarly Chattopadhyay and Behera (2006) later examined if the reform in the Indian stock market had led to the integration with the developed stock markets in the world. It was found that Indian stock market is not co-integrated with the developed market as yet although some short-term impact does exist. More recently, Janak Raj and Sarat Dhal (2008) investigated the financial integration of India's stock market with global and major regional markets. It was found that Indian market's dependence on global markets, such as U.S. and U.K., is substantially higher than on regional markets such as Singapore and Hong Kong while Japanese market has weak influence on Indian market.

One of the recent works by Singh *et. al*. (2009) applied the open and closed price volatility testing the interdependence of fifteen world indices including an Indian market index in terms of return and volatility spillover effect. Vector autoregressive model (VAR) was used to estimate the conditional return spillover among these indices in which all fifteen indices are considered together. It is found that there is greater regional influence among Asian markets in return and volatility than with European and US. Japanese market, which is first to open, is affected by US and European markets only and affects most of the Asian Markets. US market is influenced by both Asian and European markets.

In comparison to the work done above this research applied the intra-day readings to observe the linkages between China and India with major developed markets, this study will also focus on analysing whether the two major emerging markets decouple from major developed markets namely U.S., U.K., Japan and Hong Kong.

3. Research Methodology

3.1 Data

The data used in this study are from the major stock market indices both the Indian and Chinese stock market. For the Indian market, Bombay Stock Exchange (BSE) Sensex 30 Index and National Stock Exchange (NSE) S&P CNX Nifty is used. Meanwhile, for Chinese market it is Shanghai Stock Exchange Composite Index and Shenzhen Composite Index. The data for the major four major markets are the Dow Jones Industrial Average (DJIA) for the U.S., FTSE-100 for U.K., Nikkei-225 Stock Average for Japan and Hang Seng Index for Hong Kong. Refer to Figure 1 below on the trading time of these markets.

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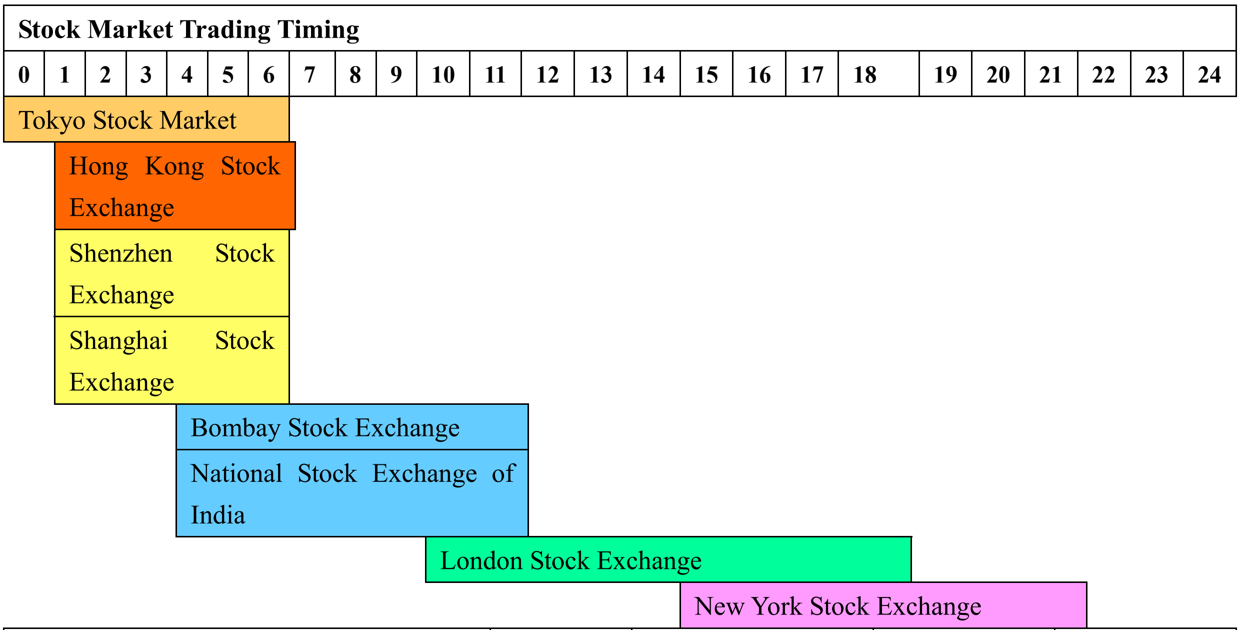

Stock Exchanges	**Index Used**	**Time Zone**	**Opening Time**	**Closing Time**
Tokyo Stock Exchange (TSE)	NKY	JST (UTC+9)	09.00	15.00
Hong Kong Stock Exchange (HKEX)	HSI	HKT (UTC+8)	09:30	16.00
Shenzhen Stock Exchange (SZSE)	SZCOMP	CSE (UTC+8)	09.30	15.00
Shanghai Stock Exchange (SSE)	SHCOMP	CSE (UTC+8)	09.30	15.00
Bombay Stock Exchange (BSE)	SENSEX	IST (UTC+5.5)	09.00	15.30
National Stock Exchange of India (NSE)	NIFTY	IST (UTC+5.5)	09.00	15.30
London Stock Exchange (LSE)	FTSE	GMT (UTC+0, DST)	08.00	16.30
New York Stock Exchange (NYSE)	DJIA	ET (UTC-5, DST)	09.30	16.00

Figure 1. Stock Market Trading Overlapping Hours

Data consists of the daily intra-day price for each index from January 2000 to December 2009, amounts a total of 1,872 observations with data omitted during market closed. The price of market indices were obtained from Bloomberg database. The cut of 31 December 2009 was used due to the preference of observing the volatile market movements even during the major swing in the developed markets due to the US Investment banks meltdown.

All of the indices are expressed in terms of local currencies to avoid problems associated with transformation due to fluctuations in exchange rates and also to avoid the restrictive assumption the relative purchasing power parity holds. In addition, the preference for local currencies focuses on the domestic causes of stock market interdependence. According to Leong and Felmingham (2001), by converting these indices to a common currency there is a possibility that the impact of local economic conditions and domestic economic policy maybe distorted. The data is then analysed using E-View 6.1 which provided the data analysis and regression output.

3.2 Methodology

In order to analyse the linkages of Indian and Chinese market with other major markets, the study adopts three major methods.

3.2.1 The Correlation Test

The first step involves a simple correlation test to measure the strength and direction of the association between the stock indices. The significance of the correlation for each index provides a preliminary indication of the strength of association between the indices of different stock markets under study. According to Leong and Bruce Felmingham (2001), correlation coefficients are known to be biased upward if the share price indices has heteroskedastic elements, thus it does not provide a sound basis for studies of interdependence.

However correlation analysis only measures the degree of linear association between two variables hence provides little insight on the dynamic linkages and causality between stock markets. Therefore, the analysis of stock market integration is extended employing Granger Causality test.

3.2.2 Granger Causality Test

Granger Causality test is conducted to further analyse the significance and direction of causality between Chinese and Indian market with other major stock markets. According to Granger (1969), this test will answer the question of whether *X* causes *Y*. *Y* is said to be Granger-caused by *X* if *X* helps in the prediction of *Y*, or equivalently if the coefficient on the lagged *X* are statistically significant. To show that *X* Granger cause *Y*, first step is to consider an autoregression for *Y*. Next, lagged values of *X* are added as the extra independent variables. Granger Causality test results are very sensitive to the number of lags used in the analysis. There are four different criteria for specifying the lag length. This study will adopt Akaike information criterion (AIC) suggested by Akaike (1974). The equation for the pairwise Granger causality tests are as follow:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + ... + \alpha_i Y_{t-1} + \beta_1 X_{t-1} + ... + \beta_i X_{t-1} + \mu_t \qquad (1)$$

Where, X_t and Y_t = daily stock market index for country *X* and *Y* respectively

μ_t = error term at time *t*

The F test is used to test the hypotheses of the Granger Causality as follow:

H_0: $\beta_1 = \beta_2 = 0$ (*X* does not Granger cause *Y*)

H_1: At least one of the $\beta_1 \neq 0$

The null hypothesis is rejected if the computed F-value exceeds the critical F value at the chosen level of significance (0.05). This implies that *X* does Granger cause *Y*. The test is performed in pair-form between China and U.S, U.K, Japan and Hong Kong. Similarly, the same method is repeated between India and U.S, U.K, Japan and Hong Kong. The causality between Indian and Chinese market is also examined.

3.2.3 Unit Root Test

Prior to the co-integration analysis, the univariate properties of the data series are examined whether the series are non-stationary or contain a unit root. A series is said to be stationary if the mean and variance of the series do not systematically differ over the time period. Regression in which the variables are non-stationary can lead to spurious result where variables may share the same time trend even though they are not really related.

Unit root test involves examining whether the series are stationary or not at level and subsequently finding the order in which they are integrated if the series is non-stationary. This study employs Augmented Dickey-Fuller (ADF) test to determine the unit root property of the stock market indices which requires regressing ΔY_i on a constant, a time trend ΔY_{t-1} and several lags of dependent terms as follows:

$$\Delta Y_t = \gamma_0 + \gamma_1 Y_{t-1} + \beta_i \sum Y_{t-1} + \varepsilon_t \qquad (2)$$

Where, Δ = first difference operator

$\gamma_0, \gamma_1 and\ \beta_i$ = coefficients to be estimated

Y_t = non-stationary time series

ε_t = error term at time t

The test statistics known as the tau statistics are checked against the critical values tabulated by Dickey and Fuller on the basis of Monte Carlo simulations[i]. The null hypothesis of series contain a unit root is rejected if t-statistics is smaller (more negative) than the critical value respectively. The Durbin-Watson test values are also observed. DW test statistics value of 2 or very close to 2 will indicate that the test result is reliable i.e. indication of no autocorrelation problem. Next the presence of co-movement between the stock market indices is tested using co-integration test.

3.2.4 Co-integration Test

Co-integration test is among the most widely used method in examining the relationship or integration in financial market. The concept of co-integration was introduced by Granger (1981) and further developed by Engle and Granger (1987) which incorporates the presence of non-stationary, long-term relationship and short-run dynamics in the modelling process. A series is said to be integrated of order one i.e., I (1) if it becomes stationary after the first differencing. If there exists a linear combination of two or more I (1) series that its stationary, then the series are co integrated. Co-integration requires that the variables to be integrated of the same order. Thus, this study employs Augmented Dickey Fuller (ADF) tests to determine the order of integration for every stock return. When both the variables are integrated of same order, then the estimate the co-integrating regression is carried out using ordinary least square.

$$Y_t = \beta_0 + \beta_1 X_t + \mu_t \tag{3}$$

Where Y and X are non-stationary series. The residuals, denotes as μ_t are then tested to ensure that they are I (0) by running the Augmented Dickey-Fuller (ADF) test. The time series is said to be co-integrated if the residual is itself stationary, I (0). The residual will still be non-stationary if the time series are not co-integrated. In result the non-stationary I (1) series have cancelled each other out to produce a stationary I (0) residual.

Next the test statistics against the critical values are checked. If t-statistics is smaller (more negative) than the critical value, null hypothesis of residuals contain unit root is rejected and conclude that the residuals or the error term is stationary. This would imply that the two stock indices are co-integrated.

3.2.5 Error Correction Model (ECM)

When the two stock indices are co-integrated, this also implies that there is a long-term equilibrium relationship between them. To test if there may be disequilibrium in the short run, the residual of the co-integrating regression is used to tie its short-run behaviour to its long-run value. According to the Granger Representation Theorem, if two variables are co-integrated, then the relationship between the two can be expressed as an Error Correction Model (ECM). In this model, the error term from the OLS regression, lagged once acts as the error correction term. The ECM allows the introduction of past disequilibrium as explanatory variables in the dynamic behaviour of current variable thus enables to capture both the short-run dynamic and long-run relationships between the stock indices. The basic ECM is as follows:

$$Y_{t-1} = \alpha_0 + a_1 X_{t-1} + \alpha_2 \mu_{t-1} + \varepsilon_t \tag{4}$$

Where μ_{t-1}, is the lagged value of error correction term derived from the co-integration regression and ε_t is the residual or error term with the usual properties. The model relates to the changes in the dependent variable i.e., stock index Y to the change in independent variables i.e., stock index X and the "equilibrating" error in the previous period.

In the above regression, X_{t-1} captures the short-run disturbance in stock index X. The F-tests of the differenced independent stock index X_{t-1}, give a sign of the short-term causal effects. Meanwhile, μ_{t-1} captures the adjustment toward the long-run equilibrium. The long-run relationship is indicated through the significance of the t-test of the lagged error correction term μ_{t-1}. However, the coefficient of the error correction term α_2 is a short-term adjustment coefficient. It will explain the speed of adjustment back to equilibrium if it is statistically significant. In other words, it represents the proportion by which the long-run disequilibrium in stock index Y is being corrected in each short period.

4. Research Results

4.1 Descriptive Statistics

The descriptive statistics for all the eight stock indices under study are given in Table 1. These include the distribution of mean, standard deviation, skewness and kurtosis. For the purpose of comparison, the daily closing price index for each stock market is transformed to its return form.

Table 1. Descriptive Statistics

	SHCOMP	SZCOMP	SENSEX	NIFTY	DJIA	FTSE	NKY	HSI
Mean	0.027	0.031	0.057	0.059	0.006	-0.002	-0.033	0.003
Median	0.050	0.101	0.139	0.148	0.037	0.023	-0.013	0.037
Maximum	9.857	9.684	8.254	8.295	6.348	6.082	14.150	10.721
Minimum	-8.841	-8.543	-11.139	-12.238	-7.129	-5.481	-11.406	-8.867
Std. Dev.	1.716	1.819	1.615	1.604	1.095	1.160	1.539	1.540
Skewness	0.163	-0.120	-0.414	-0.492	0.014	-0.072	-0.294	-0.047
Kurtosis	7.547	6.828	6.337	7.130	6.317	5.702	10.380	8.518
Jarque-Bera	1879.226	1329.949	1069.148	1629.552	995.011	661.829	4955.139	2753.485

In term of absolute value, the mean of the two Indian markets are greater than other indices. Meanwhile, in the same observation period, the Chinese markets index has been the most volatile while the DJIA index is the least volatile. Table 1 also shows that the indices' skewness values are negative, and that all the indices have Kurtosis values larger than 3, which indicate fat-tails. Therefore, the Jarque-Bera (JB) values of the indices imply that none of the indices is normally distributed which is consistent with prior literature.

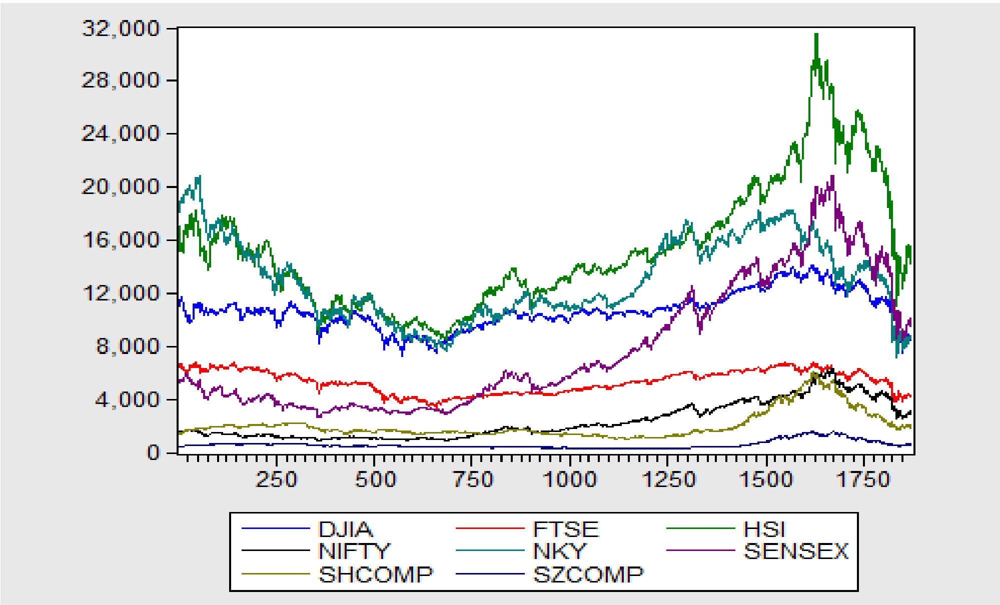

Figure 2. Movement of the Indices in the Observed Period

Figure 2 above presents the movement of all the eight indices in the observed period from

January 2000 to December 2009. As can be seen in Figure 2, Hang Seng and Nikkei record the market capitalizations that are much higher than those of the other observed indices. Interesting observation from Figure 2 is that Sensex's market capitalization started to increase in the year 2005. All stock indices started to decline or having negative growth in the February 2008 onwards. This is contributed by the credit crisis that took on a full head stem from August 2007 where most world stock markets are falling in tandem with each other.

4.2 Analysis of Correlations

The correlations between the stock indices for the period of January 2000 to December 2009 are computed to measure the strength of the association between the stock indices. Table 2 presents the simple correlation coefficients among the 8 stock indices under study.

Table 2. Correlation of stock price indices

	SHCOMP	SZCOMP	SENSEX	NIFTY	DJIA	FTSE	NKY	HSI
SHCOMP	1.000							
SZCOMP	0.985	1.000						
SENSEX	0.749	0.686	1.000					
NIFTY	0.750	0.688	0.999	1.000				
DJIA	0.731	0.683	0.817	0.813	1.000			
FTSE	0.530	0.529	0.532	0.522	0.814	1.000		
NKY	0.417	0.397	0.514	0.500	0.762	0.912	1.000	
HSI	0.828	0.791	0.918	0.918	0.895	0.733	0.671	1.000

While the numerical values of correlation coefficients may range from 1.0 to -1.0, the majority of the correlation in Table 2 exceeds 0.3 and often exceeds 0.5. From the result, we can see that both Shanghai and Shenzen are highly correlated with Hang Seng with correlation coefficient of 0.82 and 0.79 respectively. This may be due to the close proximity between the markets resulting in increase money flows as investors can easily switch investments between the two markets. Thus stock price indices between China and Hong Kong tend to correlate.

Correlation between Shanghai and Shenzen stock indices with both Sensex and Nifty are also higher than correlation between them and DJIA. This suggests that both Shanghai and Shenzen are more correlated with India as compared to U.S. in the period under study. The increasing economic interdependence between the China and India has contributed to the high correlation or co-movement between the two markets.

China has relatively lower correlation with U.K. and Japan as the correlation between Shanghai and Shenzen indices with FTSE and Nikkei are lower. The result also indicates that the correlations between Sensex and Nifty with Hang Seng index are relatively high. This implies that India is highly correlated with Hong Kong. The correlation between Sensex and Nifty with DJIA are also quite high suggesting that there is a positive correlation between India and U.S. Nevertheless, there is no negative correlation found between the eight markets under study for the period. Overall, the results from the correlation coefficients suggest some insight on the short-term relations between China and India with other major markets.

4.3 Analysis of Granger Causality Test

The Granger Causality test is conducted to investigate direction of causality between Chinese and Indian market with other major stock markets. The F-statistics from the Granger Causality test results is presented in Table 3.

Panel A in the table below show the result of Granger Causality test between Chinese market and other major markets. The test results suggest that there is a bi-directional causality between both Shanghai and Hang Seng. A unidirectional causality exists between Shanghai and DJIA where DJIA Granger causes Shanghai. Similarly, FTSE also Granger causes Shanghai and hence they have a unidirectional causality. The results also show that Shanghai Granger causes Nikkei which implies that they also have unidirectional causality. Similar result with Shanghai, Shenzen also has bidirectional causality with Hang Seng and a unidirectional causality with FTSE and Nikkei. However, an interesting result to note is Shenzen has bidirectional causality with DJIA which is not the case for Shanghai.

Table 3. Results of the Granger Causality Test

Panel A			Panel B			Panel C		
Causality	**F-statistics**	**P-Value**	**Causality**	**F-statistics**	**P-Value**	**Causality**	**F-statistics**	**P-Value**
SHCOMP → DJIA	.3915	0.2045	Sensex → DJIA	.3915	0.2045	SHCOMP → Sensex	2.6823*	0.0092
DJIA → SHCOMP	13.7304*	0.0000	DJIA → Sensex	13.7304*	0.0000	Sensex → SHCOMP	4.8723*	0.0000
SHCOMP → FTSE	2.2727	0.0264	Sensex → FTSE	2.2727	0.0264	SHCOMP → Nifty	2.5449*	0.0131
FTSE → SHCOMP	7.7012*	0.0000	FTSE → Sensex	7.7012*	0.0000	Nifty→ SHCOMP	4.1352*	0.0002
SHCOMP → NKY	4.2241*	0.0001	Sensex → NKY	4.2241*	0.0001	SZCOMP → Sensex		
NKY → SHCOMP	0.6580	0.7079	NKY → Sensex	0.6580	0.7079	Sensex → SZCOMP	3.2893*	0.0018
SHCOMP → HSI	2.2102*	0.0309	Sensex → HSI	2.2102*	0.0309	SZCOMP → Nifty	3.3279*	0.0016
HSI → SHCOMP	3.4602*	0.0011	HSI → Sensex	3.4602*	0.0011	Nifty→ SZCOMP	3.5449*	0.0009
SZCOMP → DJIA	2.7042*	0.0086	Nifty → DJIA	1.7164	0.1008		2.7291*	0.0081
DJIA → SZCOMP	2.9075*	0.0050	DJIA → Nifty	13.4686*	0.0000			
SZCOMP → FTSE	1.2501	0.2717	Nifty → FTSE	2.3895*	0.0196			
FTSE → SZCOMP	3.6839*	0.0006	FTSE → Nifty	7.5921*	0.0000			
SZCOMP → NKY	2.1465*	0.0362	Nifty → NKY	3.4333*	0.0012			
NKY → SZCOMP	1.0607	0.3865	NKY → Nifty	0.6698	0.6979			
SZCOMP → HSI	7.3174*	0.0000	Nifty → HSI	1.9739	0.0551			
HSI → SZCOMP	2.6358*	0.0104	HSI → Nifty	4.0323*	0.0002			

* indicates significance at the 5% level

Panel B show the result of Granger Causality test between Indian market and other major markets. The results show that Sensex has bidirectional causality with HangSeng. This result supports the high correlation found between them in the analysis of correlation earlier.

Meanwhile, there is also evidence unidirectional causality from DJIA to Sensex and FTSE to Sensex. In other words, Sensex is Granger caused by the DJIA and also FTSE. Results also suggest that Sensex does Granger causes Nikkei. A different causality is found in another Indian stock index i.e. Nifty. The results show that Nifty has bidirectional causality with FTSE. There is also unidirectional causality from DJIA to Nifty and Hang Seng to Nifty. Similar with Sensex, Nifty also does Granger causes Nikkei. The direction of causality between the two major emerging markets i.e. China and India are also examined here. The results of Granger causality test between the two markets is presented in Panel C. It is found that there is bidirectional causality between China and India. This can be seen in the increased amount of bilateral trade between the two countries over the years.

To sum up, overall results of Granger causality test suggest that the Chinese market has bidirectional causality with the Hong Kong market. This support the evidence of high correlation between the two markets in the analysis of simple correlation conducted earlier. Another interesting result is the evidence of bidirectional causality between China and India.

4.4 Analysis of Unit Root Test

Augmented Dickey-Fuller (ADF) test is used to test the stationarity of the stock price indices. The result of ADF unit root test in Table 4 shows that the null hypothesis of a unit root cannot be rejected, which indicates that all stock indices are non-stationary series. However, since the t-statistics is smaller (more negative) than the critical value in the first difference form, there is no evidence to support that the presence of unit in the series. Hence, all the stock price indices are stationary, and integrated of order one, I (1) which is consistent with results in the finance literature.

Table 4. Augmented Dickey-Fuller test results

Stock Index	Level (with intercept and trend)	First Difference (Constant)
SHCOMP	-0.9696	-45.2038
SZCOMP	-1.1197	-42.5494
Sensex	-1.6728	-42.7364
Nifty	-1.7862	-43.8788
DJIA	-2.0061	-45.6734
FTSE	-2.0221	-33.9525
NKY	-1.8336	-42.6997
HangSeng	-1.9343	-45.3721
1% Critical Value	-3.9630	-2.5662
5% Critical Value	-3.4122	-1.9410
10% Critical Value	-3.1280	-1.6166

4.5 Analysis of Eagle Granger Test

Once identifying that all stock indices are integrated of same order, then the co-integrating regression using OLS are estimated. The residuals, denotes as μ_t are tested to ensure that they are stationary by running Augmented Dickey-Fuller (ADF) test. The result of the ADF test on the residuals of the regression is presented in Table 5 below. Schwarz Info Criterion is used to determine the appropriate number of lags. The DW test statistics from each regression equations are examined to ensure that there is no autocorrelation problem.

Since the test statistics are smaller (more negative) than the critical value, null hypothesis of residuals contain unit root is rejected and conclude that the residuals or the error term is stationary. This would imply that the two stock indices are co-integrated. Hence the results indicate that Shanghai and Shenzen Composite Index are co-integrated with DJIA, FTSE, Nikkei, Hang Seng, Sensex and Nifty. In other words, China is co-integrated with U.S., U.K., Japan, Hong Kong and India stock market.

Similarly, the results also indicate that Sensex and Nifty Composite Index are co-integrated with DJIA, FTSE, Nikkei, HangSeng, Shanghai and Shenzen composite index. In other words, India is also co-integrated with U.S., U.K., Japan, Hong Kong and China stock market. The findings where stock market indices are co-integrated means that there is a linear combination between the indices that forces these indices to have a long-term equilibrium relationship even though the indices may wander away from each other in the short run.

Table 5. Unit Root Test applied to the Residuals of Cointegrating Regressions

Indices	**Test statistics for residuals**	**Indices**	**Test statistics for residuals**	**Indices**	**Test statistics for residuals**	**Indices**	**Test statistics for residuals**
SHCOMP / DJIA	-45.3205	SZCOMP / DJIA	-42.5724	Sensex / DJIA	-44.3596	Nifty / DJIA	-45.4221
SHCOMP / FTSE	-45.6862	SZCOMP / FTSE	-42.6642	Sensex / FTSE	-45.1657	Nifty / FTSE	-46.2349
SHCOMP / NKY	-44.6919	SZCOMP / NKY	-41.7810	Sensex / NKY	-45.0863	Nifty / NKY	-45.9832
SHCOMP / HangSeng	-44.3255	SZCOMP / HangSeng	-40.8034	Sensex / HangSeng	-43.4152	Nifty / HangSeng	-43.8789
SHCOMP / Sensex	-45.9762	SZCOMP / Sensex	-42.4048	Sensex / SHCOMP	-43.4695	Nifty / SHCOMP	-44.3998
SHCOMP / Nifty	-45.7357	SZCOMP / Nifty	-42.0861	Sensex / SZCOMP	-42.5959	Nifty / SZCOMP	-43.4066
1% Critical Value	-2.5662		5% Critical Value	-1.9410		10% Critical Value	-1.6166

4.6 Analysis of Error Correction Model

As stated in Granger Representation theorem, the relationship between two co-integrated variables can be expressed as error correction model (ECM) which is useful to capture both the short-run dynamic and long-run relationships between the stock indices. Table 6 below summarise the F-statistics, coefficient of the lagged value of error correction term (ECT) and the t-ratio between pairs of stock market indices of China and India with four major markets. This bivariate co-integration, if it exist will reveal the existence of a long-run equilibrium.

The significance of the F-statistics on the lagged value of ECT, suggests that short-run causality exists between the two co-integrating indices. On the other hand, the long-run relationship is captured through the significance of the t test of the lagged error correction term.

Table 6. Bivariate ECM for Co-integrated Indices

PANEL A				PANEL B			
Stock Indices	**α_2**	**t-stat for μ_{t-1}**	**F**	**Stock Indices**	**α_2**	**t-stat for μ_{t-1}**	**F**
SHCOMP / DJIA	-0.047	-2.043*	3.068*	Sensex / DJIA	-0.026	-1.108	48.293*
SHCOMP / FTSE	-0.054	-2.334*	12.353*	Sensex / FTSE	-0.044	-1.895*	125.877*
SHCOMP / NKY	-0.036	-1.535	51.614*	Sensex / NKY	-0.045	-1.935**	217.661*
SHCOMP/ HangSeng	-1.024	-1.031	189.966*	Sensex/ HangSeng	-0.004	-0.154	611.053*
SHCOMP / Sensex	-0.062	-2.667*	93.646*	Sensex/ SHCOMP	-0.006	-0.245	89.781*
SHCOMP / Nifty	-0.057	-2.440*	105.705*	Sensex / SZCOMP	0.015	0.636	59.551*
SZCOMP / DJIA	0.015	0.664	0.431	Nifty / DJIA	-0.049	-2.132*	44.562*
SZCOMP / FTSE	0.013	0.571	4.593*	Nifty / FTSE	-0.067	-2.909*	118.953*
SHCOMP / NKY	0.032	1.374	36.134*	Nifty / NKY	-0.065	-2.787*	212.886*
SHCOMP/ HangSeng	0.060	2.573*	125.535*	Nifty / HangSeng	-0.014	-0.611	628.000*
SHCOMP / Sensex	0.019	0.835	59.706*	Nifty / SHCOMP	-0.027	-1.163	103.151*
SHCOMP / Nifty	0.027	1.163	68.056*	Nifty / SZCOMP	-0.004	-0.181	67.349*

* indicates significance at the 5% level

** indicates significance at the 10% level

Panel A presents the result tested between Shanghai and Shenzen index with other indices. The significance of the F stat on lagged value of independent stock index X_{t-1}, suggests that short-run causality exist between Shanghai and all indices at the 5 per cent level. There is also evidence of short-run causality between Shenzen and other indices except DJIA, which means that there is no causal link from DJIA to Shenzen. However, the significant of t stat on the lagged error correction term μ_{t-1} suggests that there is long-run relationship between Shanghai and DJIA, FTSE and both Indian stock indices i.e. Sensex and Nifty at 5 per cent level. However for Shenzen, long-run relationship is only found with Hang Seng.

The results of F stat and t ratio for Indian market are summarized in Panel B. The results saw both Sensex and Nifty have short-run causality with all the four major markets. However, Sensex is found to have a long run relationship only with FTSE as evidence by the significance of t stat on lagged error correction term at 5 per cent. Result also suggests that Sensex has a long run relationship with Nikkei at 10 per cent level. Therefore, Nifty is found to have a long run relationship with DJIA, FTSE and NKY.

Although the ECT is only statistically significant in few equations, we cannot assume that all other markets are non-causal to both Sensex and Nifty since the short run channel still active indicated by the significance F stat in all equations of Sensex and Nifty with other markets.

5. Conclusion

This study has investigated the linkage of both Indian and Chinese market with other major developed markets namely United States (U.S.), United Kingdom (U.K.), Japan and Hong Kong. Extending related empirical studies, the correlation test is used as preliminary phase of examining the linkages between the markets. Next the co-integration test is applied to comprehensively investigate the direction of relationship.

Based on the analysis of correlation, it was found that both China and India are highly correlated with U.S. This is not surprising as U.S is the world's foremost stock market and has large influence on other stock markets. Beside that U.S. is also one of the main trading partners for both China and India.

It was also found that China is highly correlated with Hong Kong. This may be due to the close proximity between the markets resulting in increase money flows as investors can easily switch investments between the two markets. Thus stock price indices between China and Hong Kong tend to correlate. India is also found to have high correlation with Hong Kong.

Both Chinese and Indian markets are found to be highly correlated. The increasing economic interdependence between the China and India has contributed to the high correlation or co-movement between the two markets. Overall, the results from the correlation coefficients suggest some insight on the short-term co-movement between China and India with other major markets which suggests that the benefits of any short-term diversification, or speculative activities, are limited between them.

Several interesting observations emerge from the Granger Causality analysis. First, the findings show that there is bi-directional causality between China and Hong Kong. Again, this result supports the high correlation found between the two markets. China is also found to have bidirectional causality with U.K. China is also found to have unidirectional causality with Japan where China Granger causes Japan but not vice versa. Interestingly, different results are found between Shanghai and Shenzen with U.S market. It was also found that U.S does Granger causes Shanghai but not vice versa. However, Shenzen found to have bi-directional causality with U.S market.

Secondly, U.S market is found to Granger causes the Indian market but not vice versa. Whereas, Indian market is found to Granger cause the Japanese market but not vice versa. There is also short run causality between India-U.K and India-Hong Kong market. This result contradicts with Chattopadhyay and Behera (2006) where they found that US, UK and HK stock markets Granger cause the India stock market but do not vice versa.

Thirdly, bidirectional causality is found between the Chinese and Indian markets. This is also further supported by the high correlation found between the two markets earlier. However, this finding slightly differs from Chen *et. al.* (2006) which found that the Chinese market

Granger causes the Indian market but not vice versa.

In terms of co-integration it is seen that there is evidence of co-integration relationship across the markets under study. China is found to be co-integrated with U.S., U.K., Japan, Hong Kong and India stock market. Similarly, India is also co-integrated with U.S., U.K., Japan, Hong Kong and China stock market. Meanwhile the Chinese market is also co-integrated with Indian market.

Subsequently the error correction model (ECM) analysis showed that there is short-run causality between the Chinese markets with all the other indices. However, long run relationship is only found between China and U.S, U.K, Hong Kong and Indian market. Similarly, the analysis of ECM suggests that the Indian market does have short run causality with all the four major developed markets. However, long-run causality is only found between the Indian market with U.S., U.K. and Japanese market.

In conclusion, both Chinese and Indian market is correlated with all four developed markets under study namely U.S., U.K., Japan and Hong Kong. This result is further confirmed with the analysis of Granger causality where the both Chinese and Indian markets have at least had unilateral causality with all four developed markets. Plus there are linkages between the Chinese and Indian market. The relationship can be seen in the increasing bilateral trades between both countries as India is also one of the largest trading partners of China in South Asia.

In terms of diversification opportunities this does not mean that the Chinese and Indian markets are no longer beneficial to investors, as they could switch investments into other different emerging markets that have sufficiently low correlation to developed markets.

References

Abbas V., and Surachai C., (2008). Dynamic linkages between Thai and international stock markets", *Journal of Economics Studies,* 35, pp. 425-441.

Aggarwal R., Lucey B. M., Muckley C., (2003). Dynamics of Equity Market Integration in Europe. *Journal of Economic Literature*, 3, No. 4

Asimakopoulos, I., Goddard, J. and Siriopoulos, C. (2002). Interdependence between the US and major European equity markets: evidence from spectral analysis, *Applied Financial Economics*, 10, 41–7.

Chattopadhyay and Behera. (2006). Financial Integration for Indian Stock Market Working Paper, 12th Annual Conference On Money And Finance In The Indian Economy

Chi, J.; K. Li; and M. Young. (2006). Financial Integration in East Asian Equity Markets. *Pacific Economic Review* 11, 4: 513-526.

Choudhry T, Lu L and Peng Ke (2007). Common Stochastic Trends among Far East Stock Prices: Effects of the Asian Financial Crisis, *International Review of Financial Analysis*, 16, 242-261.

Click R. W., and Plummer M. G., (2005). Stock Market Integration in ASEAN after the Asian Financial Crisis, *Journal of Asian Economics*, 16, 5-28.

Golaka, C. Nath, (2003). Integration of Global Equity Markets – A case for India, *NSE News*, November, pp.11–16.

Granger, C.W.J. (1969). Investigating Causal Relations by Econometric Methods and Cross-Spectral Methods, *Econometrica*, 34, 424-438.

Hilliard, J.E. (1979). Relationship between Equity Indices on World Exchanges, *Journal of Finance*, 34, pp. 103-104.

Janak, R., and Sarat D. (2008). Integration of India's stock market with global and major regional markets, BIS Papers, No. 42

Leong. S. C. and Felmingham. B. (2001). The interdependence of share markets in the developed economies of East Asia. *Pacific-Basin Finance Journal*. 11: 219–237.

Lim, L.K., and McAleer, M. (2004). Convergence and catching up in ASEAN: a comparative analysis, *Applied Economics*, 36, 2, pp.137-53.

Royfaizal, R. C., Lee, C and Mohamed, Azali. (2007). Asean-5+3 and US Stock Markets Interdependence Before, During And After Asian Financial Crisis, MPRA Paper 10263, University Library of Munich, Germany

Tan, K. B., and Y.K. Tse. (2002). The Integration of the East and South-East Asian Equity Markets, International Center for the Study of East Asian Development Working Paper No. 2002-11.

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[i] D. A. Dickey and W. A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, vol. 74, 1979, pp. 427-431.