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ASSESSING THE COINTEGRATION AMONG MAJOR EMERGING ASIAN STOCK MARKETS: A VECTOR ERROR CORRECTION MODEL APPROACH

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Abstract

The impact of globalization made it more complex for the investors to make investment decisions. The portfolio creation and management became more challenging. The financial crisis has revealed the influence of financial contagion in stock markets across the globe and has gained attention of researchers and academia. The literature identifies the cointegration among the markets as the most significant reason for the spread of contagion in the markets. This scenario increases the risk of investing in global markets and results in a steep fall in the benefits gained by the investor attributing to portfolio diversification.

This study examines the presence of cointegrating relationships among four major emerging Asian markets. A Johansen cointegration test is applied and a vector error correction model is estimated on the indices values of 4 markets vis. China, India, Indonesia and South Korea. Johansen cointegration test confirms the presence of a significant cointegrating vector among the markets. Estimates of vector error correction model establish a long-run association among China, India and South Korea. The study also identifies that the Chinese market is a profitable choice for international investors in their portfolio diversification strategies over the short-run.

Keywords: Stock market integration, Emerging Asian markets, Johansen cointegration test, Vector error correction model.

JEL classification: F15, F36, G11, G15.

1. INTRODUCTION

The stock market interdependencies and co-movements have gained immense attention among the financial researchers and academicians in the recent times, particularly after the assortment of various financial crises such as Asia 1997, Brazil 1998, and the most recent subprime crisis of 2008. The empirical

finance has made a good number of attempts to establish the existence of international market integration and financial contagion, to find out the factors contributing to such interlinkages and to understand their impacts. For instance, Carrieri et al. (2007) shows that there exists a partial time-varying integration of Asian and Latin American emerging markets with the world market. Dhanaraj & Gopalaswamy (2013) reasons the increased interlinkages between the stock markets to the increase in the extent of globalization and liberalization of markets. They also attribute the same to the rapid growth in technology. Chari & Henry (2008) proves that increased level of integration among the markets contributes to the increase in real investments and to the decrease in the cost of capital. Majority of these studies focuses on the interlinkage during and around crises periods.

However, the present study does not focus on financial crisis rather it deals with co-integration of the four major emerging capital markets of Asia in normal times where the former is more or less associated with financial contagion while the latter with co-integration.

The remainder of this paper is structured as follows: Section 2 presents a review of literature on financial market co-integration, Section 3 describes the methodology adopted, Section 4 discusses about the data used in the analysis and the descriptive statistics for the data sets used, Section 5 reports the major findings of the study and Section 6 concludes the paper.

2. LITERATURE REVIEW

The market literature has widely focused on the integration among stock markets across the globe during the past two decades. The empirical findings emphasizes that the development of financial markets along with increased interlinkages among such markets can contribute to the elimination of exchange barriers leading to more effective and competitive capital allocation which in turn will add to the economic and financial growth of the countries (Calvi, 2010).

Agrawal & Rivoli (1989) while studying the linkages between equity returns in the US and four Asian equity markets, established a critical inclination of the latter towards the former on a daily basis. They provided that the stock price on day t in New York is significantly impacting the stock prices in the Asian markets on day t+1 and Malaysia is found to be having the strongest integration with the developments in the US market. Similarly, in a vector error-correction and level VAR model approach, Masih & Masih (1999) also attempted to identify the long-run relationship between the newly industrializing markets of Asia that includes Hong Kong, Singapore, South Korea and Taiwan and the developed markets vis. Japan, the US, Germany and the UK.

Meric et.al. (2012) analysed the contemporaneous co-movement of Asian securities markets and the time series lead/lag linkages between them. They inferred that the markets exhibiting highly positive correlations with close co-

movement patterns do not possess any prospects for effective portfolio diversification.

The literature also gives empirical evidences for integration between the Middle Eastern and North African (MENA) stock markets and the rest of the world (Darrat et al., 2000; Neaime, 2012). Such studies focuses on the possibilities of profitable portfolio diversification opportunities to the international investors in these markets. Similarly, the integration of European stock markets is also widely studied in the literature showing that the Central European markets such as Czech Republic, Hungary, Poland and Slovakia are inclined to exhibit stronger associations with the developed countries (Syriopoulos, 2007).

Apart from establishing co-movements during the normal times, the empirical literature also provides that certain events can have significant influence on the extent of cointegration among the stock markets. For instance, Malliaris &Urrutia (1992) exhibit that the cointegration among the stock markets in Singapore, Australia, Hong Kong, the UK, the US, and Japan has considerably increased in the outset of the 1987 stock market crash. Similarly, while attempting to detect the existence of momentous interfaces among the stock markets in European Union (EU), Oanea, D. C. (2015) report financial crisis as a factor significantly attributing to the co-movements of financial markets in the region. On the other hand, Hon, Strauss & Soo-Keong (2004) establish the presence of financial contagion followed by the terrorist attacks on the US.

The review of literature provide extensive evidences of cointegration of stock markets in different regions. However, it is found lacking concise evidence of the co-movements and cointegration among the emerging Asian stock markets which are growing in a rapid pace and possessing immense investment opportunities. Given that exploring such co-movements can significantly contribute to the international portfolio diversification strategies in a globalized world, the presents study aims at investigating the existence of co-movements and inter-linkages among four major emerging Asian stock markets viz. China, India, Indonesia and Republic of Korea.

3. DATA AND METHODOLOGY

The period post the financial crisis of 2007-08 is considered for this study which is from 01-04-2009 to 31-03-2017. The data used in the analysis consists of the most important stock market indices of four markets which are considered as major emerging markets of Asia by MSCI emerging markets index. The markets included are China (Shanghai Composite Index), India (NIFTY 50), Indonesia (Jakarta Stock Exchange Composite Index) and Republic of Korea (The Korea Composite Stock Price Index). The study employed historical daily closing values of the indices that are collected from Bloomberg database.

The descriptive statistics is used to understand the basic nature of the data used. As given by Dickey and Fuller (1979), the unit root tests are conducted to ensure the stationary properties of the data. The Augmented Dickey – Fuller (ADF) test and Philip – Perron (PP) test were carried out on the values of market indices.

The term "cointegration" used in this study is strictly referring to the time series assuming that a linear combination of two or more non-stationary variables can be stationary if there exists a long-run association among them, given that differencing non-stationary variables may result in losing significant information about original variables (Engle and Granger, 1987). Keeping this assumption intact, the maximum likelihood test is performed as recommended by Johansen (1988). Further, a K-dimensional vector error correction model is estimated as given by the following equation:

$$\Delta y_t = v + \pi y_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

y_t, v, ε_t are $k \times 1$ vectors where y_t is that of values of market indices, and ε_t is of errors. In the present model $k = 4$. Given the number of market indices considered for the study is 4, it employs a 3×1 (3-dimensional) vector error correction model.

4. EXPLORATION OF DATA

Figure 1 exhibits the price evolution of all the four indices considered in the study. It is evident from the figure that the Indian stock market has the largest and Republic of Korea has the lowest index values. The figure provides a general picture of the market movements post the global financial crisis. The markets are found to be exhibiting tendencies of steady increase during the study period.

The movements in the daily historical returns of the four stock indices considered are presented in Figure 2. The returns of all the four indices are found to be highly volatile with Chinese market as the most volatile among the four though it demands empirical confirmation.

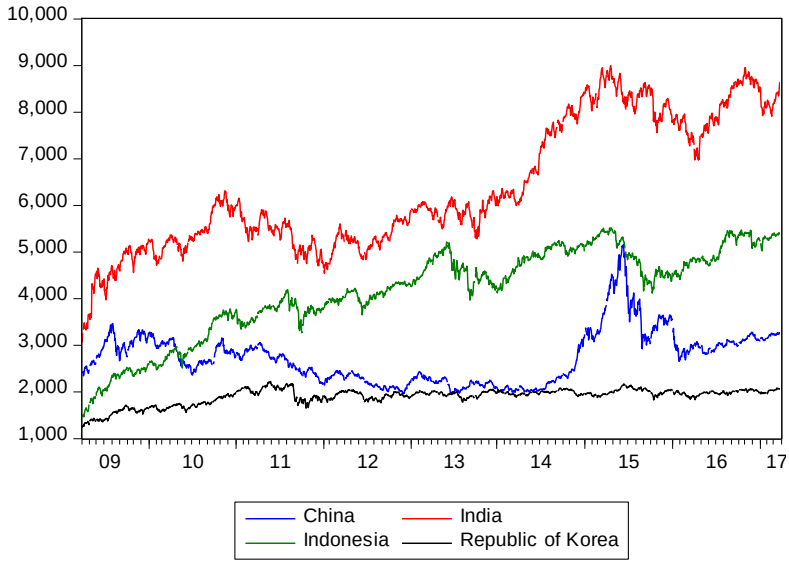

Figure 1. *Evolution of indices values for the period from April 2009 to March 2017*

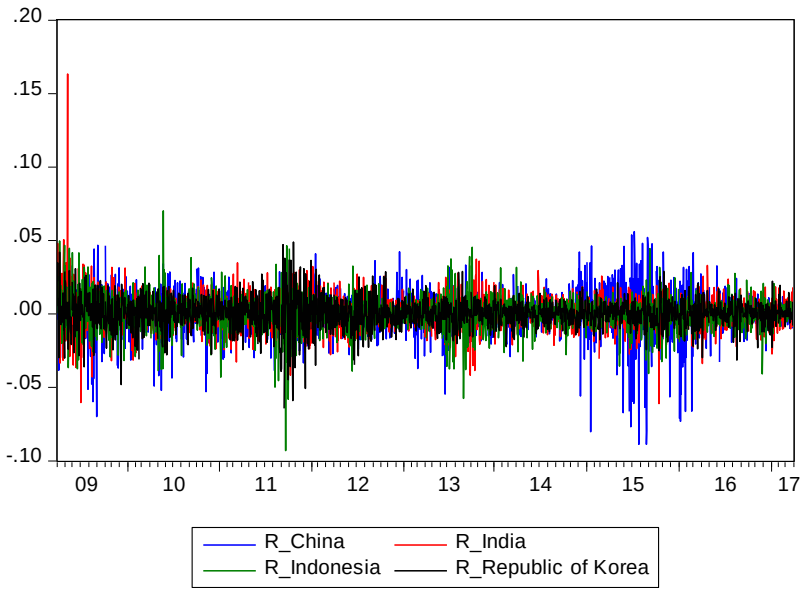

Figure 2. *The daily historical returns of indices for the period from April 2009 to March 2017*

In order to understand the basic characteristics of the data, summary statistics of the index returns are computed and presented in Table 1. From the table, the study finds Indonesian stock market as the most profitable one during the study period as it records the highest mean return with a value of 0.0684% followed by India and South Korea recording mean returns of 0.0546% and

0.028% respectively. Among the four markets, Chinese market is found to be offering the lowest mean return (0.0148%) though it is the riskiest market with a standard deviation of 1.5%. Indian market and Indonesian market are exhibiting similar level of risk (1.1%) and the South Korean market records the lowest risk (1.01%). Except Indian market, all the three markets are found to be negatively skewed indicating that the mostly record negative returns. On the other hand, Indian market is positively skewed which is in fact a good sign for the investors in this market. The Kurtosis, which indicates the degree of peakedness of the market return distribution is also presented in Table 1. The Kurtosis values for all the markets are greater than 3 indicating that the return series considered for the study are leptokurtic.

Table 1. *Summary statistics of daily returns of market indices*

	R_CHINA	R_INDIA	R_INDONESIA	R_SOUTH KOREA
Mean	0.000148	0.000546	0.000684	0.000280
Median	0.000723	0.000461	0.001177	0.000340
Maximum	0.056036	0.163343	0.070136	0.049000
Minimum	-0.08873	-0.06097	-0.092997	-0.064202
Std. Dev.	0.015001	0.011808	0.011719	0.010186
Skewness	-0.92931	1.236037	-0.393871	-0.368731
Kurtosis	7.993054	22.56807	7.951012	6.669173
Jarque-Bera	2301.553***	31543.07***	2037.873***	1135.708***

Table 2 presents the coefficients of correlation between the markets analyzed for the period from 2009 to 2017. It exhibits correlations between the index values as wells as the returns. The correlation coefficients of index values shows a strong correlation between India and Indonesia, South Korea and Indonesia, and India and South Korea. Though Indian and Chinese indices exhibits moderate correlation, Indonesian and Korean indices are found to be exhibiting weaker correlation with Chinese index. Similarly, it is found that the index returns of the four countries considered for the study are very weakly correlated which is a vital information for the international investors in framing their portfolio diversification strategies.

Table 2. *Coefficients of Correlation*

	CHINA	INDIA	INDONESIA
Index values			
INDIA	0.4984541		
INDONESIA	0.0796201	0.813141	
SKOREA	0.0463039	0.610411	0.798053867
	R_CHINA	R_INDIA	R_INDONESIA
Returns			
R_INDIA	0.0358765		
R_INDONESIA	0.0748739	-0.00906	
R_SOUTH KOREA	0.0645898	0.003914	0.014962245

5. EMPIRICAL FINDINGS AND DISCUSSIONS

This study employs Johansen cointegration test and vector error correction model (VECM) to analyze the existence of long-run as well as short-run co-movements among the four major emerging Asian stock markets viz. China, India, Indonesia and Republic of Korea (South Korea). As a prerequisite for the application of Johansen cointegration test which demands the index series to be non-stationary at their level form, but stationary at first difference, unit root test is conducted on individual series of stock market indices as represented by Augmented Dickey-Fuller (ADF) test and Philip – Perron (PP) test. Table 3 presents the result of unit root tests. Both ADF and PP tests shows that all the indices are non-stationary at their level form. The series are found stationary at first difference. The tests implies that all the selected indices are having one unit root and thus qualify to apply Johansen cointegration test. The Johansen cointegration test facilitates to analyse the existence of cointegrating relationship among the market indices considered for the study.

Table 3. *The results of unit root tests*

	ADF Test		PP Test	
	Level	1st diff.	Level	1st diff.
CHINA	-2.08063	-19.74247***	-1.948972	-41.256***
INDIA	-1.637347	-41.27749***	-1.723734	-41.19518***
INDONESIA	-2.493968	-28.22994***	-2.432227	-41.95703***
REPUBLIC OF KOREA (SOUTH KOREA)	-1.865726	-43.25348***	-1.827167	-43.34865***

The results of Johansen cointegration test is presented in Table 4. It shows the results as given by both trace statistic and maximum Eigenvalue statistics. Both the statistics suggests the presence of one cointegrating equation among the four market indices considered for the study.

Table 4. *Results of Johansen cointegration test*

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Unrestricted Cointegration Rank Test (Trace)				
None *	0.019622	76.17838	47.85613	0.0000
At most 1	0.013564	27.77224	29.79707	0.1049
At most 2	0.004014	11.30540	15.49471	0.1934
At most 3	0.001809	3.509705	3.841466	0.0610
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
None *	0.019622	38.40614	27.58434	0.0014
At most 1	0.013564	16.46685	21.13162	0.1681
At most 2	0.004014	7.795694	14.26460	0.3998
At most 3	0.001809	3.509705	3.841466	0.0610
**MacKinnon-Haug-Michelis (1999) p-values				

It can be inferred from Table 4 that there exists statistically significant cointegration among the stock market indices considered for the study at 5% level of significance rejecting the null hypothesis of no cointegrating equations. The tests confirms the existence of long run co-movements among the four market indices considered.

The empirical evidence of cointegrating vectors among the market indices make the indices data analyzed in the study fit to estimate the vector error correction model (VECM). It establishes the speed with which the indices adjust to short run changes to maintain the equilibrium position. Akaike information criterion (AIC) is used to identify the optimum lags to be employed for estimating vector error correction model. AIC provided 2 lags as optimum for the model.

In a vector error correction model, the statistically significant coefficient of the cointegrating equation which is considered as the error correction term denotes the adjustment speed of market indices back to their equilibrium level. In other words, the size of such coefficient quantifies the speed with which a market index can return to its equilibrium position implying the long run effect. In order to determine the speed of adjustment, it accounts the equilibrium errors during the past periods.

On the other hand, statistically significant individual coefficients for each index indicates the extent to which that particular index is impacted by other

indices over the short-run. Such coefficients also contain information regarding the influence of lagged values of the indices on the present indices values.

Table 5 shows the results of vector error correction model. Examining the cointegrating equation given as ECt-1, it can be confirmed the existence of statistically significant long-run interactions in all the stock markets except Indonesian market. However, the coefficients are considerably small in size indicating a slower pace correcting any disequilibrium. For instance, consider the Chinese market. The coefficient of error correction term is -0.001086 indicating that only 0.1086% of any movement in the market to disequilibrium will be corrected within a trading day. The Indian market is found to be the fastest among the markets considered for the study in the promptness of correcting disequilibrium whereas Korean market is the slowest.

The individual coefficients presented in the table indicate the short run relationships among the four indices used in the study. A number of statistically significant relationships can be identified from the table. Indian market is significantly influenced by two-period lag of Indonesian and South Korean markets. Similarly, Indonesian market is cointegrated significantly with one-period and two-period lags of South Korean market and two-period lag of Chinese market. On the other hand, South Korean market is found to be influenced only by the one-period and two-period lags of Indian stock market given that it is not getting impacted by its own lags as against the other markets which demonstrate an obvious influence of its own lags. Chinese market is found to be independent among the four emerging markets considered as it is influenced only by the past changes in itself.

Table 5. *Estimates of vector error correction model*

	D(CHINA)	D(INDIA)	D(INDONESIA)	D(SOUTH KOREA)
D(CHINA(-1))	**0.061429*** **	0.001182	-0.012804	0.008204
D(CHINA(-2))	**-0.070286*** **	-0.020327	**0.073782*** **	0.001482
D(INDIA(-1))	0.017916	**0.058612*** **	0.007554	**0.014004** **
D(INDIA(-2))	-0.008244	**-0.041142* **	-0.001657	**0.010572* **
D (INDONESIA(-1))	0.013841	0.033567	**0.056709** **	0.003041
D (INDONESIA(-2))	0.029720	**0.059261* **	-0.015880	-0.008676
D (SOUTHKOREA(-1))	0.060557	0.039060	**0.069347** **	0.023091
D (SOUTHKOREA(-2))	-0.052918	**0.161482* **	**-0.113267* **	-0.029027
EC_{t-1}	**-0.001086*** **	**-0.001736*** **	-0.000116	**-0.000473*** **
C	0.301616	2.503892	1.919443	0.351224

6. CONCLUSION

This paper examined the presence of cointegration among four major emerging Asian markets viz. China, India, Indonesia and South Korea for a period from 1st April 2009 to 31st March 2017. The study empirically proves the existence of long-run and short-run co-movements among the markets considered. It establishes statistically significant long-run cointegration between Chinese, Indian and South Korean stock markets. It is found that the two-period lag of South Korean market as the widely influencing one over short-run as it exhibits significant coefficients with Indian as well as Indonesian markets.

Indonesian market is found to be exhibiting the most statistically significant short-run relationship with any of the markets considered for the study. It shows short run relationship with Chinese market which is significant at 1% level. All other short-run relationships identified are significant either at 5% or 10% level.

Confirming the weak or moderate correlation of Chinese market with the other three markets studied, the coefficients of vector error correction model shows that the Chinese market is not exhibiting any short-run relationships with Indian, Indonesian or South Korean markets. However, it is found exhibiting highly statistically significant dependence on its own past. This information is of great value from an investor point of view as an investor from India, Indonesia or South Korea can consider China as a profitable destination in his/her international portfolio diversification decisions.

The present study aimed at analyzing the existence of cointegrating relationships among major emerging Asian stock markets. It has not made any attempts to establish other information patterns that can possibly contribute to the complex financial relationships between the markets studied which can significantly affect the cointegration between the markets. This aspect is left for further research as a detailed investigation on such information can add dimensions to the market integration and financial contagion.

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