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An Empirical Analysis of Cointegration among Asian Stock Markets

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Abstract:
The principal objective of this study is to find out the Cointegration among Asian stock markets. This study mainly concentrates to test whether Indian stock market is interdependent with the selected of Asian stock markets. The emerging stock exchanges from Asian stock markets viz. Hong Kong, Indonesia, Korea, India, Japan and Israel are selected and applied Johansen's Cointegration test. The data is collected for the period of ten years from April 2009 to July 2019. The weekly returns of HIS, JKSE, KOSPI, N225, TA125 and NIFTY for the above mentioned period are considered for testing Cointegration. The result of the study confirmed that Cointegration exists between the selected Asian stock markets.

Keywords: *Market Integration, Interdependency, Cointegration, Asian Stock, Unit Root.*

1. Introduction:

Cointegration of stock market analysis helps the global investor to take better investment decision. It helps the investor for international diversification and to minimize the risk. Essentially cointegrated stock markets exhibits long run relationship with one another. In the course of recent decades, the existence of cointegration among global stock markets has been investigated thoroughly by a number of studies in the economic literature.The cointegration among the stock markets of Asian economies was initially studied by Hung and Cheung (1995). The study applied the Johansen cointegration test to study the degree of dependency among the stock prices of the five major markets in Southeast Asia, including Hong Kong, Malaysia, Singapore and Taiwan during the period of 1981–1991.The results recommended that there was a weak co-movement of the stock prices among these five markets, particularly only three cointegration vectors were discovered in the study. Daly (2003) applied multivariate cointegration and correlation tests to analyse the co-movement of daily stock prices in Indonesia, Malaysia, Thailand, Singapore and the Philippines from 1990 to 2001. The study revealed that there was an increase of interdependencies across these five markets both earlier than and subsequent to the 1997 Asian financial crisis.In the same way, Hee Ng (2002) reinvestigated the stock market cointegration among these five economies by means of monthly data from 1987 to 1997, yet the explicit evidence of cointegration, unfortunately, has remained unobserved.Tamir(1972)investigated the share price behaviour of US, UK, Germany and Japan equity markets. The co-movement of share prices was estimated by running first and second pass regression. Thisimplies that share price changes in the three non-US countries respond immediately to changes in the price of market index.Taylor and Tonks(1989)used the bi-variate Cointegration technique and states that there is a Cointegration between the UK index and US index stock prices, Germany, Netherlands and Japan. Based on their empirical findings, they proposed the lack of long-term benefit from diversification for the UK investors after the abolition of exchange controls.Choudhury, (1997) tried to examine the cointegrating relationship

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among stock indices from six Latin American markets and the United States using Unit Root test, Johansen Cointegration and Error correction models. The results of Cointegration result possess long-run relationship between all the indices. Kumar (2002), examined whether the Indian Stocks are integrated with US, Japan, Singapore and Hong-Kong. His findings states that Indian stock market was not having cointegrating relationship with the developed markets. It indicates that there is no long run relationship between the selected markets.Nath, G. C., &Verma S (2003) examined the integration of three major stock markets viz. India, Singapore and Taiwan using multivariate Cointegration test. The result shown absence of Cointegration exists between the sample market indices. Ahmad et al (2005)explained the inter-linkages and causal relationship between the Nasdaq, Nikkei, Nifty and Sensexusing Johansen Cointegration test and Granger Causality test. The result shows that there is no long-term relationship exists between Indian stock market with US and Japanese stock markets. Tripathi and Sethi (2010)detected the integration of Indian stock market with stock markets of USA, Japan, UK and China by means of Cointegration and Correlation. They found that positive correlation was observed and weak integration shown between India and USA. Chittedi (2010) found Cointegration existing between India and developed countries (USA, UK, Japan, France and Australia).TriptiNashier (2015) examine the integration among the stock markets of BRICS and the stock markets of U.S. and U.K. The study identified the evidence for both the short-term static and long-term dynamic integration between the stock markets.Amanjot Singh and Parneet Kaur (2016) empirically analyse co-movement between BRIC countries stock markets by utilizing Johansen's Cointegration test and found that Russian market act as a cause for several market shock.

3. Objectives of the study:

1. To study the stock market interdependencies and dynamic interactions amongthe selected indices of Asian.HSI (Hong Kong), N225 (Japan), NIFTY (India), TA125 (Israel), KOSPI (Korea) and JKSE (Indonesia).
2. To establish the degree of association between selected indices of Asian Stock Markets. HSI (Hong Kong), N225 (Japan), NIFTY (India), TA125 (Israel), KOSPI (Korea) and JKSE (Indonesia).

4. Research Methodology

4.1. Hypothesis of the study:

The following null hypotheses are tested to study the cointegrationof selected indices of Asianstock markets.

1.) **Null Hypothesis (Ho1):** The stock indices of selected Asian markets are normally distributed.
Alternate Hypothesis (Ha1): The stock indices of selected Asian markets are not normally distributed.

2.) **Null Hypothesis (Ho1):** The stock Index Prices of selected Asian markets are of non-stationary i.e., Unit root exists.
Alternate Hypothesis (Ha1): The stock Index Prices of selected Asian markets are stationary i.e., No unit root exists.

3.) **Null Hypothesis (Ho1):**There is no Cointegration between stock indices of selected Asian markets
Alternate Hypothesis (Ha1): There is a Cointegration between stock indices of selected Asian markets

4.2. Data and Sources of Data:

The data is collected for the period of ten years from April 2009 to July 2019.In this study,

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closing values of weekly prices of Asian stock market indices are collected for the above mentioned periods from the respective stock exchange websites. Investigation of stock market integration is performed among Asian stock markets. The stock indices selected for this study are HSI (Hong Kong), N225 (Japan), NIFTY (India), TA125 (Israel), KOSPI (Korea) and JKSE (Indonesia). The indices are chosen based on purposive sampling.

4.3. Tools used for this study:

Returns of the indices are used to identify the Cointegration between the stock markets and monthly compounded returns have been calculated by using $r=(P_t-P_{t-1})/P_{t-1})*100$ where P_t is current closing price.

Tools used for this study are

I. **Descriptive statistics and JB Test**: To test whether data are normally distributed or not.
II. **Unit root Test:** To check the stationarity of data.
III. **Johansen's Cointegration Test:** To measure stock market interdependencies and interactions among the selected indices of Asian stock market. The Johansen's test results are compared using Trace value and Maximum Eigen value.
IV. **Correlation Coefficient:** To evaluate the degree of association between the selected stock indices stock markets. The correlation coefficient of returns of indices explains how the stock of particular market moves together with other stock markets. The result values ranges from +1 to -1. If the resulted correlation analysis shows +1 that indicates perfect positive correlation and if it is -1 it indicates perfect negative correlation. If the result is 0 there is no correlation between the selected stock markets.
V. **Vector Error Correction Model:** To find out the long run and short run causal relationship among selected indices of Asian Stock Markets.

5. Analysis and Findings:

5.1. Descriptive Statistics:

Descriptive statistics helps to explore the distribution properties of daily returns, summarizing the data and to find out the normality of time series.

Table 1: Summary Statistics

	HSI	JKSE	KOSPI	N225	NIFTY	TA125
Mean	0.165733	0.309902	0.104834	0.208953	0.267785	0.158863
Median	0.346635	0.382635	0.260792	0.291975	0.324414	0.178346
Maximum	12.04098	11.53267	7.860843	10.36248	15.43857	6.762544
Minimum	-9.49138	-10.6601	-8.88145	-11.1	-9.50105	-8.54368
Std. Dev.	2.590365	2.368985	2.008265	2.689863	2.358367	1.8578
Skewness	0.147526	-0.02403	-0.56612	-0.35928	0.44056	-0.5061
Kurtosis	4.559262	6.361514	5.046567	4.149261	6.596139	5.045382
Jarque-Bera	55.19393	247.704	122.8561	40.26373	300.4465	114.1452
Probability	0	0	0	0	0	0
Sum	87.17559	163.0086	56.50538	109.9094	140.855	83.56201
Sum Sq. Dev.	3522.745	2946.346	2169.822	3798.567	2919.996	1811.996
observations	526	526		526	526	526

Looking at the above statistics it is clearly

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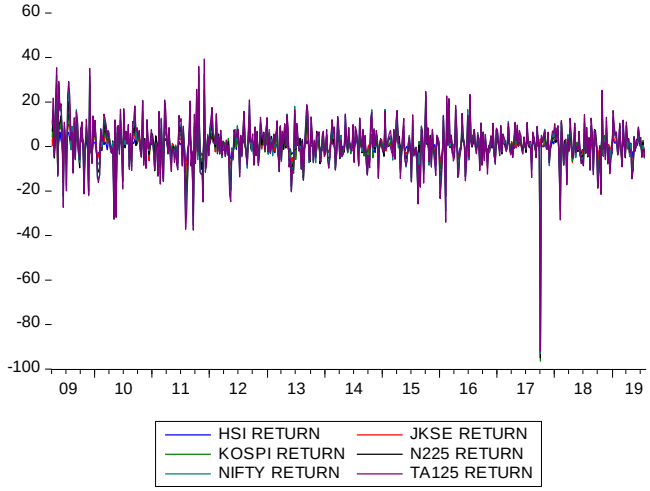
evidence that the index JKSE resulted with higher return (0.34) with lower risk (2.37) next to the index N225. Compared with all indices JKSE has highest return and TA125 index shows lowest risk. The index KOSPI shows low mean (0.10) with highest standard deviation (1.86).For any data to be random, it should possess the characteristics of a normal distribution. Skewness and Kurtosis are considered as the important distribution properties of normal distribution. Both the values are equal to 0 and 3 respectively; we can conclude that the data are normally distributed. The study result reveals that all the indices selected for this study are not normally distributed.

Movements of return of HIS, KOSPI, NIFTY, JKSE, N225 and TA125 indices are depicted below.

Fig.1 – Chart :Return movement of HIS, KOSPI, NIFTY, JKSE, N225 and TA125



5.2. Correlation Matrix:

The correlation coefficient between the stock indices during the period April 2009 to July 2019 is studied and analysed to measure the degree of association between the selected variables. Pearson correlation coefficient is used to examine the correlation between Asian stock markets. The simple correlation coefficients among six variables are given below.

Correlation Matrix

	HSI	JKSE	KOSPI	N225	NIFTY	TA125
HSI	1	0.495492	0.243409	0.58623	0.589419	0.472525
JKSE	0.495492	1	0.207813	0.315926	0.469983	0.360717
KOSPI	0.243409	0.207813	1	0.222304	0.199202	0.194838
N225	**0.586230**	0.315926	0.222304	1	0.443571	0.423461
NIFTY	**0.589419**	0.469983	0.199202	0.443571	1	0.394725
TA125	0.472525	0.360717	0.194838	0.423461	0.394725	1

The above result indicates that all the variables selected for this study are positively correlated but not at high level. Among the selected indices NIFTY and HSI are correlated at the level (0.589).

5.3. Unit Root Test:

Unit Root Test helps to check the stationarity and find out shocks in time series. Data series mean and variance are consistent over time, it is said to be stationary and vice versa. The most suitable and commonly used test is Augmented Dickey-Fuller test. The below table shows the results of unit root for Level and First difference.

Table 3 – Augmented Dickey Fuller test Result

	Level		1st Difference	
Indices	t-Statistics	Probability	t-Statistics	Probability
HIS	-2.70352	0.074	-23.7859	0.0000
JKSE	-2.09351	0.2475	-26.08	0.0000
KOSPI	-3.34563	0.0134		

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NIFTY	-1.02838	0.7445	-22.6381	0.0000
TA125	-2.45802	0.1265	-23.3877	0.0000
		Level	**1st difference**	
Critical Values	1% level	-3.44248	-3.44263	
	5% level	-2.86678	-2.86685	
	10% level	-2.56962	-2.56966	

Augmented Dickey-Fuller test result at the level indicates the series are non-stationary except the index KOSPI. If we consider the first difference of all the variables there is no evidence for unit root because the probability value is less than 5%. The null hypothesis can be rejected and the variables are stationary at first order difference I(1) for all the indices except the index KOSPI. Hence, we can employ Johansen's Cointegration test to see these variables are co-integrated or not.

5.4. Cointegration Test:

Johansen's Cointegration test is used to find out the presence of Cointegration between the variables in the long run. The Trace test result indicates that 6 cointegrating equation at 5% significant level. It clears that 6 linear combinations exist between the variables over the entire time period. If trace statistic more than critical value, we will reject the null hypothesis which means there is cointegration between the variables.

Date: 08/24/19 Time: 16:53
Sample (adjusted): 5/11/2009 7/29/2019
Included observations: 488 after adjustments
Trend assumption: Linear deterministic trend
Series: HSI_RETURN JKSE_RETURN KOSPI_RETURN N225_RETURN NIFTY_RETURN TA125_RETURN
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.** **
None *	0.221693	506.7511	95.75366	0.0001
At most 1 *	0.214880	384.4415	69.81889	0.0001
At most 2 *	0.186869	266.3852	47.85613	0.0001
At most 3 *	0.168283	165.4361	29.79707	0.0001
At most 4 *	0.129900	75.51598	15.49471	0.0000
At most 5 *	0.015478	7.612443	3.841466	0.0058

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The result of Maximum Eigenvalue also analysed to verify the result of Johansen's trace test. When the variables are more than two, maximum Eigen value test result is used to evaluate the cointegration among variables.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.** **
None *	0.221693	122.3096	40.07757	0.0000
At most 1 *	0.214880	118.0562	33.87687	0.0000

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At most 2 *	0.186869	100.9491	27.58434	0.0000
At most 3 *	0.168283	89.92013	21.13162	0.0000
At most 4 *	0.129900	67.90353	14.26460	0.0000
At most 5 *	0.015478	7.612443	3.841466	0.0058
Max-eigenvalue test indicates 6 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The result of Maximum eigenvalue test statistics also shows that there are 6 cointegrating equation exists at 5% critical value. Hence we can conclude that cointegrating relationship exists between the variables throughout the sample study period of 10 years.

Vector Error Correction Model:

Cointegration result shows that there is cointegration exist among variables. If variables are cointegrated it is necessary to identify existence of long run or short run causality relationship among selected variables. The necessity is fulfilled with the help of running restricted VAR model i.e. Vector Error Correction model.

Long run Causality between the indices JKSE, HSI, KOSPI, N225, TA125 to NIFTY index

INDICES		Coefficient	Std. Error	t-Statistic	Prob.
JKSE	C(1)	-0.536848	0.090827	-5.910654	0.0000
HSI		0.111703	0.017387	6.424395	0.0000
KOSPI		-0.915625	0.06893	-6.132818	0.0000
N225		0.077182	0.019571	3.943630	0.0001
TA125		-0.619476	0.082549	-7.504353	0.0000

Long run causality will be running from independent variables to dependent variable if C(1) is negative in sign and significant. There is necessity to run short run causality if we have significant p value but begins with positive C(1). From the above table it is interpreted that long run causality running from independent variables JKSE, KOSPI and TA125. There is no long run causality running from indices HIS and N225 to dependent variable NIFTY index.

Short run causality between the indices JKSE, HSI, KOSPI, N225, TA125 to NIFTY index

	Test Statistic	Value	df	Probability
JKSE	Chi-square	53.18728	2	0.0000
HIS		23.94983	2	0.0000
KOSPI		18.17888	2	0.0001
N225		4.279769	2	0.1177
TA125		43.35945	2	0.0000

From the above result it is interpreted short run causality running from the independent variables viz. JKSE, HSI, KOSPI and TA125 to the dependent variable NIFTY index. There is no short run causality running from index N225 to NIFTY index because the probability value is greater than 5%.

6. Conclusion:

The Cointegration between Asian stock markets have been studied using Johansen's Cointegration test. Long run causality is identified with the help

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of Vector Error Correction Model. This study focused on how Indian stock market is integrated with rest of the Asian stock markets. Return value of HSI, KOSPI, JKSE, N225, NIFTY and TA125 indices are used for this study. During the study the test outcomes explains that Cointegration exists among Asian stock markets.

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