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Cointegration among the Stock Markets of India, USA and Japan

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Abstract: *This paper documents the cointegration and causality among the stock markets of India, USA and Japan since the sub-prime crisis period. The 7-year month-end closing logarithmic returns of BSE Sensex, S&P500 and Nikkei 225 for the period 2008 -2014 have been used. Statistical and Financial Econometric Tools like Pearson's Correlation, ADF Test, PP Test, Johansen's Co-integration Test, and Granger Causality Test have been applied. The paper concludes that there exists cointegration among the Indian, US and Japanese stock markets. Also, there is unidirectional causality between the Japanese and United States stock markets.*

JEL Classification: *C22, F21, F36.*

Key words: *Stock Market Cointegration, Causality.*

1. INTRODUCTION

The largest financial markets in the world by market capitalization[2], United States and Japan stock markets have long been the source of influence for many Asian and European markets. During the financial year 2014-15, foreign institutional investors (FIIs) invested a net amount of nearly Rs 80,000 crore (US$ 13.31 billion) in India's equity market. At US$ 4.18 billion, the country's FII inflows are higher than that of other emerging economies such as Taiwan (US$ 3.6 billion), Indonesia (US$ 2.4 billion), Brazil (US$ 1.2 billion) and South Africa (US$ 0.7 billion).FIIs have made a cumulative net investment of Rs 7.08 trillion (US$ 117.77 billion) in shares since 1992, the year FII were allowed into the Indian market. During FY 14, the total number of FIIs registered in the country was 1,710[3]. The statistics indicates that India has become a destination for FIIs to diversify their international portfolio investments. The portfolio diversification will serve its purpose, only if the Indian stock market provides a trend reversal or trend neutral returns vis-à-vis the global market returns. An investor would find the incentive to invest in India, if the returns and risk are attractive and affordable.

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The hedging strategy of investing in India will work well for the FIIs, if the Indian stock market do not trend with the global stock markets.

The sub-prime crisis in US and European economies has prompted the global investors to look for investment opportunities beyond the US and Japanese markets, into the emerging economies like Brasil, Russia, India, and China. The current study is motivated to study the cointegration between the Indian stock market, US stock market and Japanese stock market after the 2008 sub-prime crisis period.

The rest of the paper is organized as follows: Section 2 covers the review of previous studies, Section 3 provides the Objectives, Section 4 discusses Methodology of the study, Section 5 discusses the results and Section 6 concludes the paper.

2. COINTEGRATION BETWEEN STOCK MARKETS - REVIEW OF PREVIOUS STUDIES

The concept of financial market cointegration has been driven by the studies considering US and Japan as prime movers of the stock markets around the world. US in the west and Japan in the east have been the source of influence for other markets, owing to their market capitalization and time zone differences.**Arshanapalli (1995)** documented the strong linkage between the US and Asian Markets, post October 1987 US market crash, whereas questioning the linkages among the Asian markets themselves and highlighted that US market has more linkages with the Asian markets than Japan. Exhaustive studies like **Chan *et al.* (1997)**collectively studied 18 nations and found that countries were increasingly cointegrated and attributed the causes to formation of trading blocks and formation of common economic systems. **Tokic (2003)**, **Wong *et al.* (2004)**observed that developed markets like US and Japanese markets are cointegrated with the developing Asian markets. **Brailsford (2006)** found that the integration strengths have become more powerful between the Asian and global markets after the Asian currency crisis, with the US market leading both the Asian markets and the markets of Japan and the UK. **Gklezakou (2009)** found evidence that the integration among the developed markets of US and Europe have strengthened during the economic crisis period. **Patel (2013)**presented a contrary evidence and documented that Indian market is not cointegrated with the other developed markets. Not much cointegration-based studies are reported after the sub-prime crisis period. Hence, this paper attempts to study the cointegration of select markets in the context of sub-prime crisis.

3. RESEARCH OBJECTIVES

The paper intends to fulfil the following objectives:

- To study the co-integration between the stock markets of India, US, and Japan.
- To study the causality between the stock markets of India, US, and Japan.

4. METHODOLOGY

The prominent indices in India, US and Japan, viz., Bombay Stock Exchange Sensitivity Index or BSE SENSEX (BSESI) floated by the Bombay Stock Exchange Limited, India, S&P 500 floated by the New York Stock Exchange Limtied, US and Nikkei 225 floated by Tokyo Stock Exchange Limited, Japan are the units of study. The secondary data includes 84 sample observations collected as the closing index values of opening day of the month for 8 years ranging from January 2008 to December 2014. The data source is *www.finance.yahoo.com*. The indices data are transformed into logarithmic values and continuous compounded logarithmic monthly returns are computed for further study. The normality of the data is tested through the Jarque-Bera (JB) test statistic. The Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (P-P) test are used to test the stationarity of data. The cointegration is studied through Johansen Cointegration test. The causality is studied through Karl Pearson's Coefficient of Correlation and the causality relationship between the indices is studied using Granger Causality Test.

5. EMPIRICAL FINDINGS AND DISCUSSIONS

5.a. Descriptive Statistics

The Descriptive Statistics of the Log returns of indices are provided in Table 1.

Table 1
Descriptive Statistics & Data Normality Test for the study period
(Monthly Log returns i.e., Level 1 Difference)

Description	*BSESI Logret Close*	*S&P500 Logret Close*	*NIKKEI225 Logret Close*
Mean	0.001545	0.000728	0.001777
Std. Dev.	0.108075	0.052501	0.044431
C.V.%	2064.94	1201.94	3906.82
Maximum	0.032088	0.028601	0.021488
Minimum	-0.118559	-0.118199	-0.080621
Skewness	-0.435220	-1.013342	-1.000392
Kurtosis	5.688919	5.357714	4.717646
Jarque-Bera	27.95783	33.83192	24.33706
Probability	0.000001	0.000000	0.000005
Observations	84	84	84

Null hyp.:Data is Not Normal, i.e., Non-Gaussian distribution.
Alt hyp.: Data is Normal. i.e., Gaussian distribution

The Nikkei225 has generated higher average returns of 0.001777% when compared to 0.001545% generated by BSESI and a dismal 0.000728% by S&P500. The risk and variability are measured through standard deviation (SD)and Coefficient of variation (CV) respectively. The SD of 0.044431% is lowest for Nikkei225, while highest

0.108075% for BSESI. The SD for S&P500 is marginally higher than Nikkei 0.052501%, whereas the consistency of return measured through CV is lowest for S&P500, viz., 1201.94%. This indicates that the S&P500 returns are lowest among the sample, but consistent in the long run. are less for S&P500 with is lessis less in Nikkei225, i.e., 0.044431%, while BSESI is highly volatile with 0.108085%. All the 3 indices are left skewed and have Kurtosis close to 5.0%. The descriptive statistics indicate that Nikkei225 presented higher average returns but with less consistency, whereas S&P500 generates lower returns but with more consistency. BSESI generates moderate return but with high risk and moderate consistency.

5.b. Discussions on the Normality Assumption

The normality of the data and Gaussian distribution is verified through the Jarque-Bera (JB) test for normality.

H_0: BSESI, S&P 500 and NIKKEI225 indices returns are not normally distributed.

H_1: BSESI, S&P 500 and NIKKEI225 indices returns are normally distributed.

Table 1 shows that all the 3 indices have a significant JB test p-values of .0000, which indicates that the null hypothesis of non-normality is rejected at 1% significance level. Therefore, the returns of BSESI, S&P500 and NIKKEI225 indices are normally distributed and fit to the Gaussian distribution.

5.c. Discussion on the Stationarity of Data

The time series modeled on stationary data sustains the relevance of its mean and standard deviation over time. The Unit root test is a test for stationarity of data. A time series is said to be stationary if the mean and auto co-variances of the series do not depend on time. To check for the stationarity or non-stationarity of BSESI S&P500 and NIKKEI225, the ADF and PP tests are applied and the results are presented in the Table 2.

H_0: BSESI, S&P500 and NIKKEI225 indices returns are non-stationary.

H_1: BSESI, S&P500 and NIKKEI225 indices returns are stationary.

The null hypothesis stated here is that Data has Unit Root, i.e., Data is non-stationary. The alternative hypothesis is Data has no Unit Root, i.e, Data is stationary. The ADF and PP test rejects the null hypothesis at 1% significance level (ADF 101.826; 0.0000 and PP 101.803; 0.0000) This implies that theBSESI, S&P500 and NIKKEI225 indices returns are stationary. Hence, the results indicate that Indian, US and Japanese stock market returnshavestationary time series.

5.d. Discussions on the Cointegration between the Markets

Co-integration is a stylized fact of two or more variables moving together through time 't', but also follow their unique trends. They will not drift too far apart since they

Table 2
Augmented Dickey-Fuller Test (ADF) and Phillips-Perron Test (PP)

Group unit root test: Summary
Series: LOGRET_BSESI, LOGRET_NIKKEI225, LOGRET_S_P500
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test Method

	Statistic	*Prob.***	*Cross-sections*	*Observations*
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-14.0760	0.0000	3	249
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-12.5516	0.0000	3	249
ADF - Fisher Chi-square	101.826	0.0000	3	249
PP - Fisher Chi-square	101.803	0.0000	3	249

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

are linked together in some underlying fact. The results of the unit root test show that the time series of BSESI, S&P500 and NIKKEI225 index returns are stationary. To observe the long-run relationship between the indices, Johansen's Co-integration test is used in the paper. The results of the test are summarized in the Table 3.

H_0: BSESI, S&P500 and NIKKEI225 indices returns are not cointegrated.

H_1: BSESI, S&P500 and NIKKEI225 indices returns are cointegrated.

Table 3
Unrestricted Johansen Cointegration Rank Test Trace test and Maximum Eigen Value Test statistics on the Cointegration Models

Included observations: 81 after adjustments
Series: LOGRET_BSESI LOGRET_NIKKEI225 LOGRET_S_P500
Lags interval (in first differences): 1 to 2
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*0.05 Critical Value*	*Prob.***
None *	0.275902	63.05886	29.79707	0.0000
At most 1 *	0.214891	36.90973	15.49471	0.0000
At most 2 *	0.192444	17.31319	3.841466	0.0000

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

contd. table

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	*Eigenvalue*	*Max-Eigen Statistic*	*0.05 Critical Value*	*Prob.***
None *	0.275902	26.14913	21.13162	0.0090
At most 1 *	0.214891	19.59654	14.26460	0.0065
At most 2 *	0.192444	17.31319	3.841466	0.0000

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

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

Table 3 shows that there exists 3 cointegration models. The null hypothesis of No Cointegration is rejected by the Trace test and Maximum Eigen Value test for all the three models at 5% level of significance. The Trace and Maximum Eigen Value Tests confirms the presence of three cointegrating equations at 5% significance level. Hence, the results confirm the presence of long-run cointegration among the Indian, US and Japanese Chinese stock markets.

5.e. Discussions on the Causality between the Markets

The causality and direction of the cointegration were studied using the Granger Causality Test. The results are presented in Table 4.

Table 4
Correlation between the log returns of BSESI, S&P500 and NIKKEI225indices

		log of ret bsesi - India	*log of ret s&p500 - usa*	*log of ret nikkei 225 - Japan*
log of ret bsesi - India	Pearson Correlation	1	.714**	.608**
	Sig. (2-tailed)		.000	.000
	N	84	84	84
log of ret s&p500 - usa	Pearson Correlation	.714**	1	.719**
	Sig. (2-tailed)	.000		.000
	N	84	84	84
log of ret nikkei	Pearson Correlation	.608**	.719**	1
225 - Japan	Sig. (2-tailed)	.000	.000	
	N	84	84	84

**. Correlation is significant at the 0.01 level (2-tailed).

The causality between the stock markets of India, US, and Japan is studied through Karl Pearson's Correlation and Granger Causality test. Correlation test is used to find the co-movement between the indices and Granger Causality test is used to find the causal variations and direction of change. Table 4 shows that S&P500 & NIKKEI225 exhibits a strong and statistically significant correlation (.714; .000) and similarly exhibited by BSESI & S&P500 (.714; .000) at 1% significance level. The correlation between BSESI & NIKKEI225 is moderate (.608; .000) but statistically significant at 1% level. This indicates that Indian stock market has high correlation with US stock market

and moderate correlation with Japanese stock markets. Hence, the co-movement between Indian and US markets are stronger than between the Indian and Japanese markets.

Next, to test the causality, Pair-wise Granger Causality test is used and the results are presented in Table 5.

Table 5
Pairwise Granger Causality Test

Lag length selected:3 Observations:81 Sig. level : 5%

Null Hypothesis	*F-Statistic*	*Prob.*	*Null rejection*
LOGRET_NIKKEI225 does not Granger Cause LOGRET_BSESI	0.99344	0.4007	No
LOGRET_BSESI does not Granger Cause LOGRET_NIKKEI225	0.77623	0.5110	No
LOGRET_S_P500 does not Granger Cause LOGRET_BSESI	0.34537	0.7926	No
LOGRET_BSESI does not Granger Cause LOGRET_S_P500	0.79179	0.5023	No
LOGRET_S_P500 does not Granger Cause LOGRET_NIKKEI225	0.18896	0.9036	No
LOGRET_NIKKEI225 does not Granger Cause LOGRET_S_P500	2.83372	0.0440	Yes

The table 5 shows that except last one, none of the null hypotheses gets rejected. The results in table 5 clearly documents that only NIKKEI225 granger causes S&P5000 and not the BSESI or S&P500. Hence, it is found that Japanese stock market precedes US stock markets and not vice versa. It is also documented that neither US nor Indian stock markets granger causes/precedes each other mutually.

The findings of this paper is in confirmation with the Cointegration studies between the US, Japanese and Asian regional markets as reported by Sewel L *et al.* (1996), Masih and Masih (1999), Cha and Oh (2000), Bhattacharyya (2004) Brailsford (2006), Chung and Chiang (2006), Chiu *et al.* (2006), Bhar and Nikolova (2009), Chiang (2013) amongst others.

6. CONCLUSION

The objectives of this research is to report the Cointegration and Causality between Indian, US and Japanese stock markets after the 2008 sub-prime crisis. The results show that Indian stock market provides moderate return but with high risk and lesser consistency. Japanese market returns are high but are more risky. The US market returns are moderate but with less risk and more consistency. All the markets are significantly correlated with each other and the returns are stationary over time.Indian market is cointegrated with both the US and Japanese markets in the long-run. Japanese stock market precede the returns of US stock markets. The study concludes that after

the sub-prime crisis, the integration between the US, Indian, and Japanese markets have become stronger. The reasons for the results of the paper may be due to the growing economic and diplomatic relationship between India, US and Japan, since 2008. The governments of US and Japan felt the need for alternative global markets after the economic slowdown and bolstered closer economic cooperation with the emerging market nations, of which India stands economically benefited. Such actions at the government level, may have transformed into synchronization of the stock markets and have led to the stock markets cointegration. Hence, the global portfolio investors may not get risk diversification benefits by investing in combination of these nations.

The scope of this research could also be extended by future researchers to other Asian partners and emerging market nations with response to specific economic events.

Notes

1. *http://www.world-stock-exchanges.net/top10.html*
2. *http://indiainbusiness.nic.in/newdesign/index.php?param=advantage/173*

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