Testing the long-run cointegration among global equity indices: Pair-wise test with Indian stock market

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ABSTRACT

Increase in the financial integration of global stock markets persuades investors to consider international investments opportunities in order to diversify the risk. However, if these markets have a common trend that leads to a long-term equilibrium, then the benefits of diversification would not be realized. This paper examines the presence of long-term relationship between stock markets of India and several developed as well as developing economies. We use pair-wise cointegration test between Indian stock market and twelve benchmark indices of global equity markets. Contrary to our expectation of a long-term equilibrium relationship between these global stock indices with Indian equity index, we find no evidence of cointegration.

Keywords*: Cointegration, Johansen test, Indian stock market, Global equity indices*

Introduction

The overall process of market integration depends on presence of a common trend between different stock markets. This common trend can be result of globalization witnessed over the past few decades that has increased the cross-country interactions between macro-economic variables. Studies that test the co-movement of global stock markets have a general view that there exists a long-run equilibrium relationship between stock markets of different countries. This long-term integration between global stock markets has implications for investors in terms of the benefits realized through international portfolio diversification.

This study analyses the existence of long-term relationship between Indian stock market and twelve global stock markets covering developed as well developed economies. We take SENsitivity indEX (Sensex) of Bombay Stock Exchange (BSE) as the benchmark index Indian stock market. The twelve global stock markets considered for the study include stock indices of US, European Union, UK, Australia, Japan, Mexico, Brazil, China, Malaysia, Canada, Singapore and Thailand. A description of the stock Indices considered for analysis is provided in Appendix-I. If the Indian stock market is found to be cointegrated with the global equity indices considered, then improvements in risk-adjusted returns through international diversification would not be realized.

Literature Review

Previous studies have supported the notion of integration between stock markets that has resulted due to opening up of bilateral trade among nations and other globalization measures. Eun and Shim (1989) detect multi-lateral interactions between nine stock markets using Vector Auto-Regression (VAR) system. Taylor and Tonks (1989) use cointegration techniques to find a long-run cointegration between for UK and certain overseas market, although, they do not find any evidence of short-term relationship between these markets. Campbell and Hamao (1992) study the comovement of expected excess returns to find evidence of long-term integration betwwn US and Japanese capital markets.

Friedman and Shachmurove (1997) use VAR framework to find high degrees of integration among developed stock markets and suggest investing in smaller equity markets to realize better benefits of international diversification. Quan and Huyghebaert (2006) examine the long-term interdependencies between European markets and US & Japan. They find that the integration of stock markets has increased after the introduction of Euro as a currency for the European region

Ratanapakorn and Sharma (2002) investigate the time-varying nature of integration between stock markets and find that there is not cointegration among stock markets before the Asian crisis periods, with some evidence of integration found in the period of Asian crisis. Raj and Dhal (2008) examine the integration of Indian stock market with stock markets and find that evidence of international integration when Indian stock prices are considered in US Dollar terms, whereas, no long-term relationship is found when the stock prices are considered in Indian currency.

Data and Methodology

We collected weekly data for all of the thirteen stock indices from April 2003 to May 2015 through Bloomberg terminal. We converted the weekly closing index price data to weekly returns by taking the log first difference. Return R_t at time t is given by $R_t = \ln P_t - \ln P_{t-1}$, where P_t is the closing price for day t. We performed preliminary analysis of the characteristic properties of the return series, by looking at the first four moments (mean, standard deviation, skewness and kurtosis). We tested the i.i.d. (identically and independently distributed) property of the all the series and substantiated the results of skewness and kurtosis through the Jarque Bera Test for testing normality, and finally, the Ljung Box to check the independence of the series.

This was followed by test of stationarity for the series through the Augmented Dickey Fuller (ADF) Test. We then estimated the appropriate lag length for the autoregressive process through the Schwarz Information Criteria (SIC) by selecting the lag length which minimized the SIC. Finally, the Johansen's Cointegration test was applied to the pair-wise data to capture the presence of any long-run equilibrium relationships between the indices. In the context of the two indices, the equation for Johansen cointegration test can be written as follows:

$$Y_t = \alpha 1 + \beta 1 X_t + \epsilon 1_t \text{ ----------} \quad (1)$$

or

$$X_t = \alpha 2 + Y2\, Ft + \epsilon 2_t, \text{ ----------} \quad (2)$$

where Yt and Xt are the equity index prices at time t.

The above can be re-written with residuals, as under:

$$Y_t - \alpha 1 - \beta 1 Xt = \hat{e}1_t \ldots\ldots\ldots\ldots \quad (3)$$

or

$$X_t - \alpha 2 - \beta 2\, Yt = \hat{e}2_t, \ldots\ldots\ldots\ldots \quad (4)$$

where $\hat{e}_t$ is the white noise residual term. Equations 3 and 4 are linear combinations of Y_t and X_t. If either $\hat{e}1_t$ or $\hat{e}2_t$ is stationary, then one of them is I(0) and there is at least one long run relationship between Y_t and X_t.

Results

The following tables provide description of the results generated through the tests mentioned above:

Table 1: Descriptive Statistics of Return series of different indices

	SENSEX_INDEX	AS51_INDEX	FBMKLCI_INDEX	FSSTI_INDEX	HSI_INDEX	IBOV_INDEX	MEXBOL_INDEX	NKY_INDEX	SET50_INDEX	SPTSX_INDEX	SPX_INDEX	SX5E_INDEX	UKX_INDEX
Mean	0.003553	0.001029	0.001685	0.001691	0.001902	0.002467	0.003129	0.001496	0.002293	0.001336	0.001366	0.00072	0.000933
Median	0.005839	0.003484	0.002655	0.002587	0.00467	0.004896	0.004396	0.004917	0.004004	0.004085	0.002377	0.004035	0.002574
Maximum	0.131709	0.091137	0.06653	0.15321	0.117189	0.168434	0.185786	0.114496	0.126136	0.128171	0.113559	0.115178	0.125845
Minimum	-0.17381	-0.17016	-0.09712	-0.16468	-0.17815	-0.22327	-0.17929	-0.27884	-0.28309	-0.17542	-0.20084	-0.25131	-0.23632
Std. Dev.	0.031636	0.022129	0.017694	0.025151	0.030113	0.036467	0.028883	0.030589	0.031985	0.023606	0.024057	0.029927	0.024471
Skewness	-0.53553	-1.14765	-0.74218	-0.49512	-0.36948	-0.46566	-0.27652	-1.50902	-1.2403	-1.20316	-0.99275	-1.27949	-1.52085
Kurtosis	6.053643	10.10823	7.028627	11.14447	6.466125	6.664065	9.8191	14.50034	13.23343	12.90164	12.92863	12.21156	19.70062
Jarque-Bera	274.4507	1462.301	483.1029	1764.16	329.179	374.5887	1226.707	3704.977	2905.886	2721.286	2686.874	2395.473	7552.267
Probability	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	2.234803	0.647429	1.060032	1.063549	1.196533	1.552048	1.968257	0.941133	1.442352	0.840099	0.859387	0.4528	0.586944
Sum Sq. Dev.	0.628516	0.307535	0.196609	0.397257	0.569459	0.835125	0.523894	0.587624	0.642477	0.349939	0.363449	0.562447	0.376067
Observations	629	629	629	629	629	629	629	629	629	629	629	629	629

Table 2: Test of Stationarity

	At Level		At First Difference	
	t-statistic	p-value	t-statistic	p-value
SENSEX Index	-2.222599	0.4756	-24.62992	0.0000
AS51 Index	-1.905878	0.6502	-25.28358	0.0000
FBMKLCI Index	-2.185436	0.4964	-24.39984	0.0000
FSSTI Index	-2.404458	0.3768	-24.12210	0.0000
HSI Index	-2.611156	0.2754	-24.67923	0.0000
IBOV Index	-2.024672	0.5862	-26.44571	0.0000
MEXBOL Index	-2.383673	0.3877	-28.59651	0.0000
NKY Index	-0.946855	0.9487	-24.59934	0.0000
SET50 Index	-2.064954	0.5638	-26.35969	0.0000
SPTSX Index	-2.492911	0.3316	-26.56682	0.0000
SPX Index	-1.000127	0.9419	-26.89804	0.0000
SX5E Index	-1.960407	0.6212	-27.77235	0.0000
UKX Index	-2.590951	0.2847	-27.56372	0.0000

ADF tests confirm the existence of unit root at level and the data series under consideration exhibit stationarity at first difference (refer Table 2) for all indices thus conforming that they are integrated to the first order. To check the dependency between the two series, Johnson Cointegration Framework has been adopted in a bivariate pattern with reference to India such that a linear combination of the two index series at level will help in canceling their stochastic component thereby establishing a long run equilibrium relationship. The lag length has been selected as was indicated by the SIC criteria as explained above.

Table 3: Results pf Johansen's Cointegration Test

	Trace Statistic		Maximum Eigen value		Lag length#	
	r=0	r=1	r=0	r=1	r=0	r=1
SENSEX _AS51 Index	4.702257 (0.8396)	0.448855 (0.5029)	4.253402 (0.8317)	0.448855 (0.5029)	2	2
SENSEX _FBMKLCI Index	4.601504 (0.8496)	1.019176 (0.3127)	3.582328 (0.9006)	1.019176 (0.3127)	2	2
SENSEX _FSSTI Index	7.691477 (0.4990)	0.335763 (0.5623)	7.355715 (0.4480)	0.335763 (0.5623)	2	2
SENSEX _HSI Index	10.30336 (0.2581)	0.413552 (0.5202)	9.889804 (0.2193)	0.413552 (0.5202)	2	2
SENSEX _IBOV Index	4.925569 (0.8167)	0.002967 (0.9550)	4.922602 (0.7516)	0.002967 (0.9550)	2	2
SENSEX _MEXBOL Index	6.657539 (0.6178)	0.872036 (0.3504)	5.785503 (0.6409)	0.872036 (0.3504)	2	2
SENSEX _NKY Index	2.000216 (0.9950)	0.535415 (0.4643)	1.464801 (0.9983)	0.535415 (0.4643)	2	2
SENSEX _SET50 Index	3.020885 (0.9659)	0.731430 (0.3924)	2.289455 (0.9825)	0.731430 (0.3924)	2	2
SENSEX _SPTSX Index	8.858574 (0.3786)	0.409224 (0.5224)	8.449350 (0.3349)	0.409224 (0.5224)	2	2
SENSEX _SPX Index	2.600456 (0.9820)	0.002852 (0.9560)	2.597604 (0.9698	0.002852 (0.9560)	2	2
SENSEX _SX5E Index	3.757251 (0.9221)	0.269630 (0.6036)	3.487622 (0.9091)	0.269630 (0.6036)	2	2
SENSEX _UKX Index	6.728165 (0.6094)	0.586692 (0.4437)	6.141472 (0.5951)	0.586692 (0.4437)	2	2

(Note: Figures in brackets indicate the corresponding p-values)

Contrary to our expectations, the results of cointegration test suggest that none of the indices has a long-run equilibrium relationship with the Indian Index i.e SENSEX for the given sample period under consideration. The results are in contrast to the expectations of dependency between major world stock market indices and SENSEX. The results were reconfirmed when the VAR tests for the same were performed to see that at the requisite lag length, demonstrating the cross index terms were insignificant for majority of these bivariate pairs. The results have been withheld for the brevity of space. It can be attributed to frequency and number of observations of data undertaken for analysis.

Conclusion

Empirical findings of Johansen Cointegration test suggest that there is no evidence of pair-wise long-run relationship between Indian stock market and twelve global stock markets considered in the analysis. This study contributes to the literature on stock market integration by providing recent evidence of no cointegration among stock indices even in this era of Globalization. It will be interesting to see the cointegration among these stock markets in a multivariate framework. Also, time-varying cointegration can be tested to analyze the relationship between stock indices during periods of high volatility as the correlation between stock indices rises during financial crisis. The current study re-emphasizes the importance of international diversification to improve the risk-adjusted returns of a portfolio.

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Appendix-I

Bloomberg Ticker	Index Description
SENSEX Index	SENSEX is a capitalization-weighted index of 30 largest, well-established and financially sound companies listed on Bombay Stock Exchange (BSE)
AS51 Index	The S&P/ASX 200 measures the performance of the 200 largest index-eligible stocks listed on the ASX by float-adjusted market capitalization. Representative liquid and tradable, it is widely considered Australia's preeminent benchmark index. The index is float-adjusted. The index was launched in April 2000.
FBMKLCI Index	The FTSE Bursa Malaysia KLCI Index comprises of the largest 30 companies by full market capitalization on Bursa Malaysia's Main Board. When launched, on July 6, 2009 it replaced the Bursa Malaysia KLCI Index starting at the closing value of the KLCI Index on July 3 2009, also inheriting the full history of the KLCI Index, see KLCIOLD Index. Eff 9/14/09 open time changed to 09:00:15.
FSSTI Index	The revamped Straits Times Index, calculated and disseminated by FTSE, comprises the top 30 SGX Mainboard listed companies on the Singapore Exchange selected by full market capitalization. The index was revamped effective January 10, 2008. ** To see the old Straits Times Index prior to reconstruction please see STIOLD Index.
HSCI Index	The Hang Seng Composite Index is a market-cap weighted index that covers about 95% of the total market capitalisation of companies listed on the Main Board of the Hong Kong Stock Exchange. The base value of the index is 2000 on base date of January 3rd 2000. HSI started to price this index end of day March 8th. Shares in index is not available from 2012, fundamental data won't be calculated
HSI Index	The Hang Seng Index is a free-float capitalization-weighted index of a selection of companies from the Stock Exchange of Hong Kong. The components of the index are divided into four subindices: Commerce and Industry, Finance, Utilities, and Properties. The index was developed with a base level of 100 as of July 31, 1964.
IBOV Index	It is a gross total return index weighted by market value to the free float & is comprised of the most liquid stocks traded on the Sao Paulo Stock Exchange. The Ibovespa Index has been divided 10 times by a factor of 10 since Jan 1, 1985:12/02/85, 08/29/88, 04/14/89, 01/12/90, 05/28/91, 01/21/92, 01/26/93, 08/27/93, 02/10/94, and 03/03/97. See IBOVHIST <INDEX> for additional history 1968-1989.
MEXBOL Index	The Mexican IPC index (Indice de Precios y Cotizaciones) is a capitalization weighted index of the leading stocks traded on the Mexican Stock Exchange. The index was developed with a base level of .78 as of October 30, 1978.
NKY Index	The Nikkei-225 Stock Average is a price-weighted average of 225 top-rated Japanese companies listed in the First Section of the Tokyo Stock Exchange. The Nikkei Stock Average was first published on May 16, 1949, where the average price was ¥176.21 with a divisor of 225. *We are using official divisor for this index
SET50 Index	The Thailand SET 50 Index is a capitalization-weighted index based on the top 50 stocks listed on the Bangkok SET index having high market capitalization and high liquidity. The index was developed with a base value of 100 as of August 16, 1995. ** Price history for this index was adjusted by a factor of 10 effective May 2, 2005. **
SPTSX Index	The S&P/Toronto Stock Exchange Composite Index is a capitalization-weighted index designed to measure market activity of stocks listed on the TSX. The index was developed with a base level of 1000 as of 1975. The sectors available under SPTSX Index GRPS<GO> do not price intraday. This index contains investment trusts effective 12/19/05. For the S&P/TSX Equity Index please see TXEQ Index.
SPX Index	Standard and Poor's 500 Index is a capitalization-weighted index of 500 stocks. The index is designed to measure performance of the broad domestic economy through changes in the aggregate market value of 500 stocks representing all major industries. The index was developed with a base level of 10 for the 1941-43 base period.
SX5E Index	The EURO STOXX 50 Index, Europe's leading blue-chip index for the Eurozone, provides a blue-chip representation of supersector leaders in the Eurozone. The index covers 50 stocks from 12 Eurozone countries. The Index is licensed to financial institutions to serve as underlying for a wide range of investment products such as Exchange Traded Funds (ETF), Futures and Options and structured products.
UKX Index	The FTSE 100 Index is a capitalization-weighted index of the 100 most highly capitalized companies traded on the London Stock Exchange. The equities use an investibility weighting in the index calculation. The index was developed with a base level of 1000 as of December 30, 1983. * Please see UKEDA100 Index and FTPTP100 Index for the official FTSE 100 Index Dividend Yield and P/E Ratio*