

Indian Equity Market Integration: Analysis of time-varying correlations with global equity indices

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ABSTRACT

This paper uses the rolling window estimation methodology to examine the correlation of global equity indices with Indian stock market over time. We consider Sensex of Bombay Stock Exchange (BSE) as the benchmark index of Indian stock market to analyze the integration between Indian and global stock markets. The global stock markets considered include equity indices of US, UK, Australia, Japan, Malaysia, Mexico, Brazil, Hong Kong, Singapore, Europe and Thailand. We find time-varying patterns of correlation, with high degrees of correlation during periods of financial crisis and low levels of correlation in recent times.

Keywords: Time-varying correlation, Rolling window estimation, Stock market integration, Indian stock market

Introduction

The basic premise of investment decision is portfolio diversification in order to reduce the risk undertaken. The underlying idea is: "don't put all your eggs in one basket". The benefits of portfolio diversification prevail due to low correlation among different assets and asset classes. To realize better diversification benefits in stock markets, investors consider global investment opportunities instead of focusing on stocks within the same economy.

Globalization has integrated economies across the world by ensuring free capital flows. This integration can be witnessed in the stock markets as well. The integration results in higher correlation among different stock markets, thereby reducing the benefits of diversification.

This paper examines the time-varying correlation coefficients of Indian stock markets with global equity indices that include developed as well as developing economies. SENSitivity indEX (Sensex) of Bombay Stock Exchanges has been considered as the benchmark index of Indian equities to analyze the integration among Indian and global equity markets. The general view of research papers analyzing stock market integration suggests that correlations between stock markets are time-varying, with increased levels of correlations during periods of financial crisis. It will be interesting to see the pattern of correlation of Indian stock markets with global stock indices. If the Indian indices show increase in levels of correlation with global stock indices over time, international portfolio diversification will have to be executed with more caution.

Literature Review

From an investor's perspective, international diversification is useful only if there are significant benefits of diversification across countries. Heston and Rouwenhorst (1994) analyze the correlation structure of returns of twelve European stock indices. They suggest that instead of diversification across industries within the same country, an investor can realize better risk reduction by diversifying across countries within the same industry. If the correlation between stock markets increases over time, then the benefits of cross-country diversification will be minimized. Longin and Solnik (1995) analyze the correlation among seven developed countries and find an increase in the correlation between these markets over the time period considered. They also find that the correlation between these markets rises during periods of high volatility.

The results of an increase in correlation between stocks markets during periods of high volatility were initially discussed by King and Wadhvani (1990), who discuss contagion effect in stock markets with a rise in correlation between markets due to the October 1987 crash leading to contagion effect. Forbes and Rigobon (2002) study the time period around 1997 Asian financial crisis and show that correlation coefficients are conditional on market volatility.

Bekaert and Harvey (1995) study the nature of world market integration and find that most of the world capital markets exhibit time-varying integration. They also find low levels of correlation between developed equity markets and emerging equity markets. Goetzmann, Li, and Rouwenhorst (2005) support the time-varying nature of correlations among world stock markets and argue that globalization has its benefits as well as drawbacks for international investors.

Data and Methodology

A diverse set of equity indices of different stock markets comprising of both developed as well as developing economies was selected. Initially, both Sensex (benchmark index) and BSE500 Index (broad-based index) were being considered to measure the integration with global equity indices, but due to the high correlation among both these indices, BSE500 was dropped from the analysis. The global indices include stock indices of US, UK, Australia, Japan, Malaysia, Mexico, Brazil, Hong Kong, Singapore, European Union and Thailand. We analyzed the time varying correlations on multiple indices from these countries, however, only the relationship with the benchmark indices is reported in this paper.

We collected weekly data for all these stock indices from 25th April 2003 to 15th May 2015 using Bloomberg terminal. We compute the correlation of Sensex with stock indices of all the eleven global equity markets and employ rolling window estimation method on log returns of these indices with a window size of 105 weeks over the time period considered.

For computation of correlation coefficients:

$$\text{Corr}(\text{Sensex}, \text{Index}(i))$$

where Index(i) represents the benchmark index of the each of the eleven equity markets,
 and sample size was rolling 105 week window in which the window changes as follows:

1-105 weeks –sample 1 (2nd May 2003 to 29th April 2005)

2-106 weeks –sample 2 (9th May 2003 to 6th May 2005)

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525-629 weeks- sample 525 (17th May 2013 to 15th May 2015)

Results

By using the rolling window estimation methodology, we generated a series of 525 data points for correlation of Sensex with each of the eleven equity indices. For analysis purpose, we represent the line graphs of each of the correlation series and discuss them independently. The description of each of the index has been given in Appendix-I.

Figure 1: Correlation of Sensex with Index 2 over time period considered with window size of 105 weeks

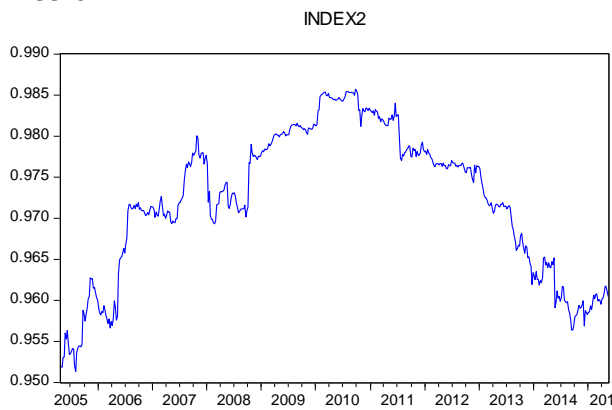
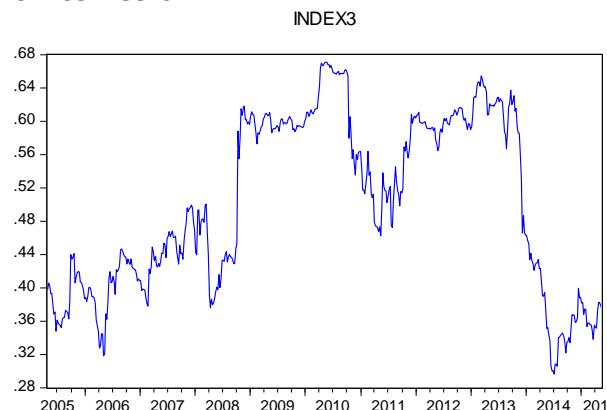


Figure 1 represents the correlation between Sensex and BSE500 Index. Due to the high degree of correlation between these indices, correlation between BSE500 and other global equity indices was not considered.

Figure 2: Correlation of Sensex with Index 3 over time period considered with window size of 105 weeks



In figure 2, high degrees of correlation can be seen during periods of high volatility due to Subprime crisis and again due to European debt crisis or third round of quantitative easing by US Government. The recent values of correlation are lower than they were a decade ago.

Figure 3: Correlation of Sensex with Index 4 over time period considered with window size of 105 weeks

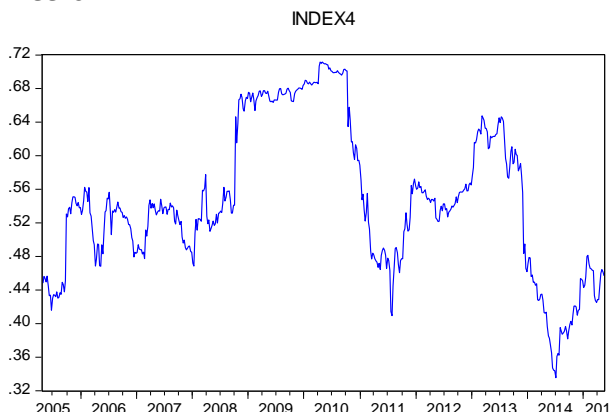


Figure 3 shows similar patterns of correlation as seen in Figure 2, with similar explanations. The recent values of correlation are at relatively the same as they were a decade ago.

Figure 4: Correlation of Sensex with Index 5 over time period considered with window size of 105 weeks

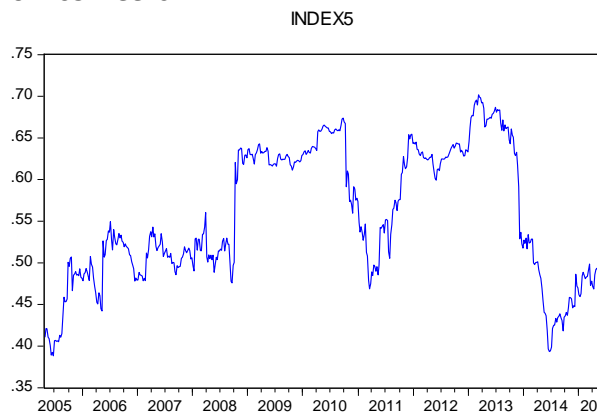


Figure 4 also shows similar patterns noted above. The recent values of correlation are marginally higher than they were a decade ago

Figure 5: Correlation of Sensex with Index 6 over time period considered with window size of 105 weeks

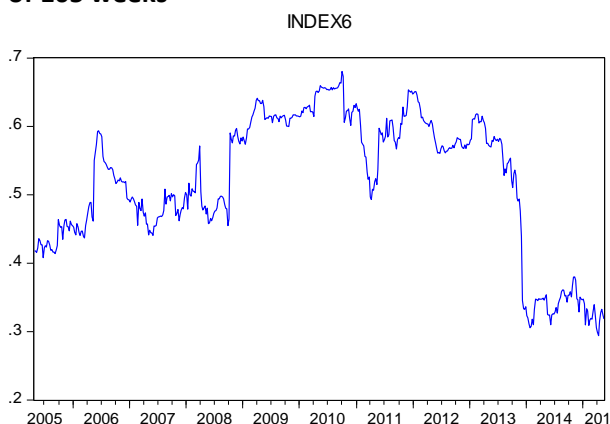


Figure 5 represents elevated levels of correlation for elongated periods, with a substantial dip in correlation with the onset of year 2014.

Figure 6: Correlation of Sensex with Index 6 over time period considered with window size of 105 weeks

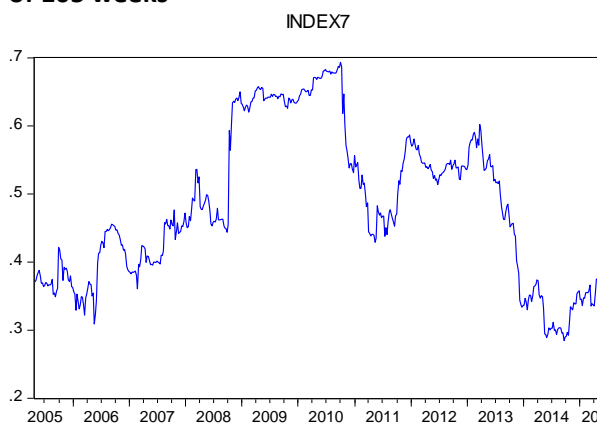
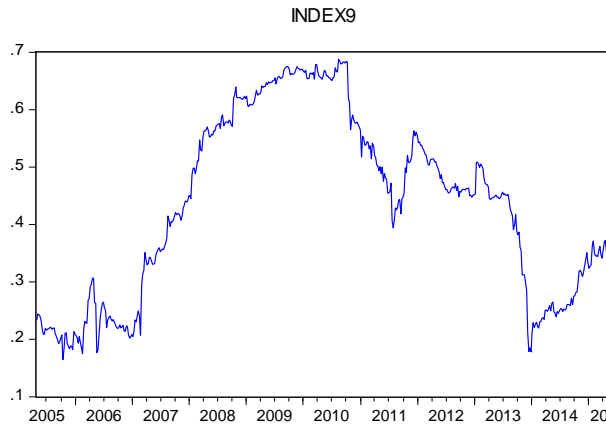


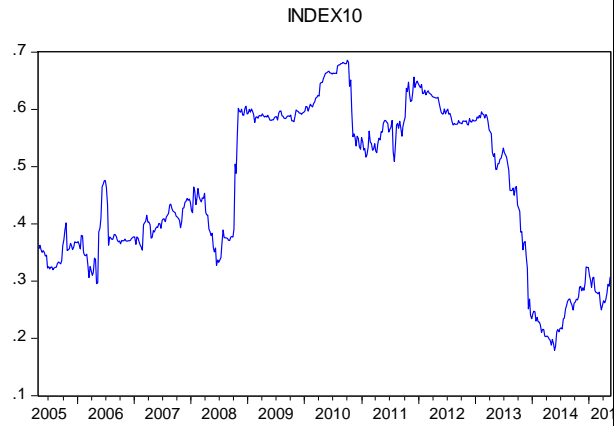
Figure 5 also shows elevated levels of correlation during period of subprime crisis, with the European debt crisis having a lesser impact on the correlation between Indian and Japanese stock markets. The recent values of correlation are approximately at the same level as they were a decade ago.

Figure 7: Correlation of Sensex with Index 9 over time period considered with window size of 105 weeks



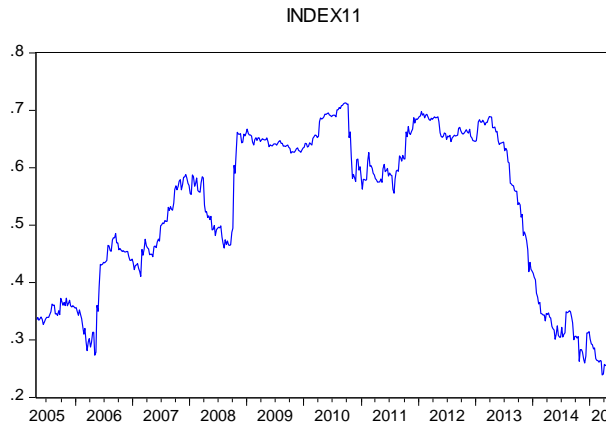
Similar to the pattern seen in Figure 7, correlation coefficients are higher during subprime crisis with marginally lower correlations during European debt crisis. However, these levels are substantially higher than the levels of correlation notices in normal situations. The recent values of correlation are higher than they were a decade ago.

Figure 8: Correlation of Sensex with Index 10 over time period considered with window size of 105 weeks



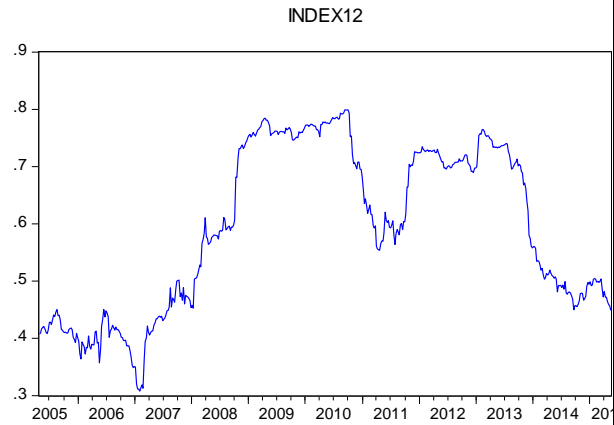
This shows similar patterns as seen in figure 2.

Figure 9: Correlation of Sensex with Index 11 over time period considered with window size of 105 weeks



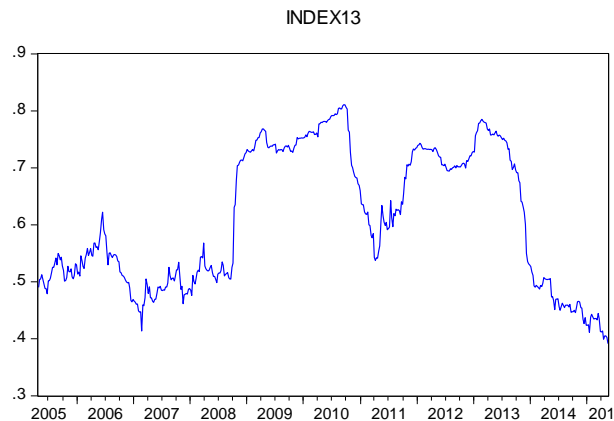
The graph starts with low levels of correlation and moves to substantially higher levels during periods of stress, and then again moves to even further lower levels than the ones notices a decade ago.

Figure 10: Correlation of Sensex with Index 12 over time period considered with window size of 105 weeks



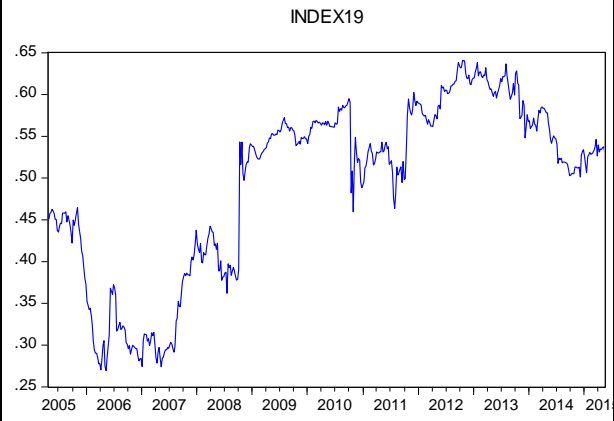
The graph shows a move from lower levels during the start date to marginally higher levels in recent times, with high degrees of correlation seen during financial crisis.

Figure 11: Correlation of Sensex with Index 13 over time period considered with window size of 105 weeks



This graph shows similar patterns as the one seen in Figure2.

Figure 12: Correlation of Sensex with Index 19 over time period considered with window size of 105 weeks



A substantial drop in the levels of correlation can be noticed just before the onset of the subprime crisis, with the general trend being upward after that.

Conclusion

The graphs in the results section re-emphasize the previous findings of high degree of correlations noticed during periods of high volatility or financial crisis. In the analysis we find that in recent times, the levels of correlation between the stock markets are approximately same or lower for most of the stock markets considered. We agree with the notion of time-varying correlation between stock markets without any trend of upward or downward movement in correlations. This study provides support to the notion of international portfolio diversification to reduce the risk undertaken by investors.

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Appendix – I

Nomenclature	Bloomberg Ticker	Index Description
Index1	SENSEX Index	SENSEX is a capitalization-weighted index of 30 largest, well-established and financially sound companies listed on Bombay Stock Exchange (BSE)
Index2	BSE500 Index	BSE 500 index capitalization-weighted index of 500 stocks listed on BSE and represents nearly 93% of the total market capitalization on BSE.
Index3	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.
Index4	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.
Index5	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*
Index6	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.
Index7	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
Index9	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.
Index10	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.

Index11	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.
Index12	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.
Index13	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.
Index19	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. **