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The Indian Stock Market and the Great Recession

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Abstract. *This study analyzes the impact of the outbreak of the Great Recession of 2007 on the behavior of the Indian stock market. The SENSEX index of the Bombay Stock Exchange is analyzed for the pre-recession period of January 2002 – November 2007 and the post-recession outbreak period of December 2007 – July 2010. Substantial increase in SENSEX return volatility observed during the post-recession outbreak period, whereas no substantial difference in returns between two periods is found. Also strong co-movements in returns and volatility are observed between the SENSEX and other major stock indexes during the post-recession period. Our results establish the dominance of global factors in influencing Indian stock market behavior during periods of economic turmoil.*

Keywords: great recession; SENSEX; contagion; volatility; daily returns.

JEL Code: G01.
REL Code: 11B.

1. Introduction

The Great Recession which started in December of 2007 in the US[(1)] had a substantial negative impact on the world economy. The Gross World Product declined by 1.1 percent during the period of 2008 to 2009 with an overwhelming 3.4 percent drop in GDP of developed countries[(2)]. In contrast, even during the height of the recession, the Indian economy managed to grow at a modest rate of 5.35 percent in 2009. But this positive growth rate in India was substantially lower than the average growth rate of 8.72 percent during the five years prior to the financial crisis. The rapid economic growth in India over the last decade has been clearly reflected in the Indian stock markets. The most widely tracked stock index in India, the Bombay Stock Exchange (BSE hereafter) SENSEX, increased from 4,300 points in 1997 to about 20,000 points in 2010. This translates into an annualized growth rate of 12.55 percent per annum over the last 13 years. However the spectacular growth experience in the SENSEX hasn't been unilateral. Over the last three years, on account of the Great Recession, the SENSEX tumbled from more than 20,000 points in Dec 2007 to little over 8,000 in March 2009. The purpose of this paper is to analyze the impact of the outbreak of the Great Recession on the behavior of the SENSEX.

Prior research has corroborated findings of substantial shift in the behavior of equity markets on account of major global events. For example, following the 1997 East Asian crisis, studies like Baig and Goldfajn (1999), Sheng and Tu (2000), Ratanapakorna and Sharma (2002), Jang and Sul (2002), Yang et al. (2002), Kim (2005), Caporale et al. (2006) documented increase in volatility and correlation among the stocks of the emerging economies. They also find increased co-movements among the stocks of developed and emerging market economies during these times. In the Indian context, studies have also identified strong correlation in volatility and returns between the global stock markets and the Indian stock market. Mukherjee and Mishra (2010), Sarkar et al. (2009) have reported strong impact of US stock markets on Indian markets. However, only a few of these studies (Yang et al., 2002) have actually analyzed the impact of global business cycle fluctuations on the Indian markets. Given the global impact of the Great Recession, this paper fills the gap in the literature on the behavior of the Indian stock markets after the onset of the biggest economic turmoil since the Great Depression of 1930s.

In this paper, we explore the change in SENSEX behavior during the pre and the post recession-outbreak period[(3)]. We also analyze the co-movements in the SENSEX with other major stock indexes from the US, Europe, Asia and Latin America. Using such time series tests as the co-integration tests and the

Granger (1969) causality test, we try to answer questions whether there existed different behavior of the SENSEX before the crisis, whether the correlations among the observed markets increased during the post-crisis outbreak period and whether there are any changes in the causal relations between the stock markets during the sample period. The major findings of this paper are:

i) Substantial increase in volatility of SENSEX is observed during the post-recession period.

ii) Although the average daily stock returns turned negative with the onset of the recession, we do not find statistically significant differences in daily returns between pre-recession and the post-recession outbreak period.

iii)Contemporaneous return and volatility correlations amongst the SENSEX and the other major equity markets are considerably higher in the post-recession outbreak period.

iv) Significant changes in the nature of return and volatility causality among the equity markets are observed during the post-recession outbreak period.

The rest of the paper is organized as follows. In section 2 we present an overview of the related literature. Section 3 descries the data. In section 4 we analyze the data and present some summary statistics. The nature of pre and post-recession contagion are explored in section 5. We perform cointegration and Granger causality tests in section 6. Finally section 7 concludes the paper.

2. Literature review

The ongoing phenomenon of globalization during the last two decades has resulted in cross-border integration of financial markets of different countries. This has invoked a growing interest in understanding the interlinkages and spillovers in the financial market disturbances across countries. Such cross border transmission of disturbances from one country to another has often been referred to as contagion in the literature. Earlier studies have found that stock market interlinkages do strengthen with global financial integration (Agmon, 1972, Hilliard, 1979). The literature on financial contagion has literally exploded since the thought-provoking paper by Forbes and Rigobon (2002). They define contagion as “a significant increase in cross-market linkages after a shock to one country (or group of countries)”, otherwise, a continued market correlation of returns at high levels is considered as “no contagion, only interdependence”.

King and Wadhwani (1990) find evidence of an increase in stock returns’ correlation following the 1987 global financial market crash(4). Calvo and Reinhart (1996) report correlation shifts during the Mexican Crisis of 1994,

while Baig and Goldfajn (1999) support the contagion phenomenon during the East Asian Crisis of 1997. Prior to the Great Recession, the 1997 East Asian Crisis has been cited as the most significant global financial crisis in recent years (Mishkin, 1999). Hon et al. (2007) find that the impact of the collapse of the technology bubble in 2000 on the US NASDAQ resulted in an increase in correlation between the US and other foreign stock markets.

Sheng and Tu (2000), Ratanapakorna and Sharma (2002), Jang and Sul (2002), Yang et al. (2002), Kim (2005) and Caporale et al. (2006) have examined the effect of 1997 Asian Financial Crisis on the financial markets across different countries. Sheng and Tu (2000) examine linkages among 12 Asia-Pacific countries before, during and after the 1997 Asian Crisis. They report that on the wake of the Asian Crisis, the relationship among the South-East Asian financial markets became stronger than the correlation between North-East Asian countries. They also confirm the dominant role of the US market in affecting the Asian financial markets at the onset of the crisis. Ratanapakorna and Sharma (2002) analyze the US, Europe, Asia, Latin America, Eastern Europe and Middle East markets during the pre-Asian Crisis and the crisis period. They find no long-run relationship among these indexes during the pre-Asian crisis period. However, during the crisis period, one significant cointegrating vector is observed and more short-run (i.e. causal) relations are observed as compared to the pre-crisis period. They infer that during the Asian crisis period, the globalization phenomenon increased and only the European markets directly affected the US market, while the other regional markets indirectly influenced the US market via the European market. Similar global spillover patterns are observed by Jang and Sul (2002), Yang et al. (2002), Kim (2005). They find that before the crisis, there is almost no co-movement in the stock markets of seven Asian countries while such inter-market linkages increase substantially since the start of the crisis. They report persistence of these linkages even after the crisis is over. Caporale et al. (2006) examine the international transmission of the 1997 financial crisis using a bivariate GARCH-BEKK model. They observe that the dynamics of the conditional volatilities differ substantially. Causality links in the variance are found to be strong and bidirectional in normal periods, while such linkages turn unidirectional (from the markets in turmoil to the others) following the onset of the crisis, consistently with crisis contingent models.

Though there is a vast amount of literature on the cross border spillover of financial disturbances, only a few have focused on the Indian equity market. Sharma and Kennedy (1977) find a strong link between Indian, US and UK markets. Rao and Naik (1990) document weak correlation between Japanese,

US and Indian stock markets during 1970s and 80s. Hansda and Ray (2002) examined the interdependence between the BSE/National Stock Exchange (NSE hereafter) and the NASDAQ/New York Stock Exchange (NYSE hereafter) at the aggregate market level. They find unidirectional causality from the NASDAQ/NYSE to BSE/NSE. Hansda and Ray (2003) further explored the price interrelationship between ten dually listed stocks i.e. the stocks, those are listed on the BSE and NSE and the NASDAQ/NYSE. They have found bi-directional causality in vector auto regression model between the prices of the dually listed stocks. More recently Mukherjee and Mishra (2010) and Sarkar et al. (2009) have identified strong correlation between the global stock market and the Indian stock market, with the impact of the US stock market on India being the most prominent. Sinha et al. (2010) have also reported increasing integration of the Indian stock markets with the world market during the post-recession period. They ascribe the recent growth and integration of the Indian stock market with the world market to the revival of foreign institutional investors' (FIIs) interest in emerging market economies including India.

While most of the studies have found growing integration of financial markets across borders, it is apparent that the nature of such integration largely varies over time[5]. The primary rationale that has been cited in the literature is that poor synchronization of country specific business cycles are responsible for such time varying integration patterns. During periods of relative stability, when global shocks do not occur, country specific factors dominate the individual stock market behavior. On the other hand, during periods of extensive global shocks, stock markets across countries are affected through the channels of cross-border trade and capital flows (Bonfiglioli, Favero, 2005). As a result, stock market returns and volatility show persistent correlation universally during periods of significant global shocks. Our present research reconfirms this time varying behavior in the Indian context using the outbreak of the Great Recession as an exogenous global shock.

3. Data

SENSEX is the most followed market index in the Indian stock market. It consists of the 30 largest and most actively traded stocks, representative of various sectors, on the BSE. These companies account for around fifty per cent of the market capitalization of the BSE. This study uses closing value of the daily SENSEX during the time period of January 2002 to July 2010. Our data set clearly accounts for two distinct phases of the global business cycles. The time span of January 2002 to November 2007 represents a booming phase of

the world economy primarily fuelled by the soaring housing markets. On the other hand the period of December 2007 to July 2010 is marked by the outbreak of the Great Recession in the US and its aftermath(6). We do not consider the period prior to 2002 because March 2001 to November 2001 is marked by another downturn in the US economy following the collapse of the dot-com bubble of 1995-2000.

In order to account for the existence of dynamic interlinkages among BSE and other stock markets in the world, we use six stock market indexes from the US, Europe, Asia and Latin America. These are NASDAQ and DOWJONES from the NYSE in the US, FTSE from the London Stock Exchange in the UK, JKSE of the Jakarta Stock Exchange in Indonesia, MERVAL from Argentina and BVSP from Sao-Paolo, Brazil. While the US and the UK markets are included to trace out the impact of developed countries on the Indian stock market, Argentinean and Brazilian markets are included because of the similarity of the level of economic development in these countries and India. Further the Indonesian market is expected to capture the regional contagion effect, if any, with the Indian stock market.

All the stock market index data are collected from the Yahoo Finance website(7). The daily returns are calculated for each series using the formula

$$R_t = (\log(P_t) - \log(P_{t-1}))$$

where R_t is the daily return series, P_t is the current stock price and P_{t-1} is the stock price in the previous period. Volatility in the stock returns is computed by the rolling standard deviation for 21 days. Our final working sample consists of 1,809 data points for seven stock indexes.

4. Data analysis

The daily SENSEX returns and volatility for the entire sample period are shown in Figures 1 and 2, respectively. Table 1 presents the summary statistics for the daily SENSEX returns for the pre and post-recession outbreak periods. The mean return during the pre-recession period is higher than the post-recession period with average daily returns turning negative and declining by almost 109 percent in the latter period. Volatility of the returns as measured by standard deviation can also be seen to increase markedly for all the indexes during the post- recessionary period. The Jarque-Bera test clearly fails to accept the null hypothesis of normally distributed daily stock returns for both the pre-recession and the post-recession outbreak periods. Mukherjee et al. (2011) also report that non-normality with fat tails is a distinguishing characteristic of the distribution of the SENSEX daily returns.

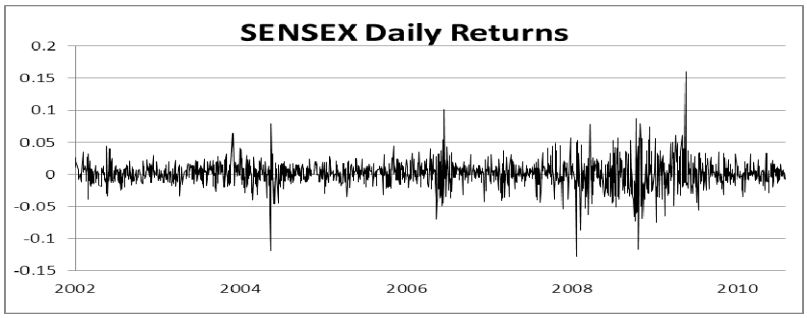

Figure 1. *SENSEX Daily Returns*

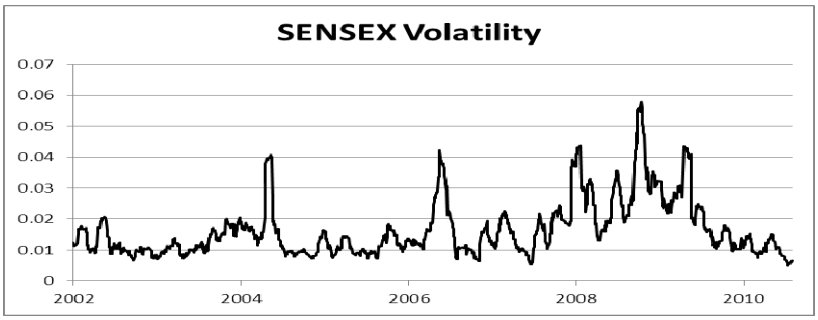

Figure 2. *SENSEX Volatility*

We also report the skewness in Table 1 in order to shed light on the asymmetry of the probability distribution of the daily stock returns. During pre-recession period, we find that the distribution of the SENSEX returns is negatively skewed, while it turns positive in the post-recession outbreak period. The spread of the distribution of returns as measured by Kurtosis declines slightly during the post-recession period. Higher Kurtosis would imply fatter tail and thus higher risk because of higher probability of observing an extreme event.

Table 1

	Pre-Recession	Post-recession outbreak
	SENSEX	
Mean	0.001442	-0.000144
Median	0.00181	-0.000078
Std. Dev.	0.015122	0.025065
Skewness	-0.317886	0.123621
Kurtosis	9.262804	8.281845
Jarque-Bera	2067.204	651.212

In order to test if the differences in the mean returns between the two subsample periods are statistically significant, we perform a t-test with unequal variances on the mean return of each series. The results of the test are reported in Table 2.

Table 2

t-Test: two-sample assuming unequal variances (SENSEX)		
	Pre-recession	Post-recession Outbreak
Mean Returns	0.001442	-0.000144
Variance of Returns	0.0002	0.0006
t Stat	1.4796	

We fail to reject the null hypothesis that pre-recession and post-recession mean returns are same, thus implying that the returns on an average remain statistically similar for both the time periods.

Similarly, we also test if the mean volatilities are statistically different for pre-recession and post-recession periods. The results of the t-test with unequal variance are given in Table 3.

Table 3

t-Test: two-sample assuming unequal variances (SENSEX)		
	Pre-recession	Post-recession outbreak
Mean Volatility	0.015122	0.025065
Variance of Volatility	0.000039	0.000129994
t Stat	-15.71376375*	

*Significant at 5% level.

The significance of the t-statistic shows that pre and post-recession volatilities in stock returns are statistically different.

5. Nature of the contagion – pre-recession and post-recession outbreak period

The analysis of the stock returns in the previous section points to the fact that there are some fundamental differences in the nature of the daily SENSEX returns and volatility during pre and post-recession outbreak periods. In this section we explore the international dimensions of the stock market behavior, with particular focus on the nature of contagion during the pre and the post-recession periods in the Indian stock market. Below we present correlation of both returns and volatility of returns across different stock market indexes considered in this paper. The most common method of investigating market linkages adopted by early researchers is to examine the return and volatility correlation structures amongst the markets under investigation. Correlation measures help to capture the nature of market co-movements without further shedding any light on the causality of such movements.

5.1. Correlations in stock market returns

The correlation of the stock market returns for the two different time periods are presented in tables 4 and 5, respectively. For the pre-recession subperiod of January 2002 – November 2007, none of the stock markets are strongly correlated except for the DOW and the NASDAQ. The strongest correlation between DOW and NASDAQ is obvious since both the indexes are US based. In terms of the degree of correlation with the US stock indexes, both FTSE and BVSP are found to be relatively more correlated with the DOW and the NASDAQ than SENSEX and JKSE. SENSEX and JKSE are also found to be weakly correlated with FTSE, but on the contrary to such trends JKSE and SENSEX exhibit a strong correlation pattern among themselves. For the post recession period however, we notice a distinctive change in overall pattern of association among the stock indexes with an increase in the correlation among all the indexes. Post-recession, SENSEX is found to become strongly correlated with the returns of the developed markets.

Table 4

Correlation in returns during pre-recession period (Jan 2002 - Nov 2007)							
	BVSP	DOW	FTSE	JKSE	MERVAL	NASDAQ	SENSEX
BVSP	1	0.5327	0.3759	0.1583	0.3099	0.5242	0.1880
DOW		1	0.5167	0.0663	0.2402	0.8540	0.0990
FTSE			1	0.2178	0.2563	0.4399	0.2406
JKSE				1	0.1731	0.1138	0.4013
MERVAL					1	0.2226	0.1357
NASDAQ						1	0.1129
SENSEX							1

Table 5

Correlation in Returns During Post Recession Period (Dec 2007 - Jul 2010)							
	BVSP	DOW	FTSE	JKSE	MERVAL	NASDAQ	SENSEX
BVSP	1	0.7721	0.6924	0.4008	0.7979	0.7758	0.4431
DOW		1	0.6611	0.2690	0.6912	0.9407	0.3800
FTSE			1	0.4314	0.7039	0.6285	0.5031
JKSE				1	0.4348	0.2745	0.5694
MERVAL					1	0.6892	0.4303
NASDAQ						1	0.3455
SENSEX							1

The divergence in the nature of correlations in returns among the indexes during the pre and the post-recession time periods clearly depicts two broad trends – first during relatively stable economic condition, stock market behaviors are more driven by country specific idiosyncratic shocks rather than global shocks. At the same time regional contagions play an important role

during relatively calm economic environment (Forbes, Rigobon, 2002, Bonfiglioli, Favero, 2005). On the other hand, following a substantial global shock, markets seem to become more integrated on a global scale across borders.

5.2. Correlations in stock market volatility

In this section, we compare the volatility of the returns across indexes. The nature of correlation of volatility across markets shows substantial change following the onset of the recession (see Tables 6 and 7). During the pre-recession time period, volatility of SENSEX is not correlated or rather slightly negatively correlated with DOW, NASDAQ and FTSE, whereas it is positively correlated with BVSP, JKSE and MERVAL. On the other hand, with the outbreak of the recession, SENSEX becomes highly correlated with all the indexes. It seems that during normal economic conditions, the Indian market is insulated to some extent to the volatility in the markets of the developed economies. During these calm times the Indian market is rather more concerned with the activities in similar emerging market economies like Brazil, Indonesia and Argentina. On the other hand, during adverse economic times, the Indian market is highly vulnerable to market conditions across the globe.

Table 6

Correlation in volatility during pre-recession period (Jan 2002 - Nov 2007)							
	BVSP	DOW	FTSE	JKSE	MERVAL	NASDAQ	SENSEX
BVSP	1	0.588	0.571	0.457	0.422	0.545	0.342
DOW		1	0.889	0.295	0.364	0.896	-0.082
FTSE			1	0.355	0.212	0.739	-0.001
JKSE				1	0.438	0.227	0.566
MERVAL					1	0.496	0.240
NASDAQ						1	-0.014
SENSEX							1

Table 7

Correlation in volatility during post recession period (Dec 2007 - Jul 2010)							
	BVSP	DOW	FTSE	JKSE	MERVAL	NASDAQ	SENSEX
BVSP	1	0.942	0.946	0.822	0.940	0.910	0.751
DOW		1	0.954	0.764	0.931	0.977	0.707
FTSE			1	0.796	0.926	0.933	0.697
JKSE				1	0.769	0.742	0.795
MERVAL					1	0.892	0.662
NASDAQ						1	0.688
SENSEX							1

6. Direction of causality

The fact that the stock markets show common patterns in terms of returns and volatility of returns during the recessionary time periods emphasizes the importance of global shocks in understanding the relationships among these markets. Although the correlation results presented in the previous section captures the association among the markets, it fails to point towards the dynamic causal relationships among these indexes. To decipher the direction of causation among the stock markets under consideration, we perform the Granger causality tests. This method was proposed by Granger (1969) and popularized by Sims (1972). Testing causality, in the Granger sense, involves using ***F***-tests to test whether lagged information on a stationary variable *Y* provides any statistically significant information about a stationary variable *X* in the presence of lagged *X*. If not, then "*Y* does not Granger-cause *X*." The bivariate vector autoregression (VAR) framework can be used to test for such Granger causality. Assuming a particular autoregressive lag length m, we can estimate the following unrestricted equation by ordinary least squares (OLS):

$$Y_t = \sum_{i=1}^{m} \alpha_i X_{t\_i} + \sum_{i=1}^{m} \beta_i X_{t\_i} + u_t$$

where u_t is iid with mean zero and the Granger causality of X to Y is tested as joint significance of α_i s i.e. the null hypothesis H_0: X does not Granger cause Y is tested as as H_0: $\alpha_i = 0$ for all i. In case time series data is non-stationary, the Granger causality test can only be performed if both the series are conitegrated of same order. But then cointegration will guarantee that the linear combination of two non-stationary time series generates a stationary time series. Thus in order to test for Granger causality, our first step is to test for stationarity of the time series data. We start our analysis in the following section by testing for stationarity of our time series variables.

6.1. Stationarity tests

Table 8 reports the results of the Phillips-Perron unit root test (Phillips, Perron, 1988) on the returns series for pre-recession and post-recession time periods.

Table 8

Phillips-Perron test for unit root in return series		
	Pre-recession	Post-recession
BVSP	-35.334	-24.778
DOW	-37.630	-28.437
FTSE	-38.764	-25.473
JKSE	-31.820	-21.060
MERVAL	-34.318	-23.182
NASDAQ	-36.940	-26.800
SENSEX	-33.847	-23.439

*Significant at 5% level.

We do not find any evidence of unit root either during the pre-recession or the post-recession periods in the returns series.

Stationarity test for volatility of returns series is given in Table 9.

Table 9

Phillip-Perron test for unit root in volatility series			
	Pre-recession	Post-recession	Post-recession (1st difference)
BVSP	-4.780	-1.012	-22.013
DOW	-3.352	-1.050	-24.369
FTSE	-2.965	-1.026	-19.848
JKSE	-5.823	-2.642	-19.939
MERVAL	-5.620	-0.941	-22.706
NASDAQ	-3.414	-0.958	-24.286
SENSEX	-4.480	-1.196	-23.983

*Significant at 5% level.

For the pre-recession period of January 2002 – November 2007, we do not find any evidence of unit root in the volatility series. We fail to accept the null hypothesis that the series are non-stationary at 5 percent level of significance. For the post-recession outbreak period, i.e. December 2007- July 2010, all the volatility series in levels are non-stationary. However, in first difference all the series in the post-recession period are found to be stationary. If two time series are integrated of the same order, then there is possibility of coinetgrating relationship between the two. According to Engle and Granger (1987), if two time series are co-integrated, then the Granger causality model is still misspecified. One needs to do proper error corrections to carry out the causality analysis in that case. Since during the post-recession sub-period volatility series in all the markets are non-stationary, we start out by testing for cointegration in the volatility series using Johansen (1991) approach. The unrestricted Johansen rank test for conitegration is shown in Table 10 below.

Table 10

Johansen cointegration test - post recession outbreak period volatiltiy

	Hypothesized No. of CE(s)	Unrestricted cointegration rank test (Trace)	
		Eigenvalue	Trace statistic
SENSEX vs BVSP	None *	0.024719	18.71153
	At most 1 *	0.008647	4.820164
SENSEX vs DOW	None *	0.019061	15.83826
	At most 1 *	0.009352	5.195731
SENSEX vs FTSE	None *	0.026023	20.02355
	At most 1 *	0.009793	5.442484
SENSEX vs JKSE	None *	0.030994	23.32989
	At most 1 *	0.010571	5.887516
SENSEX vs MERVAL	None *	0.020774	18.16137
	At most 1 *	0.012075	6.657134
SENSEX vs NASDAQ	None *	0.020547	15.71781
	At most 1 *	0.007632	4.236904

*Significant at 5%.

Cointegration test results show existence of one co-integrating relationship between the SENSEX volatility with other market index volatilities during the post-recession outbreak period.

6.2. Granger causality tests

We perform Granger causality test to determine the causality of volatility between SENSEX and other indexes in both the sample subperiods. These results are reported in Tables 11 and 12. The results are substantially different when we test for Granger causality between the pre-recession and the post-recession periods. For the pre-recession period, except for volatility of JKSE, none of the indexes cause the volatility in SENSEX. Also SENSEX does not cause volatility in the indexes under consideration. It reconfirms the fact that during the pre-recession period contagion across countries is non-existent with the exception of regional contagion effect of JKSE on SENSEX. Whereas during the post-recession period, volatility in foreign indexes does Granger cause volatility in the SENSEX. Also volatility in SENSEX is found to Granger cause volatility in BVSP. Foreign markets are thus found to have important impact on Indian market during post-recession period, but the Indian market does not have substantial impact on foreign markets with the exception of Brazil.

Table 11

Granger causality test of volatilities between SENSEX and other indices
Jan 2002 - Nov 2007

Null hypothesis:	Obs	F-Statistic	Probability
SENSEX does not Granger Cause BVSP	1251	0.47553	0.49058
BVSP does not Granger Cause SENSEX		0.9415	0.33208
SENSEX does not Granger Cause DOW	1251	0.52821	0.4675
DOW does not Granger Cause SENSEX		0.02055	0.88604
SENSEX does not Granger Cause FTSE	1251	0.19413	0.65958
FTSE does not Granger Cause SENSEX		0.00777	0.92977
SENSEX does not Granger Cause JKSE	1251	0.30992	0.57783
JKSE does not Granger Cause SENSEX		5.89978*	0.01528
SENSEX does not Granger Cause MER_SD	1251	1.18304	0.27695
MER_SD does not Granger Cause SENSEX		0.02799	0.86715
SENSEX does not Granger Cause NASDAQ	1251	0.56574	0.4521
NASDAQ does not Granger Cause SENSEX		0.03982	0.84187
*Significant at 5% level.			

Table 12

Granger causality test of volatilities between SENSEX and other indices
Nov 2007 - July 2010

Null hypothesis:	Obs	F-Statistic	Probability
SENSEX does not Granger Cause BVSP	558	5.66238*	0.01767
BVSP does not Granger Cause SENSEX		12.7913*	0.00038
SENSEX does not Granger Cause DOW	558	1.53723	0.21556
DOW does not Granger Cause SENSEX		9.46844*	0.00219
SENSEX does not Granger Cause FTSE	558	2.63446	0.10514
FTSE does not Granger Cause SENSEX		9.28626*	0.00242
SENSEX does not Granger Cause JKSE	558	0.00003	0.99576
JKSE does not Granger Cause SENSEX		6.89145*	0.0089
SENSEX does not Granger Cause MER_SD	558	1.43044	0.2322
MER_SD does not Granger Cause SENSEX		5.00537*	0.02567
SENSEX does not Granger Cause NASDAQ	558	0.61409	0.43359
NASDAQ does not Granger Cause SENSEX		8.06466*	0.00468
*Significant at 5% level.			

We further perform Granger causality tests on the returns series (Tables 13 and 14).

Table 13

Granger causality test of returns between SENSEX and other indexes Jan 2002 - Nov 2007

Null hypothesis:	Obs	F-Statistic	Probability
SENSEX does not Granger Cause BVSP	1251	1.57366	0.20991
BVSP does not Granger Cause SENSEX		38.7136*	0.00000
SENSEX does not Granger Cause DOW	1251	0.15623	0.69272
DOW does not Granger Cause SENSEX		47.3389*	0.00000
SENSEX does not Granger Cause FTSE	1251	0.6379	0.42462
FTSE does not Granger Cause SENSEX		13.6319*	0.00023
SENSEX does not Granger Cause JKSE	1251	3.77851**	0.05214
JKSE does not Granger Cause SENSEX		0.74445	0.38841
SENSEX does not Granger Cause MER_SD	1251	0.39521	0.52969
MER_SD does not Granger Cause SENSEX		7.44464*	0.00645
SENSEX does not Granger Cause NASDAQ	1251	0.27221	0.60194
NASDAQ does not Granger Cause SENSEX		43.9026*	0.00000
*Significant at 5% level, **Significant at 10% level.			

Table 14

Granger causality test of returns between SENSEX and other indices Nov 2007 - July 2010

Null hypothesis:	Obs	F-Statistic	Probability
SENSEX does not Granger Cause BVSP	558	0.80544	0.36986
BVSP does not Granger Cause SENSEX		14.32*	0.00017
SENSEX does not Granger Cause DOW	558	0.05261	0.81866
DOW does not Granger Cause SENSEX		26.0674*	0.00000
SENSEX does not Granger Cause FTSE	558	1.35292	0.24527
FTSE does not Granger Cause SENSEX		5.32195*	0.02143
SENSEX does not Granger Cause JKSE	558	2.70299	0.10073
JKSE does not Granger Cause SENSEX		0.88384	0.34756
SENSEX does not Granger Cause MER_SD	558	3.09458	0.0791
MER_SD does not Granger Cause SENSEX		3.69009**	0.05525
SENSEX does not Granger Cause NASDAQ	558	0.24736	0.61913
NASDAQ does not Granger Cause SENSEX		42.9581*	0.00000

*Significant at 5% level, **Significant at 10% level.

We do not find any substantial changes in causality among return series between pre and post-recession time periods. During both periods, BVSP, DOW, FTSE, MERVAL and JKSE Granger cause SENSEX but not the other

way round. On the other hand SENSEX Granger cause JKSE during the both the time periods.

Our results indicate that direction of causality in returns series does not vary with business cycles but volatility in return series strongly depend upon economic fluctuations. During relatively stable economic environment, volatility does not spread across countries, but during periods of economic turmoil, Indian market gets affected by the volatility in the world market.

7. Conclusion

The purpose of this study is to document the behavior of the Indian stock market, particularly SENSEX before and after the Great Recession. We find substantial change in behavior of the SENSEX following the outbreak of the recession. Prior to the Great Recession, the Indian market was characterized by positive daily returns, but such returns turned negative after the recession. But we do not find any significant statistical difference between the pre and post-recession daily mean returns. Major changes are observed in terms of volatility of returns. With the onset of the recession, there is substantial increase in volatility in the Indian equity market. In order to explore the impact of the foreign stock markets on SENSEX, we analyze the nature of contagion among the US, European, Asian and Latin American markets. During pre-recession period, the Indian market is found to be insulated from the world market. It seems that country specific and to some extent regional factors dominate the SENSEX during periods of relative economic stability. The picture is substantially different after the Great Recession, marked by strong correlation in SENSEX returns and volatility with other stock markets around the world. This study concludes that in order to understand the time varying behavior of the SENSEX in terms of international financial market integration, it is important to account for global business cycle fluctuations. Analyzing the market behavior without accounting for such global fluctuations perhaps may give distorted picture of the returns and volatility in the Indian markets.

Notes

(1) Based upon National Bureau of Economic Research (NBER) dating of US business cycles.
(2) World Economic Outlook Database, October 2009.
(3) Our study analyzes the impact of the recession on returns and hence our sample is divided into two subsamples - one prior to the recession and the other following the onset of the recession. The period following the outbreak of the recession is interchangeably termed as post-recession or post-recession outbreak period in this paper.

(4) On Monday, 19 October, 1987, stock markets around the world crashed, shedding a huge value in a very short time. The crash began in Hong Kong, spreading west to Europe, hitting the U.S. after other markets had already declined by a significant margin. In the literature it is also known as Black Friday.

(5) See Forbes and Rigobon (2002), Karolyi and Stultz (1996), Lee and Kim (1993), Lin et al. (1994), Longin and Solnik (1995, 2001) and Bonfiglioli and Favero (2005).

(6) Although the NBER dated June 2009 as the official end date of the Great Recession in the US but its effects are still persistent beyond June 2009 during the sample period used in this paper.

(7) See http://finance.yahoo.com/

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