

## On the volatility of sensex

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**ABSTRACT:** The present study seeks to analyse Volatility of popular stock index SENSEX. The present study is based on the closing time series data of SENSEX covering the period from 3<sup>rd</sup> January 2000, to 30<sup>th</sup> June 2011. The year 2008 has recorded higher Volatility compared to the other years of the study. Volatility fell in the year 2009 from the high of 2008. The years after were comparatively calmer. In the year 2000, the Volatility was higher signifying enhance market activity. The overall daily Volatility for SENSEX was approximately 1.70 % while the annualized value was approximately 25%-26%. Events Reported around Daily Returns in Excess of +/-5% have also been identified.

**Keywords:** Unit Root Test, Box-Ljung Statistics, Kurtosis, Box-pierceQ statistics.

### 1. INTRODUCTION

The Stock Market is reflecting worldwide developments. In fact, it is really reflecting the developed economies as well as the Asian economies. There is a saying: Stock Markets have predicted 10 out of the last 3 recessions. With plummeting share prices making headline news, it is worth considering the impact of the Stock Market on the economy. The financial system of a country is expected to work in a way that facilitates the channelization of resources from the surplus sectors to the deficit sectors which have a pressing need for them. This is needed with a view to ensure growth in the economy. In order to do this, an economy needs a vibrant Stock Market which would ensure safety, integrity and liquidity to the investing community which makes investments in a wide range of financial instruments. The movement of prices up or down of the Stock Markets are always in the news. It is called as "Volatility" in Stock Market parlance. This high Volatility has given sleepless nights to a lot of investors as well as market regulators. Public interest in market movements has intensified as more and more

investors have flocked to the Stock Markets to be a part of bonanza. Wide sharp price fluctuation may be unnerving for the millions of such people, who are relatively new to investing.

Studies conducted by Levine and Zervos (1998) reveal that being a part of the financial system, Stock Market plays a crucial role to the economic growth of the country. Raju M.T, Ghosh Anirban (2004) held that Volatility estimation is important for several reasons and for different people in the market. Pricing of securities is supposed to be dependent on Volatility of each asset. However, investing activity is subject to various type of risk. Dispersion of returns of an asset from its mean return is called Volatility. Stock Market Volatility is asymmetric, that is, low when prices rise and vice versa. Actually Volatility receives a great deal of concern because it can be used as a surrogate risk. A rise in the Volatility could be interpreted as a rise in risk of the concerned investment and investors may transfer funds to less risky assets.

## 2. LITERATURE REVIEW

French et al (1987) examined the relationship between stock prices and Volatility and reported that unexpected Stock Market returns are negatively related to the unexpected changes in Volatility. This negative relation provided indirect evidence of a positive relation between expected risk premiums and Volatility. Market Volatility may also affect consumer spending . According to Garner (1988), Stock Market crash in 1987 reduced consumer spending in the USA. Further more , Gertler and Hubbard (1989) revealed that business investment spending is also influenced by stock return Volatility. Schwert (1989) characterized the changes in Stock Market Volatility through time. The Stock Volatility increased by a factor of two or three during this period compared with the usual level of the series. There is no other series that experienced the similar behavior. The relationship between Stock Volatility and several measures of corporate profitability was also analysed.

Akgiray (1989) presented a new evidence about the time series behavior of Stock Market returns and summarized the results of applying some new time series models to daily return series. It was discovered that daily series exhibited much higher degrees of statistical dependence than that had been reported in previous studies. This finding was the result of recognizing the possibility of non-linear stochastic processes generating security prices. In addition to daily data, some of the analysis were also conducted for weekly and monthly data. Schwert (1990) in his study surveyed the academic evidence on Stock Market Volatility in an attempt to put the current policy debate, that the general level of Stock Market Volatility has been rising, in perspective. Volatility had been measured by the standard deviation of rates of return to a broad Stock Market index such as the Standard and Poor's 500.

Roy and Karmakar's study (1995) investigated on measurement of Stock Market Volatility for the period 1935 to 1992. They focused on the measurement of the average level of Volatility in the Indian Stock Market and whether it had increased in the current period. The current level of Volatility had been compared with this average measure in order to understand whether it was above or below the historical level. The study conducted by Bekaert (1995) observes that in segmented capital markets , Volatility is a critical input in the cost of capital. Volatility can also be used as a decision making criterion.

Piyush Kumar Chowan and Vasant Shukla(2000) have tried to analyse the following questions like, Has the Stock Market Volatility increased? Has the Indian Stock Market developed into a speculative bubble due to the emergence of New Economy stocks? Why is this Volatility pronounced? They tried to unearth the rationale for those weird movements. According to Poon et al (2003), Volatility has a wide sphere of influence including investment, security valuation, risk management and policy making. They also put emphasis on the importance of Volatility forecasting in various things such as options pricing, financial risk management etc. Karmakar (2006) measured the Volatility of daily stock return in the Indian Stock Market over the period of 1961 to 2005. Using GARCH model, he found strong evidence of time varying Volatility.

Parag Parikh (2009) had thrown flash that effect of the events on the markets are basically short lived, unless if it has the long-term implications. Basically, there are 3 E's that move the markets: Earnings, Emotions & Events. The first E factor is fundamental and stands for "Earnings". This factor spells out the stock price in relation to the company's earnings- which tells us in general , whether a stock is cheap or

expensive. However the second E factor, i.e. “Emotions” that moves and shakes the market in crazy way-such as we saw post-budget. These emotions were mainly greed and fear, where greed that prevented retail investors from taking advantage of a rising market and fear made them flee away from the market when they should be flocking to buy. The fundamentals of the companies do not change every day, yet the share prices move up and down daily. This volatility is due to the third „E“ which stands for „events“. Events impact emotions or sentiments in a positive or negative way. Not only the events per se, but also how these are presented but the media impact the sentiments. Based on

the presentation and interpretation of that events, people make decisions by taking short cuts without processing the information based on how quick the information is received.

Stock Market Volatility is a popular area of research due to the aforementioned facts. In the Indian context, Som Sankar Sen (2009) have successfully explored the movements of Stock Market Volatility of S&P CNX Nifty. The present study therefore, seeks to analyse Volatility of another popular stock index SENSEX.

### 3. DATA

The present study is based on the closing time series data of SENSEX covering the period from 3<sup>rd</sup> January 2000, to 30<sup>th</sup> June 2011. The sample consists of 2870 observation. The data have been collected form BSE website.

### 4. METHODOLOGY

#### 4.1. CALCULATION OF DAILY MARKET RETURNS

Daily market returns ( $r_t$ ) have been computed as follows:

$$r_t = \ln(I_t) - \ln(I_{t-1})$$

Where,  $\ln$  denotes natural logarithm

$I_t$  is the closing index value at day „t“

$I_{t-1}$  is the closing index value at day before „t“

The present study uses the logarithmic difference of prices of two successive periods for calculation of rate of return. The logarithmic difference is symmetric between up and down movements and is expressed in percentage terms for ease of comparability with the straightforward idea of a percentage change.

The standard deviation is also based on logarithmic units. The standard deviation of returns  $r_t$  from a sample of  $n$  observations is the square root of the average squared deviation of returns from the average return  $r$  in the sample. Thus standard deviation  $S$ , is defined as

$$S = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N-1}}$$

In the present study the standard deviation has been calculated by this method. The logarithmic standard deviation is expressed in percentage term after multiplying it by 100. Daily Volatility have been annualized by multiplying them with the square root of the number of trading days .While annualizing the returns , the multiplier used is the number of trading days.

#### 4.2 DISTRIBUTION OF DATA

To observe the pattern of distribution of the time series , Data Skewness and Kurtosis have been calculated . Zero Skewness implies symmetry in the distribution, whereas, Kurtosis indicates the

extent to which probability is concentrated in the centre and especially at the tail of the distribution, Kurtosis measures the peakedness of a distribution relative to the normal distribution. A distribution with Equal Kurtosis as the Normal Distribution is called as „Mesokurtic“; a distribution with small tails is called „Platykurtic“ and a distribution with a large tail is called „Leptokurtic“.

Furthermore, to test normality of the time series data, the study applies Jarque-Bera Test in the following form:

$$JB = (n/6)(S^2 + (1/4)(K - 3)^2)$$

where n is the number of samples or degrees of freedom, S is the Skewness, and K is the Kurtosis. For a normal distribution, the values of S and K should be 0 and 3 respectively so that JB becomes equal to 0. A high value of JB is an indicator of non-normality.

#### 4.3 AUTO CORRELATION TEST

To judge the auto correlation of the time series, data Box-pierce Q statistic in the following form has been used.

$$Q=n$$

Where n=sample size and m=lag length. Since the present study uses daily data, a lag length upto 16 has been considered. If the computed Q statistic is significant, then it indicates the presence of autocorrelation.

#### 4.4 UNIT ROOT TEST

The time series data used in the empirical study must be stationary. Mean, variance and covariance of a stationary time series data does not change with the time shift. If the data is non stationary, then regression results using such data would be spurious, because the usual „t“ test would not be applicable to test the significance of coefficients. To test the stationarity, the unit root test is applied on the time series return data. In this regard, the Phillips-Perron Unit Root Test is used. In Phillips-Perron Unit Root Test, non-parametric statistical methods are used to take care of the serial correlation in the error term ( $\mu_t$ ) of the following equation:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \mu_t$$

Where,  $Y_t$  is the time series data under consideration

The test is based on the null hypothesis  $H_0 : Y_t$  is not  $I(0)$ . If the PP statistics are less than the critical value, then  $Y_t$  is not stationarity.

**Table 1**  
**Descriptive statistics of the daily SENSEX**

Mean	0.000437
Median	0.001207
Maximum	0.159900
Minimum	-0.118092
Std. Dev.	0.017098
Skewness	-0.186473
Kurtosis	9.137619
Jarque-Bera	4521.380
Probability	0.000000
Sum	1.254515

Sum Sq. Dev.	0.838695
Observations	2870

Descriptive statistics of the daily SENSEX return have been reported in the Table 1.

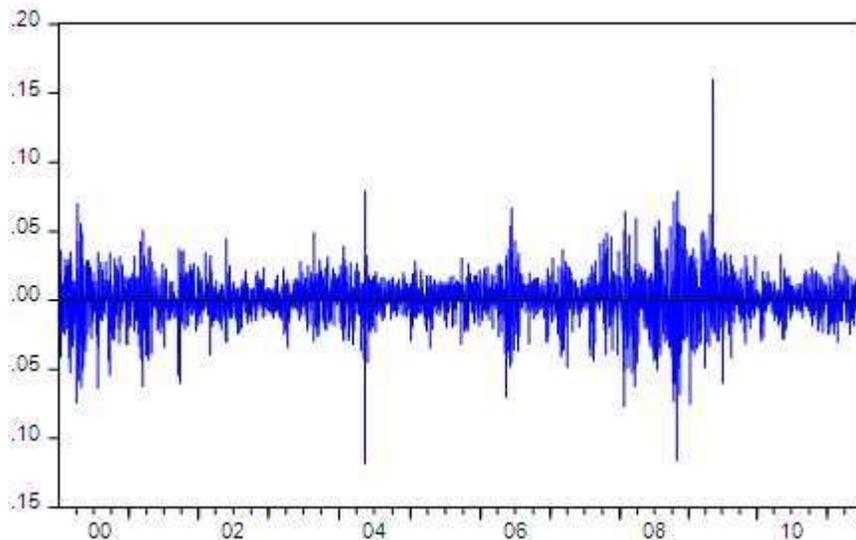
It could be seen that the returns during the study period varies between -0.118092 to 0.159900. So a wide range of fluctuation in daily returns could be witnessed. The mean return during the whole study period is 0.000437 which is very near to zero. Therefore a mean reverting process is a certain possibility.

Skewness is negative indicating a relatively long left tail compared to the right one. Kurtosis is excess of 3 indicating heavy tails and the distribution is leptokurtic. These

findings are similar to the existing literature. Mandelbrot et al (1963) observed Volatility clustering and leptokurtosis are common observation in financial time series. Moreover, a highly significant large JB statistic confirms that the return series is not normally distributed. Daily observations have been used in the present one.

Harvey (1995) points out that in many emerging markets, time series return data do not follow normal distribution. The graphical representation of the SENSEX daily returns for the selected period has been distributed in the Figure 1

**Figure 1: BSE Sensex Return**



**Table 2**  
**BSE Sensex : Volatility of Daily Returns in a Year (January 2000-June 2011)**

Year (1)	n* (2)	Average Daily return (%) (3)	Daily Volatility (%) (4)	Annualised return (%) (5)	Annualised Volatility (%) (6)
2000	250	(-)0.09	2.20	(-)22.5	34.78505
2001	248	(-)0.07	1.71		
2002	251	0.01	1.10	(-)17.36	26.92911
2003	253	0.21	1.18		
2004	254	0.04	1.60	2.51	17.42728
2005	251	0.14	1.08		
2006	250	0.15	1.62	53.13	18.76905
2007	249	0.15	1.54		
2008	246	(-)0.30	2.85	10.16	25.4998
2009	243	0.24	2.18		
2010	252	0.06	1.00	35.14	17.11042
2011	124	(-)0.06	1.19		
				37.5	25.61445
				37.35	24.30079
				(-)73.8	44.7005
				58.32	33.98284
				15.12	15.87451
				(-)7.44	13.25128
Overall	2871	.043	1.70	9.56**	25.78**

Number of trading days\*

These figures are calculated by taking the average number of trading days in a year\*\*

The above table shows measure of Volatility of daily returns in a year. A glance at the Table 2 shows that the year 2008 has recorded higher Volatility compared to the other years of the study. Volatility fell in the year 2009 from the high of 2008. The years

after were comparatively calmer. In the year 2000, the Volatility was higher signifying enhance market activity. The overall daily Volatility for SENSEX was approximately 1.70 % while the annualized value was approximately 25%-26%.

**Table 3**  
**BSE Sensex: Daily Returns in Excess of +5%, -5% (January 2000 –June 2011)**

Rank	Year	Date and Month	Positive Change (%)	Rank	Year	Date and Month	Negative Change (%)
1	2009	18 <sup>th</sup> May	15.989	1	2004	17 <sup>th</sup> M ay	-11.809
2	2004	18 <sup>th</sup> May	15.931	2	2008	24 <sup>th</sup> Oct	-11.604
3	2008	31 <sup>st</sup> Oct	7.900	3	2008	21 <sup>st</sup> Jan	-7.695
4	2008	13 <sup>th</sup> Oct	7.158	4	2009	7 <sup>th</sup> Jan	-7.523
5	2000	7 <sup>th</sup> Apr	6.992	5	2000	4 <sup>th</sup> Apr	-7.422
6	2006	15 <sup>th</sup> Jun	6.667	6	2008	10 <sup>th</sup> Oct	-7.328
7	2008	25 <sup>th</sup> Jan	6.409	7	2006	18 <sup>th</sup> May	-7.003
8	2009	4 <sup>th</sup> May	6.217	8	2008	11 <sup>th</sup> Nov	-6.838
9	2008	25 <sup>th</sup> Mar	5.893	9	2000	24 <sup>th</sup> July	-6.366
10	2008	23 <sup>rd</sup> Jul	5.772	10	2000	2 <sup>nd</sup> May	-6.321
11	2008	28 <sup>th</sup> Oct	5.693	11	2004	14 <sup>th</sup> May	-6.298
12	2008	10 <sup>th</sup> Nov	5.580	12	2008	17 <sup>th</sup> Mar	-6.223
13	2000	26 <sup>th</sup> Apr	5.554	13	2001	13 <sup>th</sup> Mar	-6.220
14	2008	3 <sup>rd</sup> Nov	5.463	14	2008	15 <sup>th</sup> Oct	-6.051
15	2006	9 <sup>th</sup> Jun	5.388	15	2001	21 <sup>st</sup> Sep	-6.027
16	2008	4 <sup>th</sup> Dec	5.367	16	2009	6 <sup>th</sup> July	-6.008
17	2008	21 <sup>st</sup> Nov	5.347	17	2008	6 <sup>th</sup> Oct	-5.958
18	2008	19 <sup>th</sup> Sep	5.313	18	2008	17 <sup>th</sup> Oct	-5.898
19	2008	2 <sup>nd</sup> Jul	5.281	19	2000	17 <sup>th</sup> Apr	-5.799
20	2008	10 <sup>th</sup> Dec	5.239	20	2000	22 <sup>nd</sup> Sep	-5.425
21	2001	14 <sup>th</sup> Mar	5.076	21	2001	17 <sup>th</sup> Sep	-5.413
22	2008	23 <sup>rd</sup> Jan	5.036	22	2001	14 <sup>th</sup> Sep	-5.411
				23	2008	3 <sup>rd</sup> Mar	-5.260
				24	2000	29 <sup>th</sup> Feb	-5.251
				25	2008	22 <sup>nd</sup> Jan	-5.100
				26	2000	8 <sup>th</sup> May	-5.034
				27	2008	15 <sup>th</sup> July	-5.033

**Table 4**  
**Sensex: Events Reported around Daily Returns in Excess of +5%**  
**(January 2000 –June 2011)**

7 <sup>th</sup> Apr 2000	6.99	A recovery on the NASDAQ and the government's soft pedaling of FII tax issue led to the flare up in the share prices with the BSE sensex registering its third highest gain of 352.47 points since its inception.
26 <sup>th</sup> Apr 2000	5.554	A rally was finally insight as strong buying support on the back of the good fundamental returns and an upturn on the NASDAQ pushed up the 30-share Index by 261.81 points.

14 <sup>th</sup> Mar 2001	5.076	The sensex which tamed a whopping 516 points or 12.7 percent over the previous three days following political turmoil, payment crisis on bourses and Global Markets meltdown, shot up on 14 <sup>th</sup> March 2001. Almost all the sectoral indices also rose with BSE IT sector index gaining 12 percent.
18 <sup>th</sup> May 2004	7.931	Investor sentiment lifted further on events that Ms.Sonia Gandhi had refused to accept the job of Prime Minister. The Reserve Bank of India provided yet another Boost when it eased margin requirements for bank lending against shares.
9 <sup>th</sup> Jun 2006	5.388	Led by index heavyweight Reliance Industries, the stock market staged a smart rebound on Friday, ending a four-day losing streak, with the BSE Sensex recorded its biggest single-day gain since March 1992.
15 <sup>th</sup> Jun 2006	6.667	Recovery in some Asian markets gave way under a fresh bout of profit booking.
23 <sup>rd</sup> Jan 2008	5.036	SENSEX rose more than 860 points mainly due to the previous days interest rate cut in the US.
25 <sup>th</sup> Jan 2008	6.409	Sensex soared 1140 points in record-breaking rally .
25 <sup>th</sup> Mar 2008	5.893	The market spurted after the Congress-led United Progressive Alliance (UPA) Government retained power by securing trust vote in Parliament late on 22 July 2008, ending political uncertainty.
2 <sup>nd</sup> Jul 2008	5.281	Stock market which lost heavily in the last three trading sessions, bounced Back on Wednesday, mainly on buying support from domestic institutions and property traders. Positive news on the political front, strong opening of the European markets and short covering brought buyers back to badly battered market.
23 <sup>rd</sup> Jul 2008	5.772	The nearly 6 percent gain for the Sensex appeared to be more of Euphoric reaction to UPA's winning the trust vote in Parliament rather than on the basis of any underlying fundamentals.
19 <sup>th</sup> Sep 2008	5.313	Developments on the Global Front, Particularly from the Euro Region, continued to be trigger for stock markets.
13 <sup>th</sup> Oct 2008	7.158	RBI cuts interest rates ,Sensex goes up 800 points to finish 11,300 levels Diwali cheers markets, Sensex was up by 505 points.

28 <sup>th</sup> Oct 2008	5.693	Indian markets have been resilient than more others in the wake of the Global financial crisis, with the Sensex having gained more than 92.3 percent from the Diwali 2008 and 17 month high.
31 <sup>st</sup> Oct 2008	7.9	The BSE 30-share Sensex rose 1086.99 points or 12.49% to 9788.06 in the week ended Friday, 31 October 2008.
3 <sup>rd</sup> Nov 2008	5.463	Sensex surged 515 points on global rally and as well as due to the massive Liquidity support announced by the RBI.
10 <sup>th</sup> Nov 2008	5.58	Last week BSE Sensex was very volatile. Crucial support level had been 9700-10200 ,while resistance level has been from 10700-10900 in daily charts.
21 <sup>st</sup> Nov 2008	5.347	U.S. stocks plunged yet again on Friday, as a frantic flight from risk prompted by investors' deepening economic fears drove the benchmark Standard & Poor's 500 index to its lowest level, however Sensex showed a positive sign.
4 <sup>th</sup> Dec 2008	5.367	India's Sensex Gained 482 Points on Rate Cut hopes.
10 <sup>th</sup> Dec 2008	5.239	Surged over 320 points, trading was firm led by banking realty and capital goods stocks.
4 <sup>th</sup> May 2009	6.217	BSE Sensex crossed 16,000 marks. A positive government view on P-notes in a state Affidavit to the Supreme court and strong FII inflows , optimistic manufacturing data from China and the taking of fresh positions on the first day after F&O expiry, all this after a four day closure of the market served to push stocks up.
18 <sup>th</sup> May 2009	15.98	The winning streak of United Progressive Alliance (UPA) had spread to the markets with the Sensex surging above 1300 points .

**Table 5**  
**Sensex: Events Reported around Daily Returns in Excess of -5%**  
**(January 2000 –June 2011)**

29 <sup>th</sup> Feb 2000	-5.251	Sensex dipped by over 294 points at close with the Budget Proposals.
4 <sup>th</sup> Apr 2000	-7.422	Sensex stocks crashed due to a Bearish NASDAQ fears of income-tax investigations against FIIs .
17 <sup>th</sup> Apr 2000	-5.799	Share prices on the BDE went into a much expected free fall under the backlash of Friday's development in the U.S markets

2 <sup>nd</sup> May 2000	-6.321	Equities went into a tailspin on Tuesday and the Sensex witnessed a wild swing of more than 393.17 points intra-day on a day of volatile trading on the BSE.
8 <sup>th</sup> May 2000	-5.034	Sensex prices went into a tailspin of Monday as FII sales triggered panic in the market. The BSE Sensex lost ground by 4.91 percent in volatile trade.
24 <sup>th</sup> Jul 2000	-6.366	Recording its worst fall in July 24, 2000, the 30-share BSE Sensitive Index (Sensex) eventually ended with a massive loss of 229.94 points
22 <sup>nd</sup> Sep 2000	-5.425	Bears triumphed on Dalal Street as bull operators were caught in a panic following meltdown in the major global markets.
13 <sup>th</sup> Mar 2001	-6.22	The Sensex touched its low of 3436 on 13 Mar 2001. Major software stocks hit their 52-week lows the same day on BSE.
14 <sup>th</sup> Sep 2001	-5.411	Sensex down on war fears. The prices plunged further following unabated selling pressure by FIIs, pulling down the benchmark intra-day to an eight year low.
17 <sup>th</sup> Sep 2001	-5.413	17% fall to 872. Stock prices, across the board completing the full eight-year circle pushed down the benchmark indices to nearly eight-year low.
21 <sup>st</sup> Sep 2001	-6.027	The nervousness in the global equity markets hit the domestic bourses once again as FIIs continued their battering in new-economy stocks on neighbouring countries by the U.S
14 <sup>th</sup> May 2004	-6.298	Sensex lost 330 points to fall to 5,070, the sentiment of the tradable list became bullish with a few counters triggering a fresh downtrend.
17 <sup>th</sup> May 2004	-11.80	The roller-coaster ride in the markets on Monday saw red splashed all over when trading was halted at about 11:20 a.m. All stocks that were part of BSE 100 were in negative territory.
18 <sup>th</sup> May 2006	-7.003	Sensex registered a fall of 826 points (6.76 per cent) to close at 11,391, following heavy selling by FIIs, retail investors and a weakness in global markets.
7 <sup>th</sup> Jan 2008	-7.523	Sensex crashed by 749.05 points.
21 <sup>st</sup> Jan 2008	-7.695	Sensex saw the biggest absolute fall in history, shedding 2062 points intra-day.
22 <sup>nd</sup> Jan 2008	-5.1	SENSEX was more than 800 points down, many investors said that they had a tough time liquidating their positions or picking up some stock as brokers could not put these trades through.

3 <sup>rd</sup> Mar2008	-5.26	Sensex witnessed second largest fall by losing 900.84 on a steep fall in the US equities dealt a severe blow to domestic stocks rattled as they were already there by the Budget announcements of the previous week.
17 <sup>th</sup> Mar 2008	-6.223	Sensex crashed by 951 points to close at 14,809 on weak cues from the overseas markets.
6 <sup>th</sup> Jul 2008	-6.008	BSE Sensex fell by 870 points on concerns over the high fiscal deficit set by the Union Budget .
15 <sup>th</sup> Jul 2008	-5.033	Sensex plunged 654.32 points or 4.91% , seemed ranged for most of the day but collapsed in late trade as Tech stocks were under pressure.
6 <sup>th</sup> Oct 2008	-5.958	Sensex fell by a massive 724 points to close below the 12000 level for the first time. In more than two years as the panic in the International markets gripped domestic Investors too.
10 <sup>th</sup> Oct 2008	-7.328	The selling pressure was so intense that the Sensex fell by more than 1000 points, recording one of the steepest declines in the last few trading days.
15 <sup>th</sup> Oct 2008	-6.051	Markets came under immense pressure following heavy FIIs selling leading to a more than five percent drop in the Sensex.
17 <sup>th</sup> Oct 2008	-5.898	SENSEX crashed below the psychological 5 figure mark of 10K, following extremely negative global financial indications in US and other countries.
24 <sup>th</sup> Oct 2008	-11.60	Investors were witness to one of the blackest days in Indian stock market history as FIIs shed a record quantity of Indian stock sending the Sensex plunging 11 percent, it drove it back three years in time.
11 <sup>th</sup> Nov 2008	-6.838	India's 15 percent decline in exports in October-the highest decline in several years and economic worries also dampened investor sentiment that made Sensex fall by 6.61 percent.

## 5. AUTO CORRELATION TEST

The Box-Ljung Statistic of return time series data for lag 1 and lag 16 have been reported in Table 6.

**Table 6**  
**Box-Ljung Statistic of Return Time series Data**

Lag	Box-Ljung Statistic	Sig
1	14.265	.000
16	43.500	.000

From the above table, it is clear that Box-Ljung Statistics are highly significant. Hence, the return series is serially correlated.

## 6. UNIT ROOT TEST

The PP test result is reported in the Table 7. The Computed value of PP is -49.91230 which is far greater than the critical value of -3.432438 at 1% significant level. Therefore, it appears that the variable used in this study is stationary at its level.

**Table 7**  
**Unit Root test Results**

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-49.91230	0.0001
Test critical values: 1% level	-3.432438	

## 7. CONCLUSION

BSE and NSE represent themselves as synonyms of Indian stock market. The history of Indian stock market is almost the same as the history of BSE. Most of the trades in the Indian Stock Markets are conducted in BSE and NSE. In this paper, volatility of return series calculated from daily time series of BSE SENSEX have been analysed. The year 2008 has recorded higher Volatility compared to the other years of the study. Volatility fell in the year 2009 from the high of 2008. The years after were comparatively calmer. In the year 2000, the Volatility was higher signifying enhance market activity. The overall daily Volatility volatility of BSE SENSEX at scrip level.

for SENSEX was approximately 1.70 % while the annualized value was approximately 25%-26%.The study reveals that the return series is mean reverting. Moreover, the return series is leptokurtic and returns are serially correlated. Furthermore, a modest attempt has been made to identify the events reported around daily returns in excess of +/- 5 %. To conclude, the movements of volatility has been explored using daily return. There may be some macroeconomic variable which could influence the market volatility and a scrip level analysis may be useful to study the

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