Post-Recessionary Stock Behavior
An empirical study examining the impact of global recession in India.

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Abstract: *In this paper the recessionary impact on the behavior of equity is studied under the Indian context. The study is based on the BSE Sensex 30 over 16 years from 2000 to 2015. In the study it is found that mean returns are lower than the pre-recessionary period. Though the stock prices have regained the level of pre-recessionary period the mean returns are still very low in the post-recessionary period. The returns have high volatility clustering and heteroscedasticty. Based on the GARCH (1, 1) model, evidences are found for the existence of high Volatility persistence in India. Equity returns for the post-recessionary period is not normally distributed. Likewise, it is also found that the returns are serially correlated. The severity of recession in Indian stock market is found only for a short span of time i.e. between Dec. 2007 and Mar.2009.*
Keywords: *Heteroscedasticity, Mean returns, Persistence, Recessionary impact, volatility.*

I. Introduction

Stock price and returns are indicators of the general economic condition of a country. The prosperity and doom both will be manifested by the stock price indices and stock returns. During the period of economic prosperity it can be seen that there is widespread enthusiasm and spirit in the market. The whole economy will be vibrant. Financial market will be upbeat with prospective micro and macro fundamentals. Stock prices will move upwards prompting more stock purchases. On the other hand in times of recession the market will be upset, investors will be at a loss, lacking enthusiasm due to dearth of incentives for investment in stocks. Recession is characterized by negative equity returns, excessive selling of stocks and lower investments. Stock holders will be in a hurry to dispose their holdings at prevailing price during financial recession. The period of prosperity when the financial market is vibrant, shows robust economic fundamentals whereas the period of recession when the asset prices plummet and equity returns falls shows the economic fundamentals disappointing.

Equity returns are time-series variables. Although they are supposed to be normally distributed, empirical evidences do not support it. Many recent studies show that equity returns are not normally distributed. Equity returns usually have high standard deviation. The mean, median and mode are different contrary to the academic presupposition of normality where they are supposed to coincide with one another. During the periods of recession large negative skewness becomes the characteristic feature of returns series. The presence of skewness itself is a clear evidence of asymmetry in the distribution. Equity returns series always show skewness positively or negatively.

Equity returns are highly volatile. Volatility is common to all types of economic crisis. Large volatility was perceived during the period of world depression, Asian crisis, US market crash of 1987 and during the last subprime crisis which severely appeared and transmitted to all over the world in 2008.

The global financial crisis which erupted in the US around the middle of 2007 was as disastrous as the world depression during the period of 1929-39. Many prominent financial institutions like Fannie Mae and Freddie Mac, Merrill Lynch, Bear Stearns and Lehman Brothers all financially collapsed and went bankrupt. Interest rates increased and asset prices tanked pathetically. Investors fled from the market after losing their investment and confidence in financial markets. Millions lost employment when finance struck the industrial activities.

The global financial crisis was actually known to the world in 2008 when the investment bank Lehman Brothers was officially declared as bankrupt. The news spread contagiously to every nook and corner of the world. Markets responded sharply to the tune of the subprime crisis of the Wall Street. Asset values started to dip and stock prices nosedived to effect the global financial recession in all countries. No country was insulated from the impact of the subprime crisis. Indian financial market too was immensely affected by the world recession. Stock prices fell sharply due to the excessive clearing of stocks by investors. The market was in the grip of great liquidity crisis.

When Choy Yoke Chong (2011)[1] studied the stock market behavior of US in terms of stock return and volatility under the backdrop of the subprime crisis it was found that the bankruptcy of Lehman Brothers had greater impact on stock prices and returns causing stock market volatility. Geert Bekaert and Campbell R. Harvey (2000)[2] in a study states that liberalization of financial markets has reduced volatility in the markets.

Volatility of returns was found when the market was more segmented. If the financial market was integrated, volatility would be decreasing. Mo Chaudhury (2011)[3] in the background of financial crisis of 2008 studied the behavior of stock returns found that the unconditional mean returns fell negatively during the period of 2007-08. During the period the unconditional volatility rose by more than 200 percent. Correlation between stocks found reduced and beta risks of stocks increased.

Kenneth R. French, G. William Schwert and Robert F. Stambaugh (1986)[4] in a paper examines the relation between stock returns and stock market volatility. The study finds that the expected risk premium is positively related to the predictable volatility of stock returns. The study also finds evidence that the unexpected stock market returns are negatively related to the unexpected change in the volatility of stock returns. Narasimhan Jegadeesh (1990)[5] in his paper finds evidence of predictable behavior of stock returns. The study also finds positive serial correlation at longer lags.

Gregory R. Duffee (2002)[6] in his paper finds that the distribution of long-horizon idiosyncratic returns to individual stocks is highly asymmetric in contrast to short-horizon distribution. Indika Karunanayake, Abbas Valadkhani, Martin O'brien (2010)[7] study the impact of Asian crisis and the recent financial crisis on the returns and volatility in the financial markets of Australia, UK, Singapore and the USA. The study concludes that there was no significant impact on the returns of any of the four markets. But the markets of these economies had marked with the impact of returns volatility.

Rolf W. Banz (1981)[8] examines the empirical relationship between returns and the total value of NYSE stocks. The study finds that the risk-adjusted equity returns of small sized firms are higher than larger firms. Kenneth R. French and Richard Roll (1986)[9] in a combined study reveals that volatility occurs during the trading hours. The explanation for this is that firstly, volatility occurs due to the arrival of public information during the normal business hours. Secondly, volatility that arises due to private information which affects price when informed investors trade and thirdly, volatility pops up when pricing errors take place during the trade.

The objective of this paper is to examine stock behavior in terms of stock price movement, the behavior of returns and volatility features. In order to study the stock behavior daily stock prices of BSE Sensex 30 for 16 years from 2000 to 2015 were collected from the website of BSE India. The entire period of study was divided in to pre-recessionary and post-recessionary periods. It was very difficult to articulate exactly when the recession actually broke out. As a matter of fact, the recessionary trends were come to know to the world only when it was announced that the hedge fund of Bear Stearns was collapsed in the mid-2007. The recessionary impact had transmitted to other countries only just after the declaration of the bankruptcy of Lehman brothers. The recession is not supposed to spark from a specific moment. It definitely would have a trend setting past. Similarly it would not have ended abruptly. It would have taken a long time (its own time) to bottom out. Therefore the study period is broadly divided in to Sub period 1 as pre-recessionary period which ranges from 1.1.2000 to 31.12.2007 and Sub period 2 as post-recessionary period from 1.1.2008 to 30.11.2015. BSE Sensex 30 is chosen to represent Indian stock Market in this study.

II. Impact of the Crisis on BSE SENSEX 30

The subprime crisis had almost shattered the US economy and adversely affected the markets of the emerging economies. There was substantial decline in stock prices in the US. In India, as Fig.1 shows, in the year 2000 the Sensex was at 5407 points. At the end of the Sub period 1 (pre-recessionary period) that was on Dec.2007 the Sensex was at 19827 points. The rate of growth in the index was 267%. The bankruptcy of Lehman Brothers had transmitted the ripples of the crisis across boundaries and rattled all financial markets. In 2008 the impact of it on BSE SENSEX 30 was severe and the index tended to decline and fall systematically till March 2009. The decline in the SENSEX was bottomed out in March 2009 at 8995 points. The impact of the recession on the SENSEX was the decline of the index from 19827 points in Dec.2007 to 8995 points in 2009. The rate of fall was -55%. It is possible to clearly demarcate the Sub period 1 (pre-recessionary) and Sub Period 2 (Post-recessionary period) from Fig.1. The recessionary impact on the SENSEX index was only for a short span between Dec.2007 and March 2009. During this period index declined gradually and systematically, then, recovered by March 2009 and tended to rise upwards thereafter.
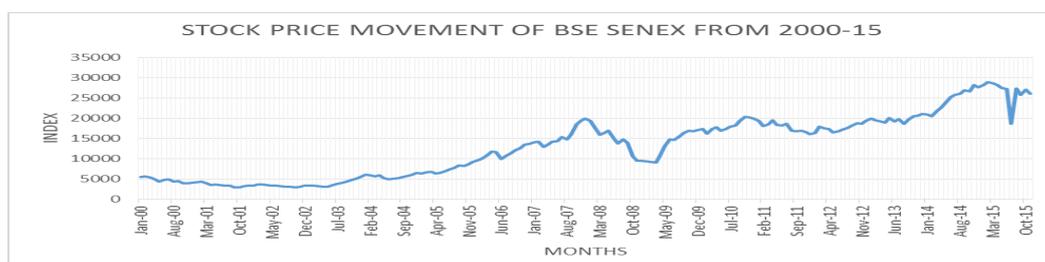

Figure 1: BSE SENSEX index movement 2000-15

BSE SENSEX 30 shows a steady rise since 2000 with an interruption on Dec.2007. From that point it declines slowly and systematically to reach the minimum point of the entire period on March 2009. Then, the index bottom out and recovered. Since 2009 index moves upwards gradually and systematically. The recession affected the stock index only for a short span of time that was from Jan.2008 to March 2009. Otherwise the index was smoothly going up and up since 2000 with a bullish trend. This trend is visible in Fig.1.

III. Impact of the Crisis on the Behavior of Equity Returns

Returns from equity arises when there is change in price. The difference between the present and the previous prices is the return to equity. In order to understand the impact on returns, here, the behavior of returns is studied in terms of its stability, magnitude and pattern. Similarly, the normality of the distribution of returns, randomness, volatility, volatility clustering and persistence are studied with a view to perceive the behavior of equity returns during post-recessionary period. Ever since 2000 the stock prices were rallying up to the close of 2007. The equity returns also were on the rise in tune with the stock prices. On an average the return on the index was 0.11% under sub-period 1. After 2007 that was under sub-period 2 the Sensex tended to fall along with the returns till March 2009. After March 2009 both the prices and returns regained their lost rhythm and started to rally through the bullish path. Table 1 shows the descriptive statistics for both the post and pre-recessionary periods. The descriptive statistics provides a summary of the behavior of equity returns during the two periods under study.

Table 1: Descriptive Statistics

Descriptive Statistics		Sub-Period 1	Sub-Period 2
Mean		0.11	0.03
Median		0.15	0.04
Standard Deviation		3.33	1.57
Kurtosis		885.36	11.5
Skewness		21.04	0.50
Largest value		120.44	17.34
Smallest value		-55.93	-10.96
Range		176.37	28.30
Jarque-Bera		65665829	10867
sig		0.000	0.000

The average return on the index was 0.03% as given in TABLE 1 in the post recessionary period. The average return before the recession was 0.11%. There was -72% fall in returns after the crisis. The median returns also fell by -73%. Though the stock prices have recovered from the shocks of the crisis, the impact on equity returns lingers on. The standard deviation which tells the volatility of returns around the mean is lower when compared to pre-recessionary period. Excess kurtosis and skewness both were lower in the post recessionary period. The Jarque-Bera test of normality says that the distribution of returns for post and pre-recessionary periods are non-normal. As per the Jarque-Bera statistic the probability for the normality under both periods is zero. The test denies normality and confirms non-normality. The presence of excess kurtosis and positive skewness shows the asymmetric distribution of equity returns for both the periods. But the asymmetry in the sub-period 2 is lower than the sub-period 1. The largest and smallest values represents the range of certainty of expected value to occur. The range 176.37 was very high in Sub period 1 and the range of sub period 2 was 28.30. The distribution of returns during sub period 2 was tighter.

IV. The Randomness of Equity Returns

The efficient market theory of Eugene F. Fama (1969)[10], the Capital Asset Pricing Model (CAPM) of William F. Sharpe (1964)[11] and the portfolio Selection of Harry Markowitz (1952)[12], all held the fundamental assumption that the stock prices and returns are random. According to Fama, equity returns arise due to change in prices. The change in prices-upward or downward-is called stock price movement. Efficient market hypothesis (EMH) holds that stock price movement is not amenable for prediction as the incidence of which is absolutely random. Changes occur when an entirely new information reaches the market. The information so reaches are fresh, new in every respect and shocking and surprising. Statistically speaking they are stochastic and can be defined as white noise. The randomness of returns says that the returns are not serially correlated. It is highly beautiful to contemplate that the stock price and returns are random. But the question is whether there are empirical evidences supporting it. Academically, the randomness of returns are tested by computing the serial correlation or auto correlation and testing the significance for the interdependence. Here Box-Ljung test is applied to test the significance of auto correlation.

Table 2: Auto Correlation and Partial auto correlation

	Sub Period 1							Sub Period 2					
				Box-Ljung statistic							Box-Ljung statistic		
Lag	AC	PAC	SE	Value	df	Sig.	Lag	AC	PAC	SE	Value	df	Sig.
1	-.292	-.292	0.022	171.146	1	.000	1	.070	.070	0.023	9.501	1	.002
2	-.033	-.129	0.022	173.331	2	.000	2	-.027	-.032	0.023	10.896	2	.004
3	-.002	-.056	0.022	173.340	3	.000	3	-.027	-.023	0.023	12.307	3	.006
4	.015	-.008	0.022	173.800	4	.000	4	-.044	-.042	0.023	16.156	4	.003
5	-.014	-.015	0.022	174.189	5	.000	5	-.032	-.028	0.023	18.165	5	.003
6	-.012	-.021	0.022	174.459	6	.000	6	-.031	-.030	0.023	20.024	6	.003
7	-.006	-.020	0.022	174.539	7	.000	7	.039	.040	0.023	23.080	7	.002
8	.006	-.005	0.022	174.623	8	.000	8	.062	.052	0.023	30.672	8	.000
9	.005	.004	0.022	174.678	9	.000	9	.007	-.003	0.023	30.756	9	.000
10	-.004	-.001	0.022	174.712	10	.000	10	.000	.002	0.023	30.756	10	.001
11	.013	.013	0.022	175.044	11	.000	11	-.002	.002	0.023	30.767	11	.001
12	-.004	-.004	0.022	175.077	12	.000	12	-.002	-.004	0.023	30.775	12	.002
13	.006	.008	0.022	175.146	13	.000	13	.000	.006	0.023	30.775	13	.004
14	.001	.006	0.022	175.147	14	.000	14	.046	.049	0.023	35.014	14	.001
15	.007	.012	0.022	175.251	15	.000	15	.001	-.010	0.023	35.014	15	.002
16	.003	.011	0.022	175.264	16	.000	16	.014	.015	0.023	35.418	16	.003

(AC = Auto correlation, PAC = Partial Auto correlation, SE= Standard Error, df= degree of freedom & Sig.= Probability in percent based on asymptotic chi-square approximation.)

TABLE 2 provides the values of auto correlation and partial auto correlation for the periods 1 and 2 for 16 lags. Standard error is also given in the table. Box-Ljung test values for both the periods are given in the table. For all the 16 lags the significance level is below 5% (see the last column of TABLE 2). When the probability is below 5% the null hypothesis cannot be accepted. Therefore the null hypothesis that there is no auto correlation is rejected and concluded that for period 1 and 2 there is auto correlation in the series. The evidence is very clear that the returns of post and pre-recessionary periods are not random. The return series of the Sensex exhibit interdependence and they are not random.

V. Heteroscedasticity in Equity Returns

Equity returns go up and down according to the changes in the prices. If the changes in returns are random, the movement does not have any direction or pattern. Fig.1 indicates that the stock prices after 2007 declines steadily and moves downwards consistently and systematically. If the changes were homoscedastic it would not be so. When the residuals of both the sub periods are put to scatter plots it is found that they form a pattern. Forming a pattern implies that the returns ratchet up towards a specific direction, say, upward or downward or vertical or horizontal or a curvature. If the residuals are plotted graphically in the absence of dissimilar variances or heteroscedasticity the plots will be formless or directionless. But if they have any consistent form or shape or pattern it can be decided that there is heteroscedasticity.

Fig.2 describes the residuals plot. In Sub Period 1 the residuals are plotted along Y axis. The plots are moving to the right horizontally along the X axis as time passes. The plots one after another are following a trend or pattern towards a specific direction horizontally. In Sub period 2 the residuals behave in the same way. The difference is that in the post recessionary period the residuals volatility clustering is found to be larger which can be inferred from the thickness of the horizontal line. The pattern formation of the residuals indicates that the volatility is not only heteroscedastic but also conditional.

The conditional heteroscedasticity is the dissimilar volatility which is influenced by the previous volatility. Accordingly current volatility is dependent upon the previous day's volatility. When one volatility is inspired by the immediately preceding volatility it is called conditional heteroscedasticity.

Here, the volatility in returns is neither random nor identical. It is differential or heteroscedastic. Heteroscedasticity results in volatility clustering when high volatility is followed by high volatility and small volatility is followed by small volatility for a relatively longer period. Returns on BSE SENSEX has conditional heteroscedasticity in the post recessionary period as well as the pre-recessionary period since their scatter plots show systematic patterns.
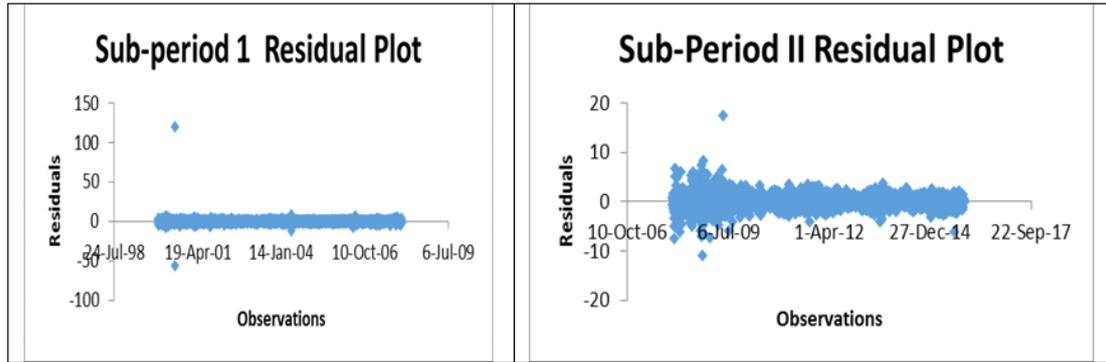
Figure 2: Scatter plots of residuals showing volatility clustering and heteroscedasticity.

VI. Volatility Persistence

Volatility represents large changes in prices or returns. Equity price and returns are highly dynamic. They change depending upon the changes in the micro and macro fundamentals. The price and returns response sharply against news which carry information about the fundamentals. For a favorable news, the price and returns show upward trend. On the contrary, for an unfavorable news they take a downward trend. Whether upward or downward the trend, the position cannot be held infinitely. Every such volatility is subject to mean reversion. Volatility never stays permanently. Volatility appears, stay for some time and decays to revert back to normalcy. How long volatility stay is the persistence. There will be in-built forces in the market which interrupt the continuity of the volatility. The span of protraction of the volatility is called the level of persistence.

VII. Measurement of Volatility Persistence

Volatility persistence can be studied with the help of GARCH (1.1) model. The GARCH parameters for the two periods are given as under:

Table 3: GARCH (1, 1) parameters

Sub Period	ω	α	β	$\alpha + \beta$
I	0.044937252	0.501807895	0.094045499	0.595853394
II	0.113107625	1.08540109	0.213537169	1.298938259

Here,

ω (Omega) is a constant representing average long term volatility.

α (Alpha) representing an unknown ARCH(Auto Regressive Conditionally Heteroscedastic) parameter

β (Beta) representing an unknown GARCH (Generalized Auto Regressive Conditionally heteroscedastic) parameter

According to GARCH (1, 1) Model current volatility is the sum of average long run volatility, α times 1 lag variance and β times 1 lag squared residuals.

Symbolically stating:

$$h_t = \omega + \alpha_1 \, \mathcal{E}^2_{t-1} + \beta \, h_{t-1} \tag{1}$$

Where, h_t is the current volatility, ω is the long run volatility, α_1 is the coefficient of 1 lag squared residuals-an ARCH term, and β is the coefficient of 1 lag variance-a GARCH term.

The Equation (1) holds the following constraints:

$\omega > 0, \alpha_1 > 0, \beta > 0$ and

$\alpha_1 + \beta < 1$

α_1 and β are coefficients of conditional squared residuals and conditional variance. α_1 together with β (that is $\alpha + \beta$) determines the volatility persistence. The persistence indicates how fast the volatility decays and regain normalcy. A weak persistence shows quick decay of volatility. A strong persistence on the other hand shows slow decay of volatility. The persistence is perfect when $\alpha + \beta$ is equal to unity. If $\alpha + \beta$ is less than 1 but above 0.5 shows the persistence stronger. When $\alpha + \beta$ is below 0.5 the persistence can be considered weak. If the persistence is very high the rate of decay is very slow. On the contrary if the persistence is low, mean reversion will take place with much rapidity. When $\alpha + \beta = 1$ the persistence level is perfect and no reversion is possible. Lower the sum of $\alpha + \beta$ greater the speed of mean reversion and vice versa.

TABLE 1 shows the GARCH parameters. Volatility persistence is shown in the last column as the sum of alpha and beta. In the post recessionary period the BSE Sensex has a high persistence level where the sum of alpha and beta is more than 1. The conditional volatility in terms of squared residuals is very high in the post recessionary period. It implies that the residuals of this period is more conditionally heteroscedastic and there is high degree of volatility clustering for the BSE Sensex during this period. In the pre-recessionary period both the alpha and beta are low. Their sum is only 0.59 showing moderate persistence. Whereas in Period 2 the sum

of alpha and beta is 1.298 which is more than 1. The persistence level is very high. In the post-recessionary period, therefore, the volatility is expected to stay for long.

VIII. Conclusion

This study attempted to examine the equity behavior in the aftermath of the global recession in Indian stock market. The index of BSE Sensex 30 for 16 years from Jan.2000 to Nov.2015 has been used as the base data for the study. The entire period of the study is bifurcated in to sub-periods 1 and 2. The sub-period 1 to show the pre-recessionary period from Jan.2000 to Dec.2007 and sub-period 2 to represent post-recessionary period from Jan.2008 to Nov.2015. The study finds that the Sensex has been rallying ever since March 2009. In the pre-recessionary period the index was showing steady increase up to Dec.2007. The impact of the recession was found to be severe in between Dec.2007 and March.2009. During this period index was showing gradual and systematic declining. The trend of declining was finally bottomed out in Mar.2009. Thereafter the stock market has been showing the signs of recovery. It is found in the study that the mean return in the post-recessionary period is lower than the pre-recessionary period. The returns during the period are not random. The test of randomness reveals that the returns series show evidences of serial correlation and interdependence. The distribution of returns in the post-recessionary period is found non-normal due to the presence of high excess kurtosis and positive skewness. The returns are not only non-normal and non-random but also heteroscdastic. The test of heteroscedasticity with the null hypothesis that there is no heteroscedasticy is rejected and concluded that the returns from the sensex for sub-period 2 are subject to heteroscedasticity. Evidences are also found for volatility clustering and volatility persistence. When GARCH (1. 1) model is employed it is found that the volatility persistence in the post-recession is very strong in Indian stock market.

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