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# A STATISTICAL ANALYSIS OF DAILY NIFTY RETURNS, DURING 2001-11

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**ABSTRACT**

*Indian equity market has witnessed tremendous growth and volatility over the last ten financial years. During this period, the value of S&P CNX NIFTY, the leading Indian benchmark Index, has increased more than 5 times. In this paper we address the problem of analysis of daily returns of NIFTY (from 1st April 2001 to 31st March 2011). First we report some descriptive statistics, such as the maximum, minimum, average, variance and skewness of daily NIFTY returns within each financial year. We find that daily NIFTY returns exhibits time varying volatility and skewness. 2008-09 was the most volatile year and the highest daily return was recorded in 2009-10. In fact the volatility in NSE during last ten financial years seems to exhibit a cyclic pattern. Next we examine whether NSE is weak form efficient, during the study period, using two well known tools of time series analysis, viz. unit root tests and plot of autocorrelation function. It turns out that for each financial year, the NIFTY daily returns are stationary i.e. the daily returns do not exhibit any trend. However until 2005-2006, the successive daily NIFTY returns exhibit significant autocorrelation, i.e. future returns can be predicted by modeling past daily returns. But from 2006-07 onwards the extent of correlation between successive daily NIFTY returns starts decreasing, and NSE seems to be weak form efficient during 2008-9 and 2010-11. It appears that due to the continuous efforts of NSE to improve stock market microstructure NSE has gradually developed into a weak form efficient market in 2010-11 i.e. one cannot predict future returns by analyzing past returns.*

**KEYWORDS**
NIFTY daily return, weak form efficiency, stationary, volatility, auto correlation.

## INTRODUCTION

The last decade has been a very eventful period for the Indian securities market. During the last ten years, the National Stock Exchange (NSE) has undertaken various reforms to improve the stock market microstructure in India. For instance, in April 2002, the Indian capital markets joined the league of developed markets in the world by the introduction of the T+3 rolling settlement cycle and further to T+2 in April 2003. In June 2002, the target of 100 percent dematerialized trading was achieved. In the year 2008, direct market access (DMA) was introduced for institutional investors. DMA provided them to access the exchange trading system through the broker's infrastructure, without manual intervention by the broker. These information are available in NSE website www.nsendia.com. The S&P CNX NIFTY Index (we call it NIFTY) is a benchmark index in NSE. It is the leading Indian benchmark index, representing 22 sectors of the Indian economy. In this paper we analyze the daily returns of the NIFTY for ten consecutive financial years, from 1st April 2001 to 31st March 2011.

During the downturn in 2008 and the dramatic post election recovery in 2009, Indian equity market witnessed great volatility. Our objective is to test whether NSE is weak form efficient and to compare volatility in NSE during the different financial years. A market is said to be weak form efficient (see Sharma and Chander (2011)) if it is not possible to predict future price changes or returns by analyzing past returns. So weak form efficiency implies that the successive daily returns do *not* exhibit any pattern, and there is *no* correlation between the returns in consecutive time period. We measure the volatility in NSE, within a financial year, by the variance of the daily NIFTY returns during that period.

## DATA

We have collected data on closing values of S&P CNX NIFTY Index, during the period 1st April 2001 to 31st March 2011, from NSE webstie, viz. www.nseindia.com.

## METHODOLOGY

The return for the "$t$ th" day is defined as $R_t = 100Log(P_t/P_{t-1})$, where $P_t$, $P_{t-1}$ are the closing price of the NIFTY on the "$t$ th" and the previous day. $Log$ represents natural logarithm. The analysis of the daily returns is performed in three stages.

First in Table 1 we report the maximum, minimum, average daily NIFTY return, the variance and skewness coefficient of the daily returns within a financial year. The variance of the daily NIFTY returns during a financial year measures the volatility in NSE during that period. Skewness refers to lack of symmetry, and it represents existence of a few extreme daily returns with in a financial year. Using **D'Agostino** test (see http://127.0.0.1:15106/library/moments/html/agostino.test.html), we test whether the distribution of daily NIFTY returns is significantly skewed, for each year under study. In this test, the null hypothesis is that the distribution is symmetric or skewness equals zero. We have computed the p-value for this test using the free software "R" for statistical analysis (see *www.r-project.org*). If the p-value is less than the level of significance we reject the null hypothesis that skewness equal zero. In this paper we fix the level of significance at 5 percent.

In Table 2, we compute the percentages of daily returns above 2 percent and below -2 percent in the ten financial years. These statistics are used for quick comparison of the market scenarios in different financial years.

Next we test whether NSE is weak form efficient. For this we apply two well known tools, viz. unit root tests and autocorrelation function (acf) plots. We describe them briefly.

If NSE is weak form efficient, over a period, then daily NIFTY returns during that period are expected to be stationary i.e. free from any pattern which can be modeled such as a random walk. We use two well known "unit root" tests, viz. **Philip-Perron (PP)** test and **Augmented Dickey-Fuller (ADF)** test (see Sharma and Chander (2011)), to verify whether the daily NIFTY returns within a financial year are stationary. In these tests the null hypothesis is that, the series of NIFTY daily returns is *not* stationary i.e the series exhibits random walk. In a statistical test, if the p-value is less than the level of significance, then the null hypothesis is rejected. In this paper we fix the level of significance at 5 percent. Consequently a small p-value, less than 0.05, will indicate that the series of NIFTY daily returns is stationary. In Table 3 we compute the p-values of ADF and PP tests for daily NIFTY return data for the ten financial years under study. These p-values are computed using the free software "R" for statistical analysis (see *www.r-project.org*).

Even if the daily returns, within a specific period, are stationary one can still model them (and hence predict future values) using stationary time series models such as an auto regression or a moving average model (see Pankratz (1983)), provided there exists non-zero auto correlation between consecutive terms in that series. Autocorrelation of lag "k" refers to the ordinary correlation coefficient between the values of $R_t$ and $R_{t-k}$ (see Sharma and Chander (2011)).

Zero (or close to zero) value of the autocorrelation coefficients imply that price changes in consecutive time periods are uncorrelated with each other, and thus can be viewed as evidence in favour of the hypothesis that NSE is weak form efficient. For daily NIFTY returns within each financial year, we plot the autocorrelation coefficients for different time lags using "**acf**" function in the software R. For instance see Figures 1 to 10. In each plot, if the values of the auto correlation coefficients fall within the confidence interval (the blue horizontal lines), i.e. if the calculated auto correlation coefficients do not differ significantly from zero, then we conclude that NSE is weak form stationary within that financial year.

## LITERATURE REVIEW

Analysis of daily returns of key Indian benchmark indices has been an area of active research in the recent past. For instance, Sharma and Chander (2011) has analyzed the daily returns of SENSEX, a benchmark index in Bombay Stock Exchange india, from July 1997 to December 2007. Their analysis indicates that SENSEX is weak form efficient during the study period.

Singh and Kansal (2010) compared the volatility in NIFTY daily returns before and after the declaration of union budgets, and concluded that there is significant short term effect of union budget announcements on NIFTY returns.

Ray and Sharma (2008) studied the efficiency of the Indian capital market, and concluded that only companies in the index show efficiency, and not the index as whole. However the authors observed that Indian capital is overall efficient, in the sense that that there is no unfair advantage to any individual or institution.

Varma and Rao (2007) examined companies included in the BSE100 index. They concluded that during the years 1998-199 and 1999-2000, Indian market was not weak form efficient. However, the market became efficient during 2000-01.

Gupta and Kundu (2006) analyzed the impact of union budgets on stock market considering the returns and volatility in SENSEX.

Kaur (2004) studied the extent and pattern of stock return volatility of the Indian stock market during the year 1990 to 2000. The author observed that April was the most volatile month followed by March and February.

The financial years 2008-09 and 2009-10 had been a period of great volatility, during which the world witnessed the greatest recession since 1930 and a contrastingly dramatic recovery in Indian equity market after the elections in 2009. From the study of Varma and Rao (2007) we see that efficiency of a stock market can vary from one year to another. So it is natural to question whether Indian equity market has remained efficient during this turbulent phase. None of the above mentioned studies covered the financial year 2008-09 and beyond. In this paper we analyze whether S&P CNX NIFTY Index is weak form efficient during the last ten financial years, from 1st April 2001 to 31st March 2011. We also compare some quantitative attributes of NIFTY such as volatility, skewness, chance of extreme returns etc. across different financial years, before and after 2008.

## FINDINGS

Following are the main observations based on Tables 1-3, and Figures 1-10, which are given in Appendix after the references.

1. From Table 1, we see that NIFTY daily returns exhibit time varying volatility and skewness. For instance, during the last ten financial years NIFTY was least volatile during 2002-03. In contrast, 2008-09 was the most volatile period. In fact, the NIFTY volatility seems to change in cyclic pattern. For instance, volatility in NIFTY daily returns started increasing from 2003-04 onwards, but fell abruptly during 2005-06. Again the volatility increased from 2006-07 onwards, reached the peak in 2008-09, and seems to be decreasing from 2009-10 onwards. Considering this periodic pattern, NIFTY volatility is expected to increase in the next few financial years.

The highest negative daily NIFTY return was recorded in 2008-09. The highest positive daily NIFTY return was recorded during 2009-10. We find that for nine out of ten years covered in this study, the distribution of daily NIFTY returns with in a financial year is either negatively skewed or symmetric (see Table 1). However during 2009-10, the daily NIFTY returns were strongly positively skewed. During this financial year the Indian equity market witnessed very strong recovery from the lows of October 2008.

2. From Table 2, we see that the chance of daily NIFTY returns exceeding 2 percent or falling below -2 percent has steadily increased from 2002-03 onwards, until 2008-09. However during 2009-10 and 2010-11, these chances seem to have decreased drastically.

3. From Table 3, we see that the daily NIFTY returns are stationary for every financial year. Next we investigate whether there exists any autocorrelation among successive daily returns during different financial years.

4. From Figures 1 and 3, we see that there exists significant positive first order autocorrelation during 2001-02 and 2003-04 i.e. it is possible to fit a moving average model (e.g. $R_t = Z_t + \alpha Z_{t-1}$ where $\{Z_t\}$ is a sequence of white noise) to the daily NIFTY returns, during these periods, and predict future price changes. From Figures 2 and 4, we see that there exists significant higher order autocorrelation in the daily NIFTY returns during 2002-03 and 2004-05, and so again one can predict future price changes by fitting time series model to these data.

Therefore during these four financial years NSE is not weak form efficient.

5. From Figures 5 to 7, we see that from 2005-06 to 2007-08 for the lower order autocorrelations (up to lag 10) do not differ significantly from zero.

6. During 2008-09 and 2010-11, none of the autocorrelation coefficients are significantly different from zero (calculated autocorrelations lie within the confidence intervals) (see Figures 8 and 10). So NSE has been weak form efficient during in 2008-09 and 2010-11.

For the daily NIFTY returns, during 2009-10, there exists significant negative autocorrelation of lag 5 (see Figure 9). So during 2009-10, NSE was not weak form efficient. However, from the previous discussions we have observed that 2009-10 was year of exceptional growth in Indian equity market and so the characteristics of the Indian equity market during that period is not comparable to other financial years.

## CONCLUSION

Our data analysis reveals NSE has gradually evolved into a weak form efficient market in 2010-2011. A remarkable feature of NSE is that it has been efficient even during the very turbulent year 2008-09, during which equity markets all over the world had suffered due to global economic recession. Success of Indian equity market to bounce back strongly, from the low of October 2008, and to be efficient even during the crisis period of 2008-09 is to a great extent due to the various reforms undertaken by NSE.

From a modeling perspective our findings justify the following model for NSE closing price

$Log(P_t) = Log(P_{t-1}) + R_t$, where $\{R_t\}$ is a random, mean stationary process and the variance of $R_t$ changes from one financial year to another in a cyclic pattern.

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## APPENDIX

**TABLE 1: SOME BASIC STATISTICS OF DAILY NIFTY RETURNS**

| Financial year | Maxium daily return | Minimum daily return | Average daily return | Variance of daily returns | Skewness coefficent | p-value | |
|---|---|---|---|---|---|---|---|
| 2001-02 | 1.586 | -2.389 | -0.001 | 0.373 | -0.572 | 0.02 | Negative skewed |
| 2002-03 | 1.669 | -1.233 | -0.025 | 0.186 | 0.091 | 0.69 | symmetric |
| 2003-04 | 1.850 | -1.883 | 0.101 | 0.387 | -0.349 | 0.13 | symmetric |
| 2004-05 | 3.461 | -5.669 | 0.024 | 0.508 | -2.2491 | 0.00 | Negative skewed |
| 2005-06 | 1.373 | -1.564 | 0.089 | 0.202 | -0.631 | 0.01 | Negative skewed |
| 2006-07 | 2.655 | -3.045 | 0.0167 | 0.5946 | -0.572 | 0.02 | Negative skewed |
| 2007-08 | 2.919 | -3.954 | 0.0469 | 0.758 | -0.4675 | 0.052 | symmetric |
| 2008-09 | 2.935 | -5.652 | -0.081 | 1.349 | -0.337 | 0.16 | symmetric |
| 2009-10 | 7.047 | -2.615 | 0.099 | 0.674 | 2.39 | 0.00 | Positive skewed |
| 2010-11 | 1.513 | -1.418 | 0.018 | 0.236 | -0.087 | 0.70 | symmetric |

**TABLE 2: PERCENTAGES OF EXTREME DAILY RETURNS**

| Financial year | Percentage of daily returns exceeding 2 percent | Percentage of daily returns below -2 percent |
|---|---|---|
| 2001-02 | 0 | 1.22 |
| 2002-03 | 0 | 0 |
| 2003-04 | 0 | 0 |
| 2004-05 | 0.39 | 1.18 |
| 2005-06 | 0.81 | 1.21 |
| 2006-07 | 0.81 | 1.21 |
| 2007-08 | 2.4 | 2.4 |
| 2008-09 | 4.96 | 3.72 |
| 2009-10 | 1.24 | 0.41 |
| 2010-11 | 0 | 0 |

**TABLE 3: p-VALUE OF ADF AND PP TEST FOR UNIT ROOT**

| Financial year | p-value of ADF test for unit root | p-value of PP test for unit root | |
|---|---|---|---|
| 2001-02 | 0.01 | 0.01 | Stationary |
| 2002-03 | 0.01 | 0.01 | Stationary |
| 2003-04 | 0.01 | 0.01 | Stationary |
| 2004-05 | 0.01 | 0.01 | Stationary |
| 2005-06 | 0.01 | 0.01 | Stationary |
| 2006-07 | 0.01 | 0.01 | Stationary |
| 2007-08 | Less than 0.01 | Less than 0.01 | Stationary |
| 2008-09 | Less than 0.01 | Less than 0.01 | Stationary |
| 2009-10 | Less than 0.01 | Less than 0.01 | Stationary |
| 2010-11 | Less than 0.01 | Less than 0.01 | Stationary |

**AUTOCORRELATION FUNCTION PLOT**

Fig1: 2001-02 daily return acf plot

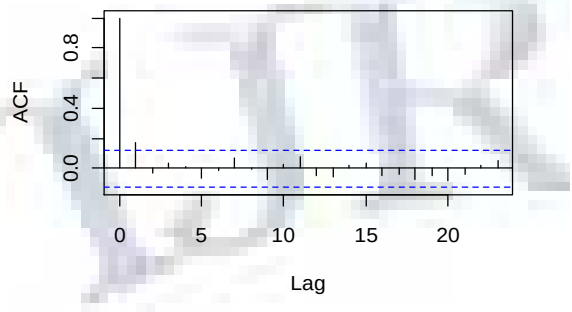



Fig2: 2002-03 daily return acf plot

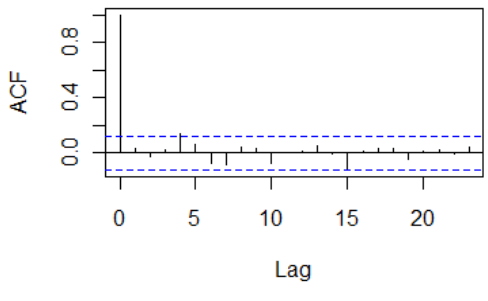


**Fig3: 2003-04 daily return acf plot**

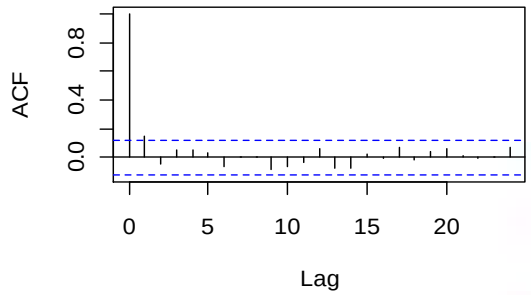



**Fig4: 2004-05 daily return acf plot**

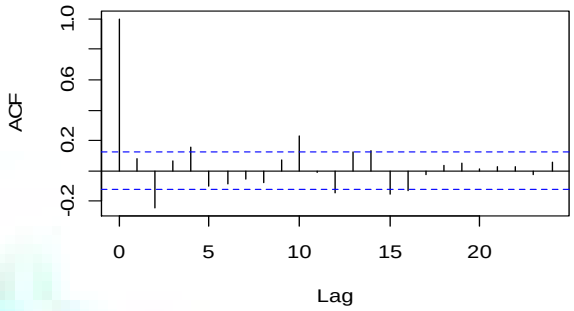



**Fig5: 2005-06 daily return acf plot**

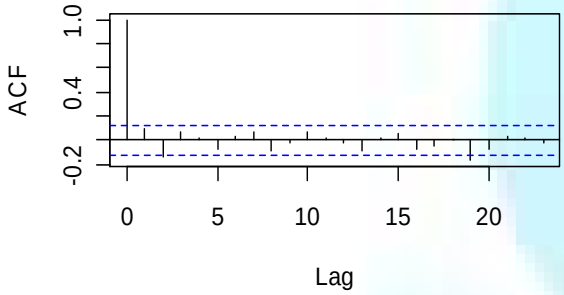



**Fig6: 2006-07 daily return acf plot**

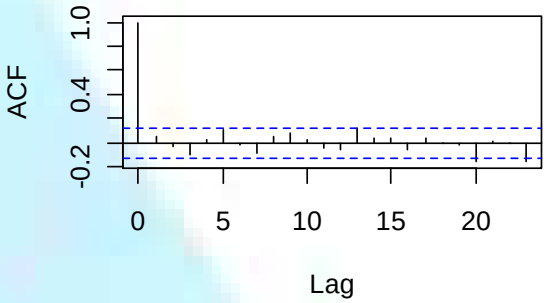



**Fig7: 2007-08 daily return acf plot**

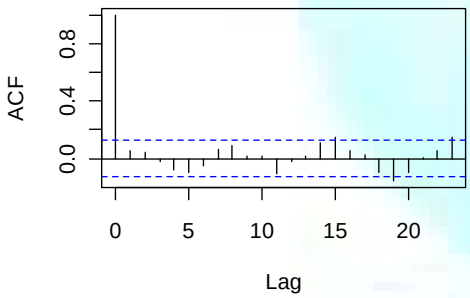



**Fig8: 2008-09 daily return acf plot**

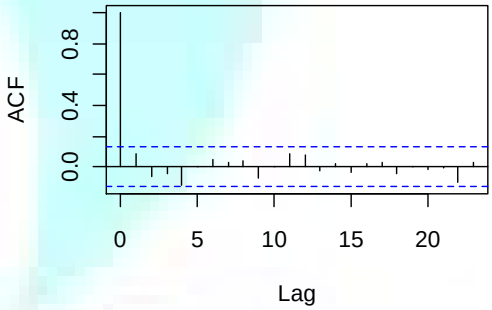



**Fig9: 2009-10 daily return acf plot**

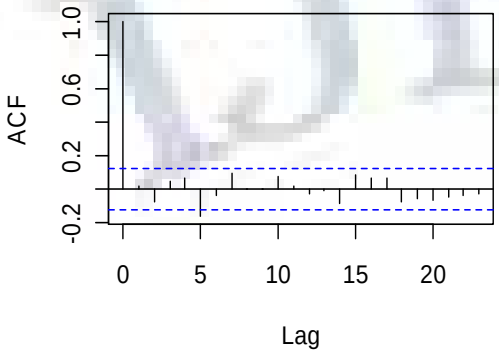
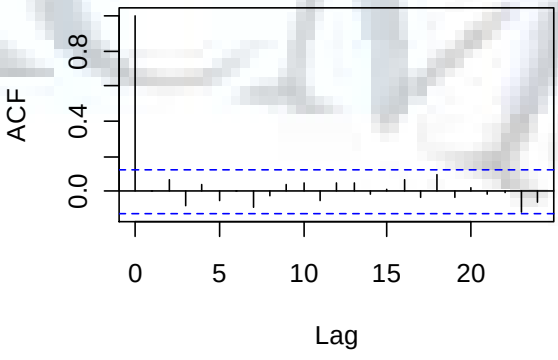



**Fig10: 2010-11 daily return acf plot**



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