Testing Of Market Efficiency In The Weak-Form Taking CNX NIFTY As A Benchmark Index: A Study

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Abstract

Efficient Capital Market Hypothesis envisages three Forms of Capital market Efficiency: Weak Form, Semi-Strong and Strong Form. Efficiency of the capital markets is a determining factor for long term investors. While Inefficient market efficiency breeds speculation, price rigging and abnormal gains for some and creates, it creates a more space for trust deficit among investors and such trust vacuum is more visible after market crashes technical analysts to prowl upon in the market. Testing of Market efficiency in any form has always contributed to the body of knowledge on capital market efficiency. The present study is also a humble attempt in this direction. Taking a Study period of 11 Years 2003-2013 with NSE(NIFTY) as a bench mark, a host of tests (parametric as well as non-parametric) were used to test market efficiency in Indian Capital market in the weak-form. Daily return of 50 Nifty Stocks for 11 years yields 2742 which have been utilized for various analysis to test whether Indian Capital Market is efficient in Weak Form or not. All Tests including run tests, autocorrelation tests reveal that Indian Capital Markets are inefficient in the weak form.

Key Words: Efficient Market Hypothesis, Weak Form, Run Tests, Nifty 50, Capital Markets

1. Introduction

With the investors losing hope of good return in the capital markets of west in general and U.S.A in particular the focus shifted to the developing countries of world especially the emerging economies of South Asia where the recession had a trifling effect. It was during the first decade of the 21st century that the stock markets of developing countries showed an upsurge as investors started investing in these so called “juvenile capital markets” and these economies started to grow exponentially. The argument would be incomplete if we miss to mention the emergence of Indian and Chinese capital markets during that period. With the investments in Indian capital markets increasing in leaps and bounds, the main topic that emerged for discussion among the investors and financial analysts was whether the returns in case of Indian stock markets can be predicted on the basis of past information. Similarly whether there is scope for abnormal profits in Indian capital markets as far as access to public and private information is concerned. This in technical terms as described by Eugene f. Fama is referred to as market efficiency.

Investors over the period of time want to know whether the Indian stock market is random (weak form efficient) or the returns can be predicted with the help of past information (weak form inefficient). In other words the focus shifted towards testing the efficiency of Indian Stock Market in weak form. This study is an attempt in this regard and focuses on the Indian stock market with a view to test its
efficiency in weak form. This study also attempts to find out the validity and applicability of technical analysis in the Indian capital markets for generating abnormal returns.

2. Statement Of The Problem

As the Indian capital markets showed a remarkable growth during the first decade of 21st century, the investors were in a position to generate good returns on their respective investments. As a result, the people developed a kind of trust on the Indian capital markets. Now the trust can be made more visible and more worthy if the Indian Capital markets are found to be efficient because in an efficient market, all the investors are at par and no investor has competitive advantage as far as access to information and utilization of that information is concerned. In an efficient market, investors do not hesitate in investing as in such a market no investor can generate abnormal profits and investors feel that the market is unbiased. Similarly the technical analysis, which has been always a point of discussion among the financial lobby needs to be tested for its relevance in Indian capital Markets. Now-a-days investment managers spend a bundle of resources in the form of money and time to find and identify trends and patterns in the historical prices with a view to predict future prices and generate abnormal profits. The technical analysis is fruitful only when the markets are inefficient. This study therefore focuses on testing the weak form efficiency of Indian stock Market with the objective of finding the relevance and validity of technical analysis in the Indian stock market.

As pointed out by all-time hit investment managers like Warren Buffet, all rational investors should invest for long term rather than developing a speculative mindset wherein people focus on speculative gains rather than long term profits. An efficient market discourages the speculative tendencies of people and on the other hand recommends investors to invest for long term.

Further, if the Indian stock market is efficient, the scope of arbitragers to make riskless profit, wherein a person looks for an opportunity of getting profits without consuming any resources becomes impossible. On the other hand if the Indian Stock Market is found to be inefficient, people can indulge in acts of buying financial assets at lower prices and sell them at higher price simultaneously. Arbitragers try to make the market efficient by taking the advantage of loopholes in the market and by such actions the inefficiencies tend to disappear with the passage of time.

Further, the Indian stock markets (BSE-SENSEX and NSE NIFTY) are vital indicators of the Indian economy and therefore are an emerging area of research. S&P CNX NIFTY in particular is an important and crucial representative of equity capital markets. CNX NIFTY is a collection of 50 well
diversified companies representing 22 sectors of economy. In this perspective, the present study aims at analyzing the S&P CNX NIFTY for the purpose of determining whether the Indian capital markets are efficient in weak form or not.

3. Objectives Of Research

1. To examine the random walk theory and related literature on the subject.
2. To test the weak form market efficiency on CNX NIFTY of National Stock Exchange of India.
3. To determine the relevance of technical analysis in predicting future prices of stocks represented by CNX NIFTY.
4. To provide valuable suggestions to the investors, academicians and research community regarding investment strategies to be adopted in Indian capital markets.

The Study will be carried out taking the following Hypothesis into account.

3.1 Hypothesis

Null Hypothesis

H0: The Indian stock market (CNX NIFTY) follows the theory of random walk.
H0: The Indian stock market (CNX NIFTY) is efficient in Weak form.
H0: The log returns of CNX NIFTY are normally distributed.

Alternate Hypothesis

H1: The Indian stock market (CNX NIFTY) do not follow theory of random walk.
H1: The Indian stock market (CNX NIFTY) is inefficient in weak form.
H1: The log returns of CNX NIFTY are not normally distributed.

3.2 Research Methodology

As already discussed, the main objective of the study is to test weak form of efficient market hypothesis of Indian stock market. For realizing the objective, the study relies on a number of parametric as well as non-parametric tests.

4. Data Sources & Sample

4.1 Data Collection

For realizing the objectives, the study has been confined to secondary data only. The study heavily relied on academic journals, books, research papers and more importantly internet for obtaining the
relevant data. In this study, daily prices of CNX NIFTY of eleven years were collected from the NSE website (http://www.nseindia.com/products/content/equities/indices/historical_index_data.htm).

4.2 Sample Source

The source of the sample is the most reliable source that is the official website of NSE. In order to make the study more reliable and creditable, sample of daily adjusted close of CNX NIFTY was taken from NSE website.

4.3 Sample Selection

For the purpose of analysis and testing the weak form efficiency of Indian stock market, daily adjusted close prices of CNX NIFTY were collected from NSE website. A total of 2747 observations (Daily adjusted close) spread over eleven years were taken into account for the purpose of the study. The study was confined to CNX NIFTY daily prices only because such an index is a vital indicator of Indian stock market as it is a combination of 50 well diversified portfolio (zero unsystematic risk) spread over 22 sectors. The CNX NIFTY is owned by India Index Services and Products limited, a joint venture of NSE and CRISIL. India Index Services and Products Limited is the first Indian Company which has this index as their core product.

4.4 Sample Period

The data used for the study is spread over eleven years ranging from 1st January 2003 up to 31st December 2013. A total of 2747 observations were taken into account for the purpose of this study. Such a huge number of observations was chosen with the objective to make the study free from thin trading and sample size neglect bias and to generalize the results. Recent data was chosen so as to make the study latest of its kind. The sample period was purposely chosen so as to cover all three phases of business cycle viz. , the Boom(upto 2007), the Recession(2008-11) and the recovery(2011-13).

4.5 Research Procedure

The adjusted close prices (2747 observations) were used to calculate the daily returns using the following formula. \[ R = \text{Ln} \left( \frac{P_t}{P_{t-1}} \right) \]
Where

- \( R \) = Daily return
- \( \text{Ln} \) = Natural Log
- \( P_t \) = Price at time \( t \)
- \( P_{t-1} \) = Price at time \( t-1 \)
Such a formula has been preferred over the traditional approach of calculating returns which employed the following formula because the results are time consistent more reliable and useful for further empirical research.

\[ R = \frac{(P_1 - P_0)}{P_0} \]

Where \( R \) = Daily return

\( P_0 \) = Price at time 0

\( P_1 \) = Price at time 1

The daily natural log returns were calculated using Microsoft excel for all 2747 observations.

4.6 Tools Of Analysis

Econometric Tools: To check the weak form efficiency of Indian Stock Market (CNX NIFTY) the study has relied on a number of statistical and econometric tools. The study has relied on descriptive statistics, runs test, Kolmogorov-smirnov test, Augmented Dickey Fuller test, Phillips Perron test and Auto-correlation test for analyzing the data and realising the objective of the study. A brief discussion of these tests is given as follows:

Descriptive Statistics: The basic requirement for any market to be random or to follow the weak form of efficient market hypothesis is that the returns should follow a normal distribution. Descriptive statistics is an essential tool to test whether the given data is normally distributed or not. In descriptive statistics, we basically calculate mean, median, mode, Skewness, kurtosis etc. to check the data for normality. Such a summary of statistics provides a basic view about the characteristics of the data. The basic criteria for any distribution to be called as normal is that its mean, mode and median must coincide.

Mathematically,

\[ \text{MEAN} = \text{MODE} = \text{MEDIAN} \]

Similarly, Skewness gives us an idea about the kind of asymmetry that the data exhibits. While the normal distribution is essentially bell-shaped and can be divided into two equal halves. In other words, the coefficient of skewness of a normal distribution is zero. Any data that deviates from these criteria that is whose coefficient of skewness is greater or less than zero is not normal and hence such data cannot be random.

Coefficient of skewness = zero, data is normally distributed.

Coefficient of skewness > zero, data is positively skewed.

Coefficient of skewness < zero data is negatively skewed.
Similarly kurtosis refers to peakedness or bullgedness of a distribution. Any group of observations that are normally distributed must and should have the value of kurtosis equal to three (mesokurtic). Any deviation that is whether the kurtosis value is greater than 3 (leptokurtic) or less than 3 (platykurtic) means that the data is not normally distributed.

4.7 Scope Of The Study
The study aims to test the weak form of efficient form hypothesis of Indian national stock exchange CNX NIFTY index. The data from NSE website was taken. Daily prices of CNX NIFTY from 01-01-2003 up to 31-12-2013 were taken into consideration for the study. The study is indeed crucial considering the rapid growth in Indian capital markets in the last decade of the 20th century and the first century of 21st century. The exchange traded funds and liberalized remittance scheme were mainly responsible for the increased investment in capital markets. More and more investors are readily investing in bulk in the Indian capital markets with the objective of generating feasible returns. More and more sectors of economy (e.g. retail, even defense) are being opened for foreign investment. The total FDI in Indian capital markets stood at 18,286 US $ million (2012-13) although showing a slight negative trend as the FDI in the year 2008-09 stood at 22697 US $ million.

5. Literature Review
Efficient market hypothesis has been a guiding light in the field of research on capital market theory. Putting it in simple terms, a market is referred to as efficient if all the information is immediately discounted by all investors and reflected in share prices in the stock market. In an ideal efficient market, everyone knows all possible relevant information simultaneously, interprets it similarly and behaves rationally. Market efficiency refers to direct relationship between share prices and information. In the words of Brunnermeir, information in the market makes the price process more informative in the short run and reduces its value in the long run. Some famous definitions of efficient security markets put forward by renowned Capital Market Researchers are assembled below:

Eugene Fama (1991) “Market efficiency is a continuum. The lower the transaction costs in a market, including the costs of obtaining information and trading, the more efficient the market”.

Eugene Fama (1970) “Efficient capital markets: A review of theory and empirical work” defined a market to be “informationally efficient” and as he puts it “A market is said to be efficient if no investor has competitive advantage as far as access to information and utilization of that information is concerned”.
The efficiency of the market has a direct bearing on the investments made. In an efficient market, investors are able to earn only normal returns and analysis of past, public and inside information has no relevance in generating abnormal returns because the prices move in slapdash direction. On the other hand, if the market is inefficient, the price movements can be predicted on the basis of past information, publically available information or hidden private information.

The efficient market hypothesis is commonly known as the theory of random walk because it is based on the idea that the stock prices do not follow a particular trajectory or a particular path but moves in a non-cohesive, un-identical and haphazard manner and at the same time absorbs all the relevant information quickly and disseminates the same in stock prices. The efficient market hypothesis has direct bearing on the investment proposals of financial managers and investors and answers crucial questions like why do security prices change and can these changes be guessed at an earlier point of time?

Burton G. Malkiel (1973) in the book “ A Random Walk Down Wall Street” suggests that in an efficient market a stock chosen by a blind folded chimpanzee by throwing darts at the wall street Journal could ideally select a portfolio of stocks as good as selected by a bundle of financial analysts.

The Efficient Market Hypothesis says that earning abnormal profits is seldom possible. In an efficient market the investors should try to invest for the long term because the speculative mindset is not going to yield anything. Arbitragers try to identify and exploit loopholes in the inefficient market with the objective of generating returns without investing any resources. Such persons are regarded as riskless profit makers. In an efficient market, arbitrages cease to exist as everyone can access, avail and use the information in similar way and no one can befool anyone.

In an efficient market prices do change and are seldom stationary because the prices react sharply and quickly in an unbiased manner to the new information. The current prices are optimum and reflect all information and there is no reason to believe that the prices are too high or too low.

Requirements for a Market to be Efficient

1. Prices must be efficient and stock prices will rise with new inventions and better products and motivate investors to supply share capital to the firm.
2. Information must be discussed freely and quickly across the nations and react quickly to new information.
3. There are no transaction costs.
4. Taxes have no effect on the investment proposals.
5. Investors are in a position to borrow and lend at the same rate.
6. All the investors are unbiased and believe in a rational manner.

5.1 Theoretical Background

The credit of first empirical research in the field of analyzing the efficiency of stock markets goes to LOUIS BACHELIER. Louis Bachelier (1900) who did his Ph.D. dissertation titled “theory of speculation” came to the conclusion that mathematical expectation of the speculator is zero and described it as a fair game. This was the first research of its kind that gave an idea regarding the randomness of markets and this marked the beginning of a new era in the field of capital markets.

A much better model derived by Osborne also advocated that the markets are non-stationary and non-cohesive. The findings of Osborne were based on two assumptions- new information is independent and affects the intrinsic value of the stock and impact of new information will be irrespective of past prices. Both the models (Osborne and Bachelier) advocated that the prices in the capital markets move in a haphazard way identical to the footsteps of a drunkard.

Perhaps, one of the pioneers in the field of capital market efficiency was Maurice Kendall who in 1953 published a study stating randomness of the capital markets. However, he did not use the term “efficiency” to state the same. Instead he simply stated that today’s price are not a function of yesterday’s prices. Maurice Kendall in his study attempted to identify regular price cycles in the markets but concluded otherwise i.e. he found that regular price cycles cease to exist as markets move in an unsystematic manner. This opened the gates for an emerging area of research as scholars wanted to know what exactly affected the stock prices because the past prices did not. Kendall’s results faced stiff resistance from the financial analysts and economists of that era because they were of the opinion that such random movements may represent inefficient markets but later they reinterpreted the findings of Kendall to conclude that random movements are indeed a signal of an efficient market.

A major contribution in the field of efficient markets was propounded by Eugene F. Fama (1965). Fama (1965) in his famous study “The behavior of stock market prices” put an end to the era of chartists ( DOW Theory) and other technical analysts by providing an empirical evidence that the markets are random. Fama in his theory of random walk suggested that a market with random walk has two properties:-
1. Today’s prices are not related to tomorrow prices.
2. The price changes confirm to some probability distribution (normal distribution).

Eugene Fama further asserted that the fundamental analysis which primarily focuses on analyzing the company, the market and the industry to determine the intrinsic value of the stock, is a futile exercise in an efficient market. Fama based his argument on the fact that in the world of uncertainty, intrinsic value of a stock is not known precisely. So there would be always a mismatch between the actual prices and intrinsic prices. The mismatch of intrinsic value and actual prices was described as “Noise” by Fama. Fama further asserted that in an efficient market, the intrinsic value of a particular stock keeps changing continuously with respect to new information pertaining to the market, industry or the Company which makes it impossible to estimate the intrinsic value of a stock precisely.

Eugene Fama further concluded that the process of security and portfolio management becomes a walk in the park as securities are fairly priced – neither over nor below and provide a fair return for a given level of risk taken by the investor. Fama described the capital markets as martingale i.e. a fair game. By a fair game, he meant that all relevant information is available to investors who behave in a rational manner and generate fair returns on their investment. So, no investor can use the information to gain unjustified returns.

It was Levy who first tested the random walk hypothesis by using three techniques – runs test, auto-correlation test and simulation model. Levy was the first, even before Fama (1970) to identify different forms of efficiency. He however, categorized efficiency of capital markets into two categories only- weak form efficiency and strong form efficiency.

5.2 Review Of Research

Augustine O. Ekechi (1989) concluded that the Nigerian Stock Markets are weak form inefficient and rejected the null hypothesis of Nigerian Stock Exchanges following the theory of random walk. The Author used serial correlation test, runs test and descriptive statistics to validate the results.

Sunil Poshakwale (1996) analyzed the returns of Bombay Stock Exchange for the period 1987 to 1994 by using various techniques like descriptive statistics, Kolmogorov-Smirov Goodness of fit test, runs test, serial correlation test and concluded (on the basis of interpretation of runs test and serial correlation test) that the returns in Indian Capital Markets were non-random and therefore rejected the null hypothesis of Indian Capital Markets being efficient in weak form.
Asma Mobarek and Keayin Keasey (2000) used a variety of non-parametric tests like Kolmogorov-Smirnov normality test and run test and parametric tests like auto correlation test, auto regression test and the ARIMA model to check whether the Dhaka Stock Market of Bangladesh follows the theory of random walk or not. The researchers concluded that the test results depicted that the null hypothesis of Dhaka Stock Exchange being efficient in weak form was invalid and there exhibited a significant auto correlation between the returns.

Andrew C. Worthington and Helen Higgs (2003) analyzed the markets of Latin America with the objective to detect whether these markets follow the theory of random walk or are weak form efficient. The Researchers analyzed the daily returns of seven countries Latin America i.e. Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela through various techniques like correlation coefficient analysis, runs test, Augmented Dickey Fuller test, Phillips Perron Test and Multiple Variance Ratio Tests and concluded that significant correlation existed between returns and therefore rejected the presence of randomness in the daily returns in these seven emerging markets.

Andrew C. Worthington and Helen Higgs (2004) tested the weak form efficiency of European equity markets. The researchers analyzed returns of capital markets of sixteen developed countries of Europe (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and U.K) and four emerging markets (Czech Republic, Hungary, Poland and Russia). The researchers used serial correlation test, runs test, Augmented Dickey fuller test, Phillips Perron and Kwiatkowski, Phillips, Schmidt and Shin (KPSS), unit root tests and multiple variance ratio (MVR) tests and concluded that out of all sixteen developed markets, only 5 countries-Germany, Ireland, Portugal, Sweden and U.K exhibited random walk and tested positive for weak form efficiency and out of emerging countries only Hungary followed random walk.

Justin Robinson (2005) studied the weak-form efficiency of Jamaican Stock Exchange by analyzing all listed stocks rather than the market index alone. The author analyzed the returns from January 2nd 1992 upto December 31st 2001 through various parametric and non-parametric tests like the auto-correlation test, runs test, Kruskal –Wallis Test etc. and subsequently rejected the null hypothesis of the Jamaican Stock Exchange being weak form efficient because 65% of stocks listed on the JSE gave predictable return.

Khan Maqsood Ahmad, Shahid Ashraf and Shahid Ahmad (2006) tested the weak form of efficient market hypothesis on the Indian Stock Markets. The Researchers analyzed the returns of SENSEX
and NIFTY from 1999 to 2004 using Augmented Dickey Fuller test, auto-correlation, GARCH (1,1), descriptive statistics, Kolmogorov – Smirnov test, Ljung Box (Q) statistic, Descriptive statistics etc. and concluded that the Indian Stock Markets are not weak form efficient and therefore do not follow the theory of random walk. The Researchers further pointed out that the returns showed high volatility and the indices showed a negative auto correlation at lag 2, indicating over reaction one day after information arrival, followed by a correlation on the next day.

Abid Hameed, Hammad Ashraf and Rizwana Siddiqui (2006) analyzed the Karachi Stock Exchange (KSE). For the purpose of analyzing whether the Karachi Stock Exchange is weak form efficient or not. The Researchers relied on GARCH (p, q) and ARIMA (1,1) model to measure the volatility and test the weak form efficiency of the Karachi Stock Exchange returns. After analyzing the returns from December 1998 to March 2006 the Researchers concluded that the Karachi Stock Exchange returns exhibited persistence and volatility clustering and the null hypothesis of Stock Markets of Pakistan being efficient was also rejected.

Hazem Marashdeh and b. Shrestha (2008) analyzed the stock market index of UAE with a view to test the efficiency in weak-form. For the said purpose, the researchers relied on unit root tests and the results confirmed that the stock markets of UAE follow random walk.

P. Srinivasan (2010) tested the weak form efficiency of Indian Stock Markets. The study observed 13 year data (3244 observations) taken from two major indices of India i.e. SENSEX and CNX NIFTY. Based on two unit root tests i.e. Augmented Dickey Fuller test and Phillips Perron (1988), the null hypothesis of Indian Stock Markets being in line with the theory of random walk was rejected.

6. Analysis & Interpretations

A number of statistical and econometric tools have been used to realize the objectives of this study. A comprehensive description of these tests and the results thereof have been described in a lucid style here under:

6.1 Statistical Tests

One of the important requirements for any data to follow the theory of random walk is that the distribution should be normal. Descriptive statistics provides us with comprehensive measures to check whether a given distribution is normal or not. If the distribution is found to be not normal, then the null hypothesis of the data being random is out-rightly rejected.
The data of 11 years obtained from NSE website is used to calculate returns as follows:

\[ R = \ln \left( \frac{P_t}{P_{t-1}} \right) \]

Where \( R \) = Daily return  
\( \ln \) = Natural Log  
\( P_t \) = Price at time \( t \)  
\( P_{t-1} \) = Price at time \( t-1 \)

The returns (2747) calculated by the above mentioned formula are put to operation to calculate various statistical measures like mean, mode, skewness, kurtosis, range, standard error, minimum and maximum value, sum etc.

For a normal distribution,

Mean = Mode = Median

The results calculated through Microsoft excel and SPSS software depicted that the value of mean, median and mode was 0.000637714, 0.0012477211, -0.005333346 for the given 2747 observations. As is clear from the above mentioned figures that mean, mode and median are unequal therefore, the stream of data is not normal.

Another property of a normal distribution is that its skewness and kurtosis are zero and three respectively. The values for the same measures (skewness and kurtosis) were obtained through Microsoft excel and SPSS and it was found that the coefficient of skewness for the data is -0.254240429 and the kurtosis measure is around 9.032780512. As is clear from the above mentioned values of skewness and kurtosis that the distribution is negatively skewed and highly leptokurtic.

All in all, all the statistical measures calculated through Microsoft Excel reveal that the distribution is anything but not normal, therefore, the null hypothesis of the data being normal is out rightly rejected. Further, normal distribution is a pre-requisite for any data to be called as random. Therefore, it indirectly suggests that the total returns used for the study do not follow the theory of random walk.

### 6.2 Runs Test

This test is one of the primary tests used to check the randomness of the data. This kind of non-parametric test is also called as Wald-Wolfowitz test. Basically Runs Test measures the total number of runs in a data and then compares them with the expected number of runs. A run refers to a
continuum of either positive or negative movements. Suppose if + is used to depict a positive movement, then a streak of these positive signs (+) constitutes a run.

If the number of actual runs if less than the expected runs it means that there is serial correlation in the data and the null hypothesis of the data being random is rejected. Most of the literature like Suresh Chandra Das and Bishnupriya Mishra (2013), Asma Mobarak and Keavin Keasey (2000), Sunil Poshakwale (1996), Sajeela Rabbani, Nida Kamal, Mehwash salim (2013), Muhammad Irfan, Muhammed saleem, Maria Irfan (2011) have employed this test to test the weak form efficiency of the respective Stock Markets. The formula used for calculating the expected runs and variance of the data is given hereunder:

\[
Z = \frac{R - X}{\sigma}
\]

Where

\[
R = \text{Total number of runs}
\]

**EXPECTED RUNS(X) =** \(2n_1n_2+1/n_1+n_2\)

\(n_1 = \text{Number of positive runs}\)

\(n_2 = \text{Number of negative runs}\)

**Variance \((\sigma^2) = 2n_1n_2\ (2n_1n_2 - n)/n_2\ (n - 1)\)

\(n = n_1 + n_2\)

\(z = \text{Normal variate}\)

For the purpose of the study the Runs Test was performed in both Microsoft Excel and SPSS program. Both the Soft-wares gave identical results, as the expected number of runs and the actual runs calculated from mean were 1372.092829 and 1301 respectively.

In Microsoft excel, the daily returns were compared with the mean of the distribution. If the respective return was greater than the mean, a positive movement depicted by 1 was recorded in the Binary column. Similarly if the respective return was less than the mean return, a negative movement was represented by 0 was recorded in the binary column. Another column(count) was used to compute the total number of runs cumulative manner. For this purpose, the figures in the Binary column were compared with the previous one. If the next figure was same as the previous figure, then the run continued otherwise 1 was added to the cumulative runs figure. the total cumulative figure at the end(2747th observation) was 1301.
Since the number of actual runs is very much less than the expected number of runs this in other words specifies that there exists a significant level of auto correlation among the returns. As we know that in a normal distribution, mean plus minus 1.96 standard deviation represents 95% of the total distribution so for the data to be regarded as normal the actual number of runs should fall in this range but the calculations reveal otherwise.

Expected number of runs – 1.96 x standard deviation = 1320.83.
Expected number of runs + 1.96 x standard deviation = 1423.34.

Since the actual runs (1301) do not fall in this range, so the data cannot have the properties of a normal distribution.

6.3 Unit Root Tests

Augmented Dickey Fuller Test and Phillips-Perron Test are the two widely used Unit Root Tests. These two tests are primarily used to check whether a given series is stationary or non-stationary. If the series is found to be non-stationary, then the null hypothesis of the market being random will be accepted. It was Hassan et al who explained the use of Unit Root Tests in testing the weak form efficiency of capital markets.

The ADF test is based on estimating the test regression:

\[ y_t = \beta' D_t + \phi y_{t-1} + \sum_{j=1}^{p} \psi_j \Delta y_{t-j} + \epsilon_t \]

Where \( D_t \) is a vector of deterministic terms (constant, trend etc.). The \( p \) lagged difference terms, \( \Delta y_{t-j} \), are used to approximate the ARMA structure of the errors, and the value of \( p \) is set so that the error \( \epsilon_t \) is serially uncorrelated. The error term is also assumed to be homoskedastic. The specification of the deterministic terms depends on the assumed behavior of \( y_t \) under the alternative hypothesis of trend stationarity as described in the previous section. Under the null hypothesis, \( y_t \) is I(1) which implies that \( \phi = 1 \). The ADF t-statistic and normalized bias statistic are based on the least squares estimates and are given by

\[ ADF_t = t_{\phi=1} = \frac{\hat{\phi} - 1}{SE(\phi)} \]

\[ ADF_n = \frac{T(\hat{\phi} - 1)}{1 - \hat{\psi}_1 - \cdots - \hat{\psi}_p} \]
The ADF test given us a t-statistic which is generally negative. The more negative the t-statistic, higher are the chances of rejecting the null hypothesis. The t-statistic is often compared with the critical values calculated at particular level of significance. If the t-statistic is less than the critical value calculated at a given critical level (generally the values are calculated at 1%, 5%, 10%), then the Researcher has to reject the null hypothesis of the series being random.

Another commonly used Unit Root Test to check whether a given data is non-stationary or not is the Phillips-Perron test. The Phillips-Perron test given us a t-statistic which is generally negative. The more negative the t-statistic, higher are the chances of rejecting the null hypothesis. The t-statistic is often compared with the critical values calculated at particular level of significance. If the t-statistic is less than the critical value calculated at a given critical level (generally the values are calculated at 1%, 5%, 10%), then the Researcher has to reject the null hypothesis of the series being random.

The Augmented Dickey Fuller Test was done through EVIEWS 6 and the input data taken was the returns (2747 observations) calculated using natural log. The Augmented Dickey Fuller t-statistic so generated for a total of 2747 observations was equal to \(-48.92934\) and the test critical values at 1%, 5% and 10% were equal to \(-3.432540, -2.862393, -2.567269\) respectively. At a significance level of 5%, the null hypothesis of the data being non-stationary is rejected because the ADF t-statistic is too negative \((-48.92934)\).

The ADF test was also done using Microsoft Excel and the results were identical and therefore in both the cases the null hypothesis stands rejected. Also Phillips – Perron Unit Root Test was done in the EVIEWS 6 software and the Phillips-Perron test statistic calculated using 2747 observations was equal to \(-48.92934\) with the probability of 0.0001 and the test critical values at 1%, 5% and 10% were \(-3.432540, -2.862393, -2.567269\) respectively.

All in all, both the Unit Root Test i.e. the ADF and the PP test revealed that the input series of data is not non-stationary and so the null hypothesis of the Indian Stock Markets being random has to be rejected.

### 6.4 Kolmogorov – Smirnov One Sample Test

The Kolmogorov Smirnov one sample test is used to examine an unknown distribution. This test is widely used to check whether a particular data follows a particular distribution or not. The test is relevant here because we want to check whether our data follows a normal distribution or not.
For continuous fields, this tests,

**H0**: \( F_x = F_0 (x) \) for all \( x \),

Where \( F_x \) is the distribution of the sample and \( F_0 (x) \) is the hypothesized distribution which in our case is the normal distribution.

**H1**: \( F_x \neq F_0 (x) \)

If the distribution is not as specified by null hypothesis.

For any set of date to be normal, following formula has to be satisfied

\[
F_0 \left( x_i \right) = \Phi \left( \frac{x_i - \mu}{\sigma} \right)
\]

where \( \mu \) and \( \sigma \) are user-specified (default sample mean and standard deviation).

The Kolmogorov Smirnov test was done on the eleven year returns in SPSS program. The results revealed that the Kolmogorov Smirnov Z statistic value to be 3.667 and the probability being 0.000 which clearly means that the data that was put to operation with the objective to check whether it is a normal distribution or not is by no means a normal distribution (the probability of 0.000 specifies the chances of accepting the null hypothesis).

As probability depicted by the one sample Kolmogorov Smirnov test was equal to zero, this clearly indicated the null hypothesis of the distribution being normal is out rightly wrong. As the distribution is not normal this in other words clearly means that the above mentioned distribution cannot be random. As we know a normal distribution is a pre-requisite for a data to be regarded as random.

### 6.5 Auto-Correlation Tests

This kind of parametric test is used to identify the correlation among the observations of a single time series data. As we know that if the coefficient of correlation is found to be zero, then the data is random. Autocorrelation refers to the correlation of a time series with its own past and future values. Autocorrelation is also sometimes called “lagged correlation” or “serial correlation”, which refers to the correlation between members of a series of numbers arranged in time. Positive autocorrelation might be considered a specific form of “persistence”, a tendency for a system to remain in the same state from one observation to the next. Autocorrelation can be exploited for predictions: an auto-correlated time series is predictable, probabilistically, because future values depend on current and past values. Three tools for assessing the autocorrelation of a time series are (1) the time series plot, (2) the lagged scatterplot, and (3) the autocorrelation function.
**Autocorrelation function (correlogram)**

An important guide to the persistence in a time series is given by the series of quantities called the sample autocorrelation coefficients, which measure the correlation between observations at different times. The set of autocorrelation coefficients arranged as a function of separation in time is the sample autocorrelation function, or the ACF. An analogy can be drawn between the autocorrelation coefficient and the product-moment correlation coefficient. Assume $N$ pairs of observations on two variables $x$ and $y$. The correlation coefficient between $x$ and $y$ is given by

$$
r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\left[ \sum (x_i - \bar{x})^2 \right]^{1/2} \left[ \sum (y_i - \bar{y})^2 \right]^{1/2}}$$

The auto-correlation test was done using SPSS program and the EVIEWS 6 software for maximum lags of 22 and the results revealed that although the correlation coefficients are not too alarming to make a market too predictable but most of such coefficients show significant values other than zero. The coefficient of correlations for $8^{th}, 10^{th}, 13^{th}, 14^{th}$ and $17^{th}$ lags are significantly positive and the coefficient of correlation for the $2^{nd}, 5^{th}, 6^{th}$ and $20^{th}$ lags are significantly negative.

The auto-correlation coefficient clearly depicts that the future returns can be predicted by analyzing the past prices with clearly means that the Indian capital markets are not random and don’t follow the theory of random walk.

**7. Conclusion & Suggestions**

In the foregoing analysis done in chapter III regarding Testing of Efficient market Hypothesis in Weak form where in various tests both parametric as well as non-parametric were used to arrive at the objectives of the study. The objectives of the study were primarily to test whether the market is efficient/inefficient in the weak form. For this study NSE CNX NIFTY was used as a benchmark for returns for the period 2003 to December 2013. The conclusions drawn from the study are put forth in the following pages.

1. The capital markets of India are still in phase of infancy and juvenile stage. Although the investments in these markets are increasing at an exponential rate but they will continue to blossom and groom only and only if the markets are fair (efficient).
2. All the statistical and Econometric tools used for the study clearly reveal that the Indian capital markets are inefficient in weak forms.
3. The validity of the theory of random Walk in Indian Capital markets also stands refuted as the tests used to determine the same clearly rejected the null Hypothesis of the Markets being random.

4. As the Indian capital Markets are Inefficient in Weak form That Clearly means that these markets are also Inefficient in Semi-strong and strong form.

5. There will be always a scope of Technical and Fundamental analysis in the Indian capital Markets as long as they continue to be efficient. While the technical analysis mainly focuses on short term gains, the fundamental analysis on the other hand focuses on determining the intrinsic value and investing for long term.

6. The Best strategy in Indian capital Markets is to identify a value stock and to buy and hold the same for long periods so as to earn fair return on investment.

7. In the Indian Capital Markets, The arbitragers can easily make risk-less profit. Such persons can easily look for undervalued assets and sell the same simultaneously at higher prices without using any resources of their own.

8. References


Website

http://www.nseindia.com/products/content/equities/indices/historical_index_data.htm.