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TESTING WEAK FORM OF EFFICIENT MARKET HYPOTHESIS (EMH): EMPIRICAL EVIDENCE FROM LEADING STOCK EXCHANGES IN INDIA

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ABSTRACT

In recent decades business organisations as well as governments are realizing the importance of capital markets in general and particularly stock markets in the economic growth and development of a country. A truly efficient capital market has great role to play in the development of a country. A market is said to be efficient if prices in the market reflects all private or publicly available or historical information of the concerned security in the market. Empirical testing of market efficiency in India revealed mixed results – some concluded it is weak form efficient and others have concluded that it is not even weak form efficient. So, in this paper an attempt has been made to test weak form of market efficiency of Bombay Stock Exchange and National Stock Exchange. Daily values of S & P BSE Sensex and Nifty 50 from January 1, 2014 to December 31, 2018 have been used and daily returns have been calculated. The Kolmogorov-Smirnov Goodness of Fit Test result shows non-normal daily returns of both the Sensex and Nifty. Then run test with mean, median and zero as base have been used to test the weak form market efficiency. All the test results for both the Nifty and Sensex have evidenced that the markets are not even efficient in the weak form. To substantiate the conclusion the Augmented Dickey-Fuller test and Philips-Perron test of Stationarity have been used and the results revealed that both Sensex and Nifty return series are stationary at level. As one can model the stationary series and predict the future movements so the market cannot be regarded as efficient.

So, it can be concluded that the Indian stock market is not efficient in the weak form and security prices do not reflect all past information and it is possible to earn super-normal gain by utilizing past information as share prices do not adjust instantaneously in response to any new information release in the market.

Keywords: Efficient Market Hypothesis, Kolmogorov-Smirnov Goodness of Fit Test, Run Test, Sensex and Nifty, Augmented Dickey-Fuller Test, Philips-Perron Test

INTRODUCTION

In recent decades business organisations as well as governments are realizing the importance of capital markets in general and particularly stock markets in the economic growth and development of a country. Capital market is a virtual place (typically) where long term debt and equity are traded, and government and businesses can raise fund against long term financial instruments.

An important feature of capital market is that it is assumed to be 'Efficient'. A market is said to be efficient if prices in the market reflect all private or publicly available or historical information of the concerned security in the market. This implies that security prices are worth their intrinsic value, which means at any given point of time market price of security exactly equals to the intrinsic value of the security. So, according to the Efficient Market Hypothesis (EMH), security prices reflect all available information and there is no scope for any abnormal gain or abnormal loss on the part of market participants.

Levy (1967) first to segregate the market efficiency into two forms – weak and strong, later further analysis was made by Fama (1970) and divided the efficient market hypothesis into three sub hypotheses – weak, semi-strong and strong depending on the types of information reflected in the stock prices. In order to test the market efficiency, the understanding of the three form of efficiency is important.

A market is said to be efficient in a weak form if security prices reflect all past information, this means that no investor would be able to earn super-normal gain (/loss) by utilizing past information as share prices adjust instantaneously in response to any new information release in the market. Statistical tests like serial autocorrelation test, run test, Komlogrov-Smirnov goodness of fit test etc. can be used to test the weak form of EMH. A market would be regarded as efficient in

semi-strong form if security prices reflect all past information as well as all publicly available current information. Semi-strong form of EMH can be tested using event study, portfolio study etc. Further, a market is regarded as efficient in the strong form when security prices reflect not only all past as well as publicly available current information but also reflect privately held information. Testing of strong form of EMH is something unique. There are three groups who possesses private information-large stock brokers in the market and management of top Mutual Fund (MF) as they have abundant resources so they have greater influence over the market and they can collect hidden and secret information; the third group is the top management of the company as they actively participates in the decision making process of the company so they possess the secret information. If we assume that the third group of persons are not directly or indirectly participating in buying/selling of their own securities, then this group is eliminated. Out of the first two groups it is very difficult to get earning information of the large stock brokers, but it is very easy to get accurate picture of earnings of the top MF. If we compare the earnings of MF with the earnings of retail investors and found there is no significant difference in the earnings of the two, the market would be regarded as efficient in the strong form as no super normal gain could be earned by utilizing hidden or secret information.

The scope of the present study is confined to the testing of weak form of Efficient Market hypothesis only in the Indian context.

The rest of the study proceeds in the following order. Literature Review is presented in Section II, followed by Research Objectives and Research Hypotheses in section III and IV respectively. The section V dedicated to Methodology. Section VI is dedicated to Results and Discussion followed by the last section on Conclusion and Recommendations.

LITERATURE REVIEW

Patel, Rajpal & Modi (2018) in a study titled "Testing Weak form of Market Efficiency: A Study on Indian Stock Market" tested daily successive price changes of Bombay Stock Exchange Sensex from 1st April 2015 to 31st March 2018 with run test. They concluded that successive price changes of BSE Sensex during the said period are interdependent, and the market can be outperformed, hence not efficient in weak form.

Hawaldar, Rohit & Pinto (2017) in a study titled "Testing of weak form of efficient market hypothesis: evidence from the Bahrain Bourse" tested weak form of market efficiency of individual stocks listed on Bahrain Bourse for a period from 2011 to 2015. They used Kolmogorov-Smirnov goodness of fit test, run test and autocorrelation test. Based on K-S test they concluded that general stock price movement doesn't follow random walk. But the run test results showed only out of 43 companies 36 companies follow random walk and only 7 companies don't follow. So, based on the mixed results they found it difficult to conclude the weak form of efficiency of Bahrain Bourse.

Rahman, Simon & Hossain (2016) in their paper titled "An Empirical Analysis of Weak Form Market Efficiency: Evidence from Chittagong Stock Exchange (CSE) of Bangladesh" have tested weak form of market efficiency of daily returns of the three indices of Chittagong Stock Exchange for a period from 2006 to 2015. They have used Runs Test, Variance Ratio Test and Kolmogorov-Smirnov Goodness of Fit Test, Augmented Dickey-Fuller Test and Autocorrelation Function Test. Based on the findings of these tests they have concluded that Chittagong Stock Exchange is not efficient in weak form and therefore, superior profits can be made.

Chavannavar & Patel (2016) in a paper titled "Efficiency of Indian Stock Market: A Study from National Stock Exchange" have studied Nifty 50 index and Nifty 50 stocks for a period of three years from 1st April 2013 to 31st March 2016. They have used auto-correlation test and run test in order to examine weak form efficiency and the residual return on event study was conducted to examine the Semi strong form of market efficiency. Based on the findings they have concluded that Indian stock market is efficient in both weak form and semi strong form.

Kumar & Kumar (2015) in a paper titled "Market Efficiency in India: An Empirical Study of Random Walk Hypothesis of Indian Stock Market – NSE Midcap" have studied closing prices of NSE Midcap 50 Index for a time period of 15 Sept 2010 - 28 Nov 2014. They have used auto-correlation, Q-statistics and the run test in order to check weak form of market efficiency. Based on the results they have concluded that stock prices do not reflect all past information and hence market is not efficient in the weak form.

Gupta & Gedam (2014) in a paper titled "Testing of Efficient Market Hypothesis: A study on Indian Stock Market" have studied eight automobile and IT companies listed on NSE from 1st January 2014 to 31st March 2014. They have used run test for each eight companies. Result showed that out of eight companies seven companies follow random walk and are efficient

in weak form.

Sharma & Kennedy (1977) in their paper titled "A Comparative Analysis of Stock Price Behavior on the Bombay, London and New York Stock Exchanges" have compared the behaviour of stock indices of the Bombay, London and New York stock exchanges during the period from 1963-1973. They used run test and spectral analysis. Both the test confirmed the random movement of stock indices for all the three stock exchanges. They concluded that stocks on the BSE (Bombay Stock Exchange) follow random walk and are weak-form efficient.

Research Objectives:

General objective of the present study is to empirically test the weak form of Efficient Market Hypothesis in the Indian context. The following three specific objectives may be considered:

- To give an overview of Efficient Market Hypothesis (EMH) and how different forms of EMH can be tested.
- To test weak form of market efficiency of Bombay Stock Exchange (BSE).
- To test weak form of market efficiency of National Stock Exchange (NSE).

Research Hypotheses:

Based on the last two specific research objectives as discussed in the previous section, the following two sets of hypotheses have been constructed:

H_{01}: Bombay Stock Exchange is efficient in the week form.

H_{11}: Bombay Stock Exchange is not efficient in the week form.

H_{02}: National Stock Exchange is efficient in the week form.

H_{12}: National Stock Exchange is not efficient in the week form.

RESEARCH METHODOLOGY

India being one of the fastest growing economy in the world, I have selected two major stock indices namely S & P BSE Sensex and Nifty 50 (hereafter referred as Sensex and Nifty) of the two leading stock exchanges in India - Bombay Stock Exchange (BSE) and National Stock Exchange (NSE). Daily stock prices of Sensex and Nifty from January 1, 2014 to December 31, 2018 have been collected from their respective websites. The continuously compounded rate of return is used as a measure of daily return, which is calculated as follows:

$$R_t = Log_{pt} / Log_{pt} - 1 \quad (1)$$

Where R_t is the return at time t, Log_{pt} is the logarithm of price at time t, Log_{pt-1} is the logarithm of price at time t-1.

Popularly there are two tests one being non-parametric, or distribution free test known as Run test, another one is Autocorrelation test which is a parametric test, that is it assume that the sample have been drawn from a parent population. In other words, sample must be normally distributed in order to apply autocorrelation test, and no such restriction is being impose for the application of run test.

So, after finding the daily returns in the manner as stated above, the next crucial step is to identify whether the daily returns follow normal distribution or not. In order to know whether the daily returns follow normal distribution or not, the Kolmogorov-Smirnov Goodness of Fit Test have been applied.

Kolmogorov-Smirnov Goodness of Fit Test (K-S test) is a non-parametric test designed to determine whether a randomly selected dataset fits to a given statistical distribution. Here it is tested whether the daily returns follow normal distribution or not.

$$\max_x |F(x)-S_n(x)| < D_{n,a} \quad (2)$$

The null and alternative hypotheses of the K-S test are as follows:

H_0: The dataset follows normal distribution.

H_1: The dataset doesn't follow normal distribution.

If the calculated test statistic lies between ±1.96 we accept the null hypothesis and conclude that the daily returns, follow normal distribution and in that case, we should apply autocorrelation test instead of run test. But if the test statistic is less than -1.96 or more than +1.96 then we reject null hypothesis and conclude that daily returns doesn't follow normal distribution and, in that case, we should apply run test instead of autocorrelation test.

Autocorrelation test or Serial Correlation coefficient test is the most direct and widely used parametric test for testing EMH in weak form. It provides a measure of the relationship between returns in the current period and those in the previous period. Autocorrelation tests determine whether the correlation coefficients are significantly different from zero (Hou & Sun, 2014).

Auto-correlation or Serial Correlation coefficient is denoted as ρ (K) and defined by

$$\rho(k) = \frac{Cov(r_t, r_{t-k})}{\sqrt{Var(r_t)}\sqrt{Var(r_{t-k})}} = \frac{Cov(r_t, r_{t-k})}{Var(r_t)} \quad (3)$$

Where,

ρ (K) = autocorrelation coefficient on a security at time t.

K = lag of the period

Cov (r_t, r_t - k) = covariance between the return of an index over time period (t) and its lagged return t-k periods earlier

Var (r_t) = variance on the return of a security over time period.

Run Test is a non-parametric test designed to determine whether sequence of data occurring randomly or not. A run is defined as a sequence of one symbol such as '+' or '-'. The mean and variance of runs are calculated as follows:

$$\mu = \frac{2n_1 \cdot n_2}{n_1 + n_2} + 1. \quad (4)$$

$$\sigma^2 = \frac{2n_1 \cdot n_2 \cdot (2n_1 \cdot n_2 - n_1 - n_2)}{(n_1 + n_2)^2 \cdot (n_1 + n_2 - 1)}. \quad (5)$$

Where,

μ = Mean.

σ^2 = Variance.

n_1 = Number of positive runs.

n_2 = Number of negative runs.

The standard normal Z-Statistic used to conduct run test is as follows:

$$Z = \frac{Observed - Expected}{\sqrt{Variance}}. \quad (6)$$

Stationarity Test – one of the modern methods for checking market efficiency is unit root test.

Hassan, Shoaib & Shah (2007) have explained that Stationarity test or unit root test can be used for testing efficient market hypothesis, market efficiency demands randomness (i.e. non stationary) in behaviours of price of the security. So, if the test results show the return series are stationary then the market cannot be regarded as efficient. Augmented Dickey-Fuller test and Phillips-Perron test have been used to test whether the returns are stationary or not.

RESULTS

Table 1 represent the Descriptive Statistics of daily return series of both Sensex and Nifty. Interestingly, both Sensex and Nifty have reported positive mean returns over the past five years. The mean return of Sensex (0.000920) is more than double the Nifty return (0.000442). The standard deviation, which is a measure of volatility, shows Sensex is relatively more volatile than Nifty as the standard deviation of Sensex (0.008691) is more than the standard deviation of Nifty (0.008468). Just by bearing a little more risk in Sensex compared to Nifty (0.000223) investors could earn more mean return 0.000478. Maximum returns for both Sensex and Nifty are almost same. Minimum returns of both Sensex and Nifty are negative and are also almost same.

Skewness is a measure of lack of symmetry (i.e. asymmetry) of the distribution of a series around its mean value. A series having normal distribution has skewness value of zero and is known as symmetric distribution. A Positive skewness implies that the distribution of the series has a long right tail whereas, a negative skewness means that the distribution has a long-left tail. Both Sensex and Nifty return series shows negative skewness (-0.411420 and -0.503948 respectively) and hence both the series have long left tails.

Kurtosis is a statistical measure of the peakedness or flatness of the distribution of a series. A series having normal distribution has kurtosis value of 3 and is called mesokurtic. Kurtosis value exceeding 3 of a series is called leptokurtic and the distribution is more peak relative to normal distribution. Whereas, a kurtosis values less than 3 is called platykurtic and the distribution is flatter relative to normal distribution. Both Sensex and Nifty return series shows kurtosis values more than 3 (5.542391 and 5.940422 respectively) and hence both the series are leptokurtic, that is their distributions are more peak relative to normal distribution.

Jarque-Bera (J-B) test is a goodness of fit test which of whether the skewness and kurtosis are matching with that of the normal distribution. The J-B test follows χ^2 distribution with 2 degrees of freedom with null hypothesis that the sample data are not significantly different than normal population. Probabilities of J-B statistic for both Sensex and Nifty are 0.0000, so we reject the null hypothesis and conclude that sample data are significantly different than normal population. Although such non-normality would be confirmed by Kolmogorov-Smirnovtest.

Table 1: Result of Descriptive Statistics of Daily Returns

	Sensex	Nifty
Mean	0.000920	0.000442
Median	0.000875	0.000624
Maximum	0.033236	0.033115
Minimum	-0.061197	-0.060973
Std. Dev.	0.008691	0.008468
Skewness	-0.411420	-0.503948
Kurtosis	5.542391	5.940422
Jarque-Bera (J-B)	366.5619	495.9793
Probability of J-B Stat	0.000000	0.000000
Observations	1232	1232

Source: Computed by the Author with EViews 10

Table 2 presents the results of Kolmogorov-Smirnov goodness of fit test (K-S test). It provides evidence whether the distribution conforms to a given distribution, here it is tested whether the distribution conforms to normal distribution. The *P*-Values of K-S test result shows 0.005 for Sensex and 0.001 for Nifty which are well below than 0.01 (at 1% level of significance). Thereby rejecting the null hypotheses and concluding that the movements of daily return of Sensex and Nifty do not follow normal distribution. So, the results of both the test for normality, namely Jarque-Bera test and Kolmogorov-Smirnov test unanimously confirms that the Sensex and Nifty returns distribution do not follow normal distribution.

Table 2: Result of One-Sample Kolmogorov-Smirnov Test

	Z-Value	*P*-Value
Sensex	1.604	0.012
Nifty	2.027	0.001

Source: Computed by the Author with SPSS 18

Since, both the Sensex and Nifty returns have non-normal distribution, so the non-parametric test i.e. run test has been applied in order to examine the randomness as the run test does not require the return distribution to be normal. Table 3, 4 and 5 represents the results of run test for randomness with mean, median and zero respectively as base.

A close look at the results would reveal that the Sensex is statistically significant under all the assumptions that is mean, median and zero as base. The Z-values under all the three assumptions are less than -1.96 and the *P*-values are less than 0.05. So, we reject the null hypothesis that the movement of Sensex returns are random and conclude that the daily return realizations of Sensex are not independent, hence they are not random and the stock market in terms of Sensex is not efficient in the weak form.

Nifty is only significant if zero is taken as base and we can say that national stock exchange is not efficient in the weak form. With either mean or median as base the *P*-values are more than 0.05, hence we accept the null hypothesis for Nifty and conclude that national stock exchange is efficient in the weak form. Here, the results under the three assumptions are contradicting. So, a more advance and sophisticated test like unit root test have been applied in order to resolve the contradiction and to reach conclusion.

Table 3: Result of Run Test for Randomness with Mean as the Base

	Z-Value	*P*-Value
Sensex	-2.106	0.035
Nifty	-1.243	0.214

Source: Computed by the Author with SPSS 18

Table 4: Result of Run Test for Randomness with Median as the Base

	Z-Value	*P*-Value
Sensex	-2.337	0.019
Nifty	-1.140	0.254

Source: Computed by the Author with SPSS 18

Table 5: Result of Run Test for Randomness with Median as the Base

	Z-Value	*P*-Value
Sensex	-3.132	0.002
Nifty	-2.446	0.014

Source: Computed by the Author with SPSS 18

Table 6: Result of Stationarity Test

	Augmented Dickey -Fuller Test		Phillips-Perron Test	
	t-Statistic	*P*-Value	Adj. *t*-Statistic	*P*-Value
Sensex	-15.99587	0.0000	-31.86742	0.0000
Nifty	-32.49347	0.0000	-32.40805	0.0000

Source: Computed by the Author with EViews 10

As the efficient market hypothesis propounds that release of new information are instantaneously reflected in the stock prices, so with these information future stock prices cannot be predicted. As stock prices cannot be predicted according to efficient market hypothesis so the daily return series should be non-stationary. The daily returns of Sensex and Nifty are put to Stationarity/unit root test – both Augmented Dickey-Fuller test and Phillips-Perron test have been used. Test results for both Sensex and Nifty return series as shown in table 6 are statistically significant. As *P*-values are less than 0.01 in

all the cases, hence we can accept the alternative hypotheses that the return series of both Sensex and Nifty does not have unit root. So, both Sensex and Nifty daily series are stationary at level, and the stationary series can be modelled, so future stock prices can be predicted with these stationary series.

So, the conflicting results in case of Nifty are resolved with Stationarity test. As the Nifty return series is stationary, hence one can forecast the market movement with such stationary series. As such, the Indian stock market cannot be regarded as efficient.

DISCUSSION

Empirical analysis showed that the Sensex and Nifty returns are not normal hence non-parametric test like run test with mean, median and zero as base have been used to test the weak form market efficiency. All the test results for both the Nifty and Sensex have evidenced that the markets are not even efficient in the weak form. Apart from rum test, unit-root tests like Augmented Dickey-Fuller test and Philips-Perron test have been used and the results revealed that both Sensex and Nifty return series are stationary at level. As the return series are stationary, hence the series can be modelled and hence predictions of future movements are possible.

CONCLUSION

In the present study, the result support the previous conclusion that the Indian stock market is not efficient in the weak form and security prices do not reflect all past information and it is possible to earn super-normal gain by utilizing past information as share prices do not adjust instantaneously in response to any new information release in the market.

RECOMMENDATIONS

Market efficiency has long been a matter of controversy in the emerging economies like India. Since Fama's 1970 study on market efficiency, many studies have been conducted to test market efficiencies. Although in the developed economies it is mostly found that the market is weak form efficient. But in emerging markets like India the results are found to be mixed – some concludes Indian stock market is weak form efficient and some concludes it is not even efficient in the weak form.

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