TESTING THE WEAK FORM EFFICIENCY OF INDIAN STOCK MARKET

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This paper discusses the weak form efficiency of Indian stock market. The data for the purpose of study includes the daily and monthly value of the NIFTY and SENSEX which are the most commonly used indicator of Indian stock market movements. The time period of the study is 10 year covering the NIFTY and SENSEX data from July 2003 to June 2013. The Run test and Autocorrelation test are conducted to test the null hypothesis of random walk. The study concluded that the Indian stock market is not weak form efficient as the random walk hypothesis is rejected for Indian stock market on the basis of both run test and autocorrelation test. This is in confirmation with the previous studies conducted in India with reference to the weak form efficiency. It means that the investors can earn abnormal return by analyzing the past information and detect the profitable pattern in financial time series. One of the pillars of the effective corporate governance is to enable shareholders take an informed decision. Thus, the efforts should be made by the state to bring more and more efficiency in the stock market so as to reflect the true value of the share price and help prospective as well existing investors make the right decisions.

Key words: Random Walk, Efficient Market Hypothesis, Run Test, Autocorrelation, NIFTY, SENSEX.

1. INTRODUCTION

The efficient market hypothesis (EMH) is the most widely discussed and debated theory in the field of finance. Its starting can be traced back to 1900 by the PhD work of Bachelier titled 'The Theory of Speculation' which provided some initial ideas about the randomness of stock price series. However, he did not use the term randomness. The real breakthrough came in 1953 when Maurice Kendall presented a paper before the Royal Statistical Society, London discussing the randomness of the stock price time series. Then later on, in 1959, two more papers were published, one by Harry Roberts and another by Osborne where they showed the randomness of stock prices. By that time the theory of random walk was well established and the need was felt to identify the process which resulted in this random walk. The answer to this question was provided by Fama

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(1965) who propounded the theory of EMH. Fama stated that price change occurs due to the availability of new information in the market and as this information comes in the market randomly and thus prices also respond to the changes randomly making the stock price series random. Later on Fama (1970) also classified the efficiency in three forms: weak form, semi-strong form and strong form efficiency of the stock market. It is followed by numerous studies on this topic.

The main objective of the study is to test the weak form efficiency of Indian stock market. The weak form efficiency in the Indian stock market will be tested by using the results of serial correlation test and run test. The data is related to NIFTY and SENSEX index covering the time period from July 2003 to June 2013.

H_0 : Null Hypothesis = Indian stock market return is a random walk series.
H_1 : Alternative Hypothesis = Indian stock market is not a random walk series.

The study is organized in six chapters. The first chapter is of the introduction of the study i.e. this section itself. The second chapter gives the review of literature. Though, there is a plethora of literature available on EMH, however, few important studies have been reviewed and efforts are made to do justice to this seemly endless task. The third chapter provides the details regarding the data which is used and the methodology applied to analyze the data. The chapter four presents the empirical results of the study in detailed manner. The fifth chapter of the study provides the succinct summary and conclusion of the paper.

2. REVIEW OF LITERATURE

One of the most interesting theories of finance is efficient market hypothesis (EMH). There is voluminous literature available on this topic, which is the most debated issue in financial literature.

Efficient market hypothesis theory is credited to Fama (1960) who propounded this theory and in later study Fama (1970) provided a useful framework of EMH when he classified market efficiency in three forms namely weak form, semi-strong and strong form. Since Fama, a huge number of researches have been conducted to test the random walk hypothesis on many stock markets.

Solvik (1973) conduct the test of random on European market. The time period was from March 1966 to April 1971. The study concluded that the random walk is found more visible in European market than in American market.

Jennergren and Korsvokd (1975) investigated the daily stock price changes of relatively small European stock markets such as Austria, Denmark, Greece, Norway and Sweden. They detected high serial correlation in price changes i.e. these markets deviate from random walk.

Errunzu and Losq (1985) studied the behavior of prices of 10 less developed markets, namely, Argentina, Brazil, Chile, Greece, India, Jordon, Korea, Mexico, Thailand and Zimbabwe. The study concluded that the LDC markets are similar to smaller European markets than to developed markets in terms of randomness in stock prices.

Poshakwale (1996) studied the Indian stock market to test the day of the week effect and weak form efficiency of the Indian stock market. The data which is used for the study was of Bombay stock exchange national index (BSENI). The daily data was obtained from January 1987 to October 1994. It is found that the return on Fridays is more than the rest of the days. It all indicates the investors can design their strategies to earn abnormal profits by analyzing the past information of Indian stock market.

Mookerjee and Yu (1999) studied the Shanghai stock exchange and Shenzhen stock market indices to study the efficiency of the market. The data was related to the time period from December 1990 to May 1992 and from 1992 to December 1993. The methodology used was the serial correlation test and run test. The study concluded that the Chinese stock market is inefficient.

Shiguang Ma and Michelle L. Barnes (2001) paper is the most comprehensive study on the Chinese stock market. The data was collected from December 1990 to April 1998 for Shanghai stock exchange and from April 1991 to April 1998 for the Shenzhen stock exchange. The methodology was the serial correlation tests, run tests and variance test. The overall conclusion of the authors is that the Chinese stock market is not weak form efficient.

Basu and Gupta (2007) investigated the weak form efficiency of Indian stock market by analysing the two main indices of Indian stock market i.e. SENSEX and NIFTY. The data was obtained for the time span starting from 1991 to 2006. The ADF, PP and KPSS methods were employed to test the weak form efficiency of Indian stock market. The results of the data analysis confirmed to the previous findings regarding the equity markets of emerging countries i.e. the Indian stock market is not weak form efficient.

Srinivasan (2010) studied the Indian stock market data to analyse the weak form efficiency of Indian stock market. The data analysis of the study showed that the Indian

stock market is not weak form efficient and the traders can predict the future movements of the stock prices by analysing the past information and earn abnormal returns.

The previous literature on Indian stock market showed that random walk hypothesis is not applicable for India and the Indian stock market is not weak form efficient just like most of the emerging stock markets.

3. DATA AND METHODOLOGY

DATA

The data employed for this study consists of closing daily and monthly value of NIFTY and SENSEX index. The data is obtained from the National Stock Exchange website and Bombay stock exchange website and it is converted into logarithmic return before undertaking any analysis. The time span which is covered under the study is from July 2003 to June 2013 i.e. the ten year time period is covered for the study.

METHODOLOGY

The logarithmic return is

$$R_{t+1} = \ln(P_{t+1} / P_t) = \ln(P_{t+1}) - \ln(P_t)$$

The empirical studies have found that simple return of financial asset exhibit limited liability, which is contrary to the normal distribution.. The log return takes care of this drawback. Thus, this study makes use of the logarithmic return for various indices of Indian stock market.

Serial Correlation Test

As Fama recommended that one of the most direct and intuitive tests of the random walk for an individual time series is to check for serial correlation. A serial correlation coefficient is estimated from two observations of the same time series at different dates.

The model of the serial correlation coefficient is

$$\rho(k) = \frac{\text{cov}(r_t, r_{t-k})}{\text{var}(r_t)}$$

Where $\rho(k)$ is the serial correlation coefficient of the time series r_t, here r_t is the logarithmic return at time t and k is the lag of the period. In this study lags are selected as

one through ten to confirm to some previous studies (Fama 1965, Hsiao 1997, Ma and Barne 2001).

To test the joint hypothesis that all the serial correlation coefficient, $\rho(k)$ are simultaneously equal to zero, the Ljung-Box test is used, where

$$LB-statistic = n(n+2)\sum_{k=1}^{m}\frac{\rho^2(k)}{(n-k)}$$

And LB-statistics follows the chi-square distribution with m degree of freedom.

Run Test

To test for serial independence in the returns the study also employ a runs test, which determines whether successive price changes are independent of each other, as should happen under the null hypothesis of a random walk. The runs test is based on the premise that if price changes (returns) are random, the actual number of runs (R) should be close to the expected number of runs μ_r.

Let n_1 and n_2 be the number of positive returns (+) and negative returns (-) in a sample with n observations, where $n = n_1 + n_2$. For large sample sizes, the test statistic is approximately normally distributed:

$$Z = \frac{R-\mu_r}{\sigma_r} \approx N(0,1) \quad \text{Where}$$

$$\mu_r = \frac{2n_1n_2}{n}+1 \quad \text{and}$$

$$\sigma_r = \sqrt{\frac{2n_1n_2(2n_1n_2-n)}{n^2(n-1)}}$$

4. EMPIRICALANALYSIS

The results of the data analysis are discussed in this section. This section covers the brief summary of descriptive statistics which is followed by the detailed discussion of serial correlation test and run test.

NIFTY-EMPIRICAL ANALYSIS

Descriptive Statistics

The mean value of the return series is 0.00065 or .065% i.e it is the daily average return with 0.0164 value of standard deviation. The series is non normal on the basis of skewness and kurtosis. Similarly, monthly return series also exhibits non normality. However, we can invoke the central limit theorem as the sample size is 120 which is well above 30, the limit which is required to use central limit theorem.

SERIAL CORRELATION TESTS : Daily Return Series

The NIFTY index shows the significant autocorrelation at lag one at 5% level of significance as well as at 1% level of significance.

Table 1

DAILY- NIFTY	**Serial Correlation Test Result**				
Lags	AC	S.E.	Z-statistics	LB Statistics	Prob
1	.064	.020	3.2	10.181	.001
2	-.039	.020	-1.95	13.920	.001
3	-.004	.020	-0.2	13.962	.003
4	.006	.020	0.3	14.043	.007
5	-.028	.020	-1.4	15.974	.007
6	-.054	.020	-2.7	23.164	.001
7	.020	.020	1	24.176	.001
8	.045	.020	2.25	29.241	.000
9	.014	.020	0.7	29.703	.000
10	.026	.020	1.3	31.458	.000

The same fact can be observed from the correlogram where the value of ACF is moving outside the specified limits and there is spike at lag one. The other major significant spikes occur at 2nd, 6th and 8th lag as observed from diagram one.

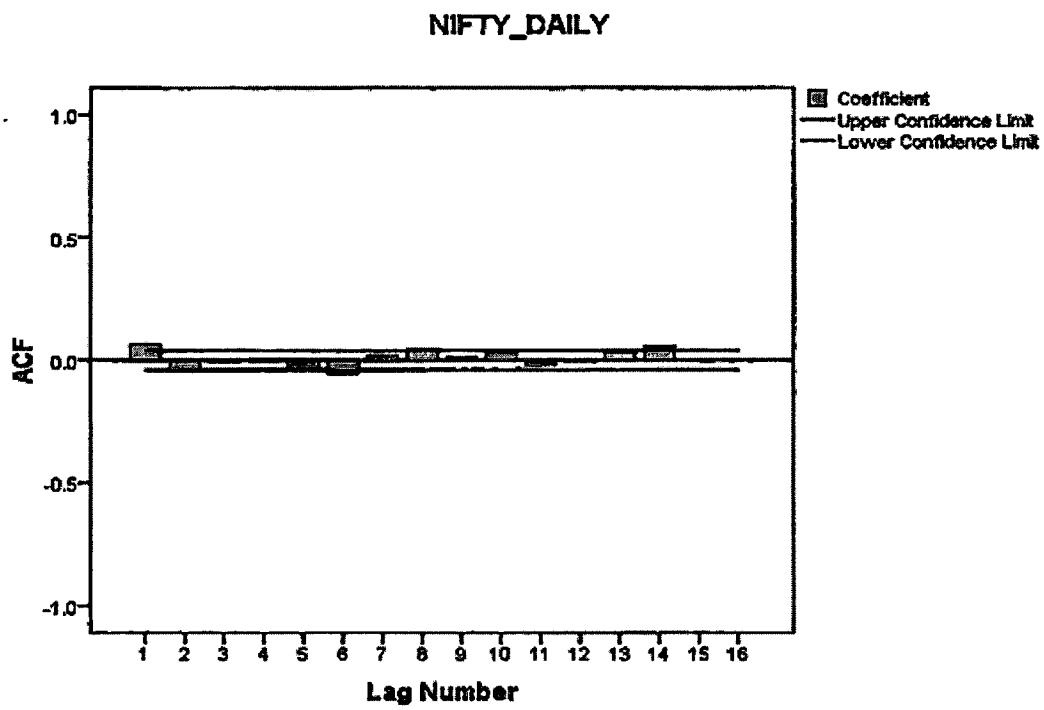


Diagram 1

Further it is also found that the significant autocorrelation is observed at 2nd, 6th and 8th lag at 5% level of significance. When we try to interpret the JB statistics to understand the null hypothesis that the overall serial correlation coefficients from lag one to lag ten is rejected at 5% level of significance as well as at 1% level of significance as reported in table 1 of this paper..

All these are contrary to the efficient market hypothesis which states that the efficient market is the one which immediately reflects the impact of news on the price and consequently return of the securities.

SERIAL CORRELATION TESTS: Monthly Return Series

The monthly index data series is analysed by taking return from July 2003 to June 2013. The results are reported in table 2 for the purpose of interpretation.

The Z values from the table 2 shows that the autocorrelation is not significant for any lag individually as the Z value is less than 1.96 for all the lags. When we consider the overall significance of autocorrelation by using LB statistics, it is noted in the table 2 that the overall autocorrelation is not significant for any lags up to 10 lags.

Table 2

Monthly- NIFTY	**Serial Correlation Test Result**				
Lags	AC	S.E.	Z-statistics	LB Statistics	Prob
1	.054	.090	0.6	.360	.549
2	.002	.090	0.022222	.360	.835
3	.050	.089	0.561798	.672	.880
4	.153	.089	1.719101	3.619	.460
5	-.063	.089	-0.70787	4.130	.531
6	-.155	.088	-1.76136	7.230	.300
7	-.010	.088	-0.11364	7.244	.404
8	-.083	.087	-0.95402	8.155	.418
9	.042	.087	0.482759	8.387	.496
10	-.008	.087	-0.09195	8.395	.590

The same facts can be observed by taking a look at the correlagram which is shown in diagram 2. All these indicators tell us that the stock market of India does not show any significant autocorrelation for the monthly return series. It is expected as the month time is very long and it is highly unlikely that previous month event would affect this month value of the share price.

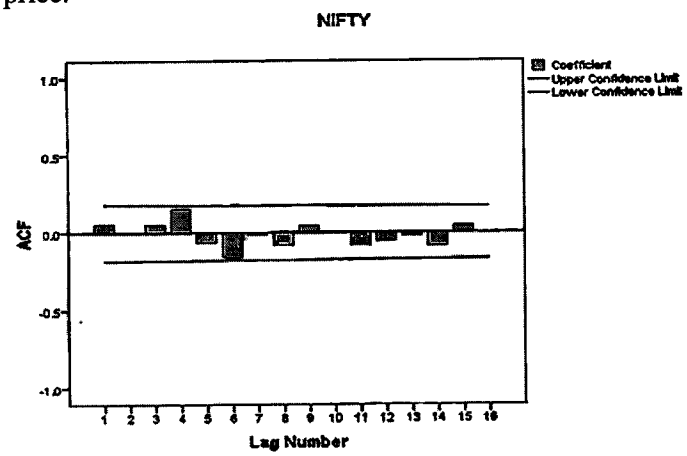


Diagram 2

SERIAL CORRELATION TESTS: Daily Return Series

The results are same as we found in case of NIFTY, the significant spikes are reported for 1st, 2nd, 6ht and 8th lag. The Ljung-Box test for upto 10 lags finds the presence of autocorrelation because the p-value is close to zero. It also indicates that the Indian stock market is not weak form efficient.

Table 4

DAILY- SENSEX	Serial Correlation Test Result				
Lags	AC	S.E.	Z-statistics	LB Statistics	Prob
1	.069	.020	3.45	11.872	.001
2	-.043	.020	-2.15	16.517	.000
3	-.007	.020	-0.35	16.638	.001
4	-.004	.020	-0.2	16.679	.002
5	-.028	.020	-1.4	18.675	.002
6	-.047	.020	-2.35	24.169	.000
7	.015	.020	0.75	24.776	.001
8	.052	.020	2.6	31.725	.000
9	.019	.020	0.95	32.650	.000
10	.027	.020	1.35	34.553	.000

The same fact can be observed from the correlogram where the value of ACF is moving outside the specified limits and there is spike at lag one. The other major significant spikes occur at 2nd, 6th and 8th lag as observed from diagram 3.

Run test

The empirical result of the run test for daily and monthly return series is given in table 3. The run test is another measure to identify the randomness of the data. The overall results of run test based on 1%, 5% and 10% level of significance does not give any conclusive evidence of randomness in the return series of the Indian stock market. Further, on the basis of previous test of autocorrelation, the signals are more towards non randomness in the daily return series which indicates that the Indian stock market is not weak form efficient.

On the other hand, when we interpret the monthly return data of NIFTY for the randomness by using run test, we get the results as shown in table 3.

Table 3

	N2(Minus)	N1(Plus)	N(Total)	R(Actual)	Z test	P-value
DAILY						
NIFTY	1192	1306	2498	1204	-1.741	.082
MONTHLY						
NIFTY	58	62	120	68	1.297	.195

We do not reject the null hypothesis of randomness of the return series even at 10% level of significance. It means monthly data reflects the randomness and it is weak form efficient. This result is in line with the autocorrelation result which also showed that the monthly weak form efficiency of the stock return. It means both the methods of knowing weak form efficiency give the same results for the monthly return series.

SENSEX – EMPIRICAL ANALYSIS

The results of the data analysis of SENSEX return series are given in the following paragraphs.

Descriptive Statistics

The mean and standard deviation of the daily return is 0.00071 and 0.0162 respectively. The negative skewness and excess kurtosis is also found for the daily return series indicating non normality of return series. The monthly return series has 0.014 and 0.0747 value of mean and standard deviation respectively. This series is also found to be non normal.

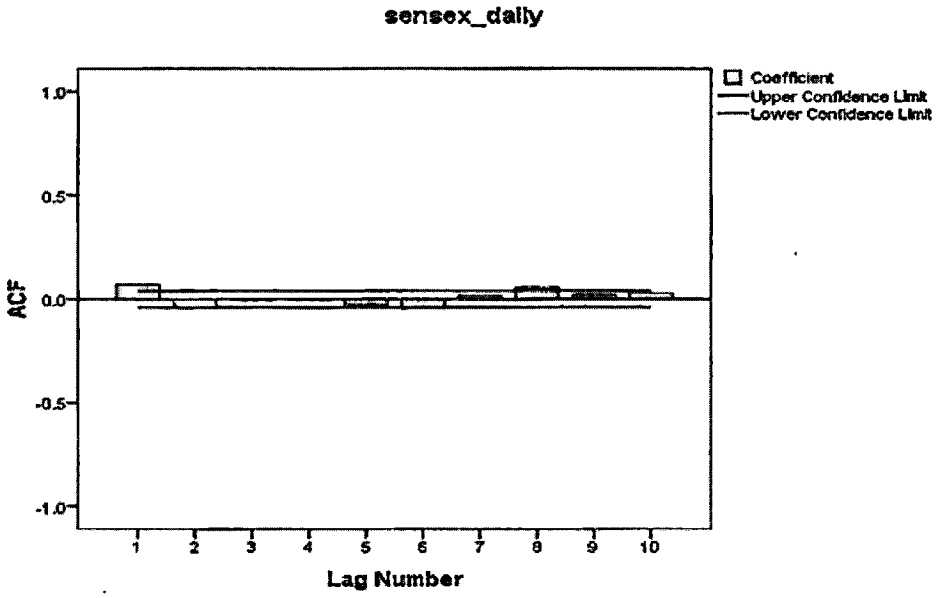


Diagram 3

We can infer that the Indian stock market is not weak form efficient in terms of daily stock index return series.

SERIAL CORRELATION TESTS: Monthly Return Series

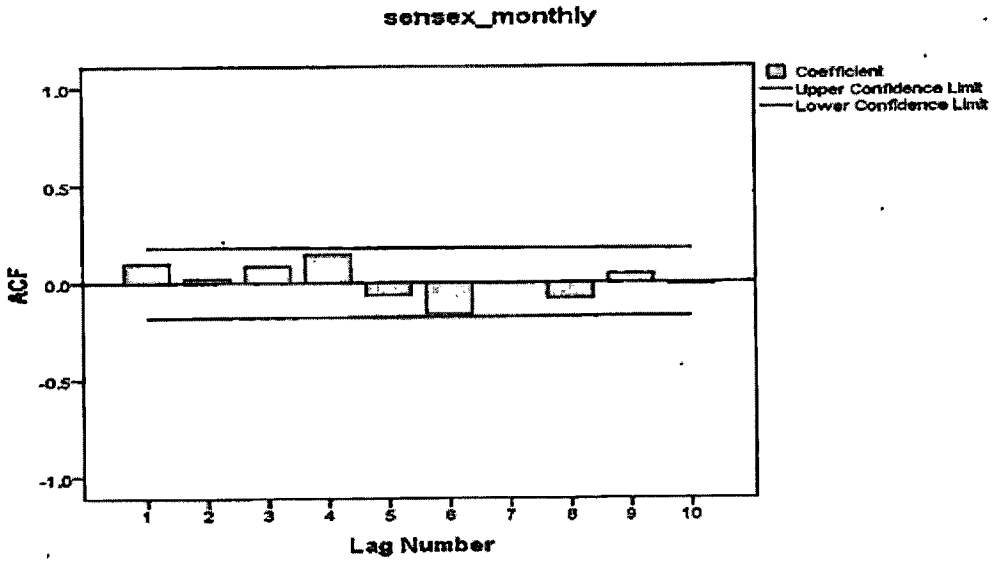
The monthly index data series for SENSEX also shows the results which were found for NIFTY return series. The Z values from the table 5 shows that the autocorrelation is not significant for any lag individually as the Z value is less than 1.96 for all the lags. When we consider the overall significance of autocorrelation by using LB statistics, it is noted in the table 5 that the overall autocorrelation is not significant for any lags upto 10 lags.

Table 5

Monthly- SENSEX	**Serial Correlation Test Result**				
Lags	AC	S.E.	Z-statistics	LB Statistics	Prob
1	0.1	0.09	1.111111	1.233	.267
2	0.02	0.09	0.222222	1.281	.527
3	0.083	0.089	0.932584	2.150	.542
4	0.146	0.089	1.640449	4.831	.305

5	-0.065	0.089	-0.73034	5.373	.372
6	-0.162	0.088	-1.84091	8.723	.190
7	-0.007	0.088	-0.07955	8.728	.273
8	-0.081	0.087	-0.93103	9.591	.295
9	0.042	0.087	0.482759	9.822	.365
10	-.011	.087	-0.12644	9.839	.455

The same facts can be observed by taking a look at the correlagram which is shown in diagram 4. All the values are lying within the given limits and no spikes are found.



Run test

The empirical result of the run test for daily and monthly return series is given in table 6. We reject the null hypothesis of randomness at 5% and 10% level of significance for the daily return series. It shows that the Indian stock market is not weak form efficient as found by the autocorrelation test and run test of NIFTY.

Whereas the monthly data of SENSEX return series does not reject the null hypothesis of randomness. Here also the results are in same tune as were found for NIFTY.

Table 6

	N2(Minus)	N1(Plus)	N(Total)	R(Actual)	Z test	P-value
DAILY						
SENSEX	1205	1313	2518	1196	-2.464	0.014
MONTHLY						
SENSEX	60	60	120	66	.917	.359

It means both the methods of knowing weak form efficiency give the same results for the monthly return series.

5. SUMMARY AND CONCLUSION

This study was undertaken to test the weak form efficiency of Indian stock market. The data included the index data of national stock exchange of the India, i.e. NIFTY and SENSEX covering the time period from July 2003 to June 2013 i.e. for 10 years. The data was converted into logarithmic return by taking log of closing index value and then taking first difference of it. The log return instead of simple return was used due to its superior properties and taking cue from the recent literature which invariably uses logarithmic return for analysis purpose.

The two methods were used to test the weak form efficiency: serial correlation test and run test. In case of serial correlation, from one through ten lags were taken for analysis. The decision to take lags up to ten was on the basis of review of literature.

Thus the overall result of both serial correlation and run test provide us the conclusive evidence regarding the weak form inefficiency of the Indian stock market. The daily return data series shows the presence of autocorrelation in the data series even upto 10 lags for both NIFTY and SENSEX. The significant spikes were observed at 1st, 2nd, 6th and 8th lag and it reflects that the news has its impact on the stock return even a week later. It is the sign of weak form inefficiency of Indian stock market. The same results were provided by run test for daily return series. Thus, we can conclude that the Indian stock market is weak form inefficient on the basis of daily return series. It means an investor can earn excess returns by observing the past information about the market because past affects the future return over some time period.

The analysis of the monthly data showed the conclusive evidence for the weak form

efficiency in the Indian stock market. When we used the autocorrelation test, the results showed us no autocorrelation between the lagged values of the return even upto ten lags. It means there is no pattern to detect for the monthly data which behaves randomly. This outcome was further checked by using the run test which also showed the randomness in the data overwhelmingly. Thus the investors cannot use the monthly data to detect any pattern in the return series and earn some excess profits.

On the basis of our results, we can conclude that the Indian stock market is not weak form efficient and traders can use the recent past data to earn excess returns. As of now, the recent data affects the stock returns whereas distant data which is monthly data does not contain any pattern in it. It means that on an average it takes one month for the market to consume the news and reflect it in the stock market. The weak form inefficiency is the most common feature of emerging markets. This is the task of the regulators to introduce some more measures to bring more and more efficiency in the Indian stock market.

The weak form inefficiency has a lesson for corporate governance. One of the pillars of the effective corporate governance is to enable shareholders take an informed decision. When there is an information asymmetry as represented by the weak form inefficiency of Indian stock market, it is hard to imagine investors making right decision on the basis of market prices reflected in the stock prices. Thus, the efforts should be made by the state to bring more and more efficiency in the stock market so as to reflect the true value of the share price and help prospective as well existing investors make the right decisions.

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