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WEAK-FORM EFFICIENCY IN INDIAN STOCK MARKET INDEX

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ABSTRACT

This study examines the random walk hypothesis to determine the validity of weak-form efficiency for one of the major stock market in India. Daily returns from February 1, 2008 to December 30, 2011 of the Nifty Index are used in this study. To verify the normality of the data series, Anderson-Darling Normality test was taken and visualized the skewness and kurtosis. The results reveal that Anderson-Darling Normality test rejects the normal distribution of Indian Stock Market, because they are positively skewed and leptokurtic and to verify the weak-form of efficiency four statistical tests, namely a serial autocorrelation test, an Augmented Dickey-Fuller unit root test & a non-parametric runs test were applied for this purpose. The statistical tests are conducted for full sample period. The empirical results of this study support previous studies that Indian stock markets are weak-form inefficient. Thus excess returns can be earned in the long run by using investment strategies based on historical share prices.

Keywords: Weak-form market efficiency, random walk, runs test, Nifty.

JEL codes: C12, C14, D53, G14

1. INTRODUCTION

According to Efficient Market Hypothesis (EMH), historical trends, publicly available information, and insider information cannot be used to generate abnormal return from securities because they are already reflected in the current market price. Nevertheless, investors have been using historical data and publicly available information to build strategies which allow them to earn abnormal return from market anomalies. The evidences of market anomalies prove that EMH has a gap that is unable to explain some market phenomena.

So, efficient market theory and the random walk hypothesis have been major issues in financial literature, for the past thirty years after the research contribution of Fama (1965, 1970). However, Fama is considered one of the most important researchers who set the foundation and discussed in depth the market efficiency and the random walk theory. A market is said to be efficient if it responds immediately and accurately to all available information. On the other hand, the random walk theory asserts that stock price movements

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are unpredictable and it follows a random erratic behavior. Therefore, past stock price movements are of no use to predict future price movements.

Kendall (1953) is considered one of the earlier scholars who suggested that stock prices move randomly. Later on, Fama (1965) concluded also that price changes are random and past movements were of no use in predicting future movements. This could be an indication that financial markets operates with high degree of efficiency (Gitman, Joehnk, and Smart 2011, 324). Fama (1970) suggested that investors can be confident that a current market price fully reflects all available information about a security and the expected returns based upon this price is consistent with its risk.

There are three major versions of the hypothesis: the weak–form, the semi-strong-form, and the strong-form EMH. The weak-form of the EMH assumes that current stock prices reflect all security market information, including the historical sequence of prices, rates of return, trading volumes, and other market generated information. Therefore, we should gain little from using any trading rules that decides whether to buy or sell a security based on past rates of return, or any other past market data. On the other hand, the semi-strong-form of the EMH asserts that security prices adjust rapidly to the release of all public information. Therefore, it implies that investors who base their decisions on any important new information after it is public should not derive above average risk–adjusted profits from their transactions. However, the strong-form of the EMH is the most extreme form. It states that security prices fully reflect all information from public and private sources. This means that no investor has a monopolistic access to information relevant to the formation of prices. Therefore, no investor will be able to consistently derive above-average risk-adjusted rates of return.

Presence (or absence) of a random walk has important implications for investors and trading strategies, fund managers and asset pricing models, capital markets and market efficiency, and consequently financial and economic development as a whole. Trading strategies, for example, differ when returns are characterized by random walks or by positive autocorrelation (or persistence) over short horizons and negative autocorrelation (or mean reversion) over long horizons. In this instance, and as the investment horizon lengthens, an investor would invest more (less) in stocks if the relative risk aversion is greater (less) than unity, than if the returns were serially independent.

Over recent decades, there has been a large body of empirical research concerning the validity of the random walk hypothesis or weak-form efficient market hypothesis with respect to stock markets in both developed and developing countries. Empirical research on testing the random walk hypothesis has produced mixed results.

There have been a few previous studies concentrated on testing for efficiency of the Indian stock markets (e.g., Dr. T. R. Bishnoi and Bhanu Pant; A. C. Worthington and & H. Higgs 2005; Hamid, Suleman, Shah & Akash 2010; K. Venkatesan 2010 etc).

The objective of this study is to test the random walk hypothesis or weak-form efficient market hypothesis on the behavior of the Indian equity market. It utilizes multi-approaches, specifically, unit root, runs and variance ratio tests.

This study uses most recent daily observations of NIFTY index for four years covering the period of the global financial crises.

This study is organized into six sections as follows: Section 2 describes the Index Nifty, while section 3 addresses the literature review. On the other hand, section 4 presents the data and illustrates the research methodology. Section 5 reports the empirical findings. Finally, section 6 provides the concluding remarks.

2. INTRODUCTION OF MARKET INDEX S & P CNX NIFTY

The S&P CNX Nifty, also called the Nifty 50 or simply the Nifty, is a stock market index and benchmark index for Indian equity market. Nifty is owned and managed by India Index Services and Products Ltd. IISL), which is a joint venture between NSE and CRISIL (Credit Rating and Information Services of India Ltd). IISL is India's first specialized company focused upon the index as a core product. IISL has marketing and licensing agreement with Standard & Poor’s for co-branding equity indices. 'CNX' in its name stands for 'CRISIL NSE Index'.

S&P CNX Nifty has shaped up as the largest single financial product in India, with an ecosystem comprising: exchange traded funds (onshore and offshore), exchange-traded futures and options (at NSE in India and at SGX and CME abroad), other index funds and OTC derivatives (mostly offshore).

The S&P CNX Nifty covers 22 sectors of the Indian economy and offers investment managers exposure to the Indian market in one portfolio. The S&P CNX Nifty stocks represent about 67.27% of the free float market capitalization of the stocks listed at National Stock Exchange (NSE) as on September 30, 2012.

The S&P CNX Nifty index is a free float market capitalization weighted index. The index was initially calculated on full market capitalization methodology. From June 26, 2009, the computation was changed to free float methodology. The base period for the S&P CNX Nifty index is November 3, 1995, which marked the completion of one year of operations of NSE’s Capital Market Segment. The base value of the index has been set at 1000, and a base capital of Rs 2.06 trillion. The S&P CNX Nifty currently consists of the 50 major Indian companies.

This study used nifty index to test the random walk behavior and the weak-form of efficiency of the Indian stock market.

3. REVIEW OF LITERATURE

There have been an extensive number of empirical researches investigating the weak-form of market efficiency for different financial markets around the world, but this study is restricted to Indian markets, so the literature review related to it is summarized in the following table.

Table 1: Literature Review

S. No.	Study done by	Markets Under Study	Period of Study	Methodology Used	Results Found
1	S.K. Chaudhuri (1991)	India	1988-1990	Serial Correlation, Run test.	Study indicates that market does not seem to be efficient even in its weak form.
2	Sunil Poshakwale (1996)	India	1987-1994	Serial Correlation, Run test, KS test.	Evidence concentrating on the weak form efficiency and the mean returns except for the Monday and wednesday are positive.
3	Bhanu Pant and T. R. Bishnoi	India	1996-2000	Unit Root test, Autocorrelation, Variance Ratio.	The random walk hypothesis for daily and weekly market indices returns was not accepted.
4	Ashutosh Verma (2005)	India	1996-2001	Serial Correlation	Over all the market is weak form efficient
5	Lee at al. (2010)	32 developed and 26 developing countries	January 1999 to May 2007	-	Stock markets are not efficient.

4. DATA & METHODOLOGY

Lo and MacKinlay (1988) suggest the use of a variance-ratio (VR) statistic to test the random walk hypothesis. However, this procedure is not sufficient on its own to assess weak-form efficiency. In fact, when the random walk hypothesis is rejected, the alternative hypotheses are that the series analyzed are serially correlated. Therefore, further testing must be completed to provide an accurate assessment of weak-form efficiency. This has been commonly done with unit root tests and runs test.

4.1 Data

The dataset of daily stock returns of Indian equity market represented by the Nifty index was obtained from the official web site of the national stock exchange (www.nse.com). The data consist of the periods covering daily returns from February 1, 2008 to December 30, 2011. Returns are calculated by the difference of two successive log daily price of the nifty index:

$$R_t = \ln P_t - \ln P_{t-1} \qquad (1)$$

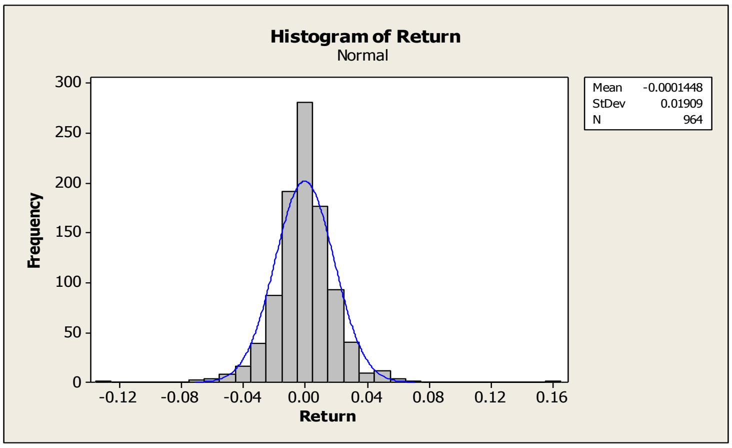
Where P_t and P_{t-1} are the closing prices of stock index at time t and t-1 respectively and ln is the natural logarithm.

In order to obtain a better understanding of the behavior of stock prices, a preliminary analysis of the data is carried out in this section. Figure 1 shows the plot of the return data based on the index covering the aforesaid period. It is clear from this plot that the data exhibit medium volatility during this period. Figure 1 shows the time series plots of the Nifty Index where the logs of daily closing prices are used. As we can see the market experienced negative returns throughout the year 2008 due to impact of the global financial crisis and shown recovery in 2009 and thereafter the returns are almost flat.

Fig. 1: Time Series Plots of Nifty Index in logarithm

Summary statistics of Nifty Index series of Indian stock market are presented in Table 2, using Minitab. These include mean, maximum, minimum, standard deviation, skewness, kurtosis, Anderson-Darling Normality Test, and probability value.

Table 2: Descriptive Statistics for Stock Price Index of Indian Stock Market



Variable	Return
Count	964
Mean	-0.000145
StDev	0.019095
Minimum	-0.130142
Median	0.000111
Maximum	0.163343
Skewness	0.26
Kurtosis	8.45
A-Squared	9.06
P- Value<	0.005

Estimates are given for the period 2008-2011. The returns are positively skewed. The level of kurtosis is greater than three. The positive skewness implies that the stock index returns are flatter to the right compared to the normal distribution. However, positive skewness and high kurtosis indicate that there is strong departure from normality in the unconditional distribution of the return. The Anderson-Darling Normality Test rejects the hypothesis of a normal distribution of returns, at a significance level of 1%.

4.2. Research Methodology

As mentioned above, the present study employs Auto Correlation and Ljung- Box statistics, Unit root tests & Runs test. A brief description of these tests is provided in this section.

4.2.1 Auto Correlation and Ljung-Box Statistics

The serial autocorrelation is used to test the relationship between the time series its own values at different lags. If the serial autocorrelation is negative it means it is mean reverting and accepts the null hypothesis and if the result is positive coefficients then it rejects the null hypothesis. Another technique that will be use is Ljung-Box. The Ljung-Box test is based on the autocorrelation plot. However, instead of testing randomness at each distinct lag, it tests the "overall" randomness based on a number of lags.

H_0 : The data are random

H_a : The data are not random

$$Q_{LB} = (n(n+2) \sum_{j=1}^{h} \frac{\rho^2(j)}{n-j} \qquad (2)$$

where n is the sample size, ρ(j) is the autocorrelation at lag j, and h is the number of lags being tested.

4.2.2. Unit Root Tests

Unit root tests are commonly used to test the stationary property of a time series data. In this study two different unit root tests are employed to test the null hypothesis of a unit root. These tests are the Augmented Dickey-Fuller (ADF) test & the Phillips-Perron (PP) test. However, under the assumption of the random walk, the price series must have a unit root while the return series must not.

Test statistics can be based on the OLS estimation results from a suitably specified regression equation. For a time series $Y_{t,}$ two forms of the "augmented Dickey-Fuller" regression equations are:

$$\Delta Y_{it} = \alpha_{0i} + \theta_i Y_{it-1} + \alpha_{i1} + \sum_{j=1}^{p} \delta_{ij} \, \Delta Y_{it-j} + \varepsilon_t \qquad (3)$$

$$\Delta Y_{it} = \alpha_{0i} + \theta_i Y_{it-1} + \sum_{j=1}^{p} \delta_{ij} \, \Delta Y_{it-j} + \varepsilon_t \qquad (4)$$

where ε_t for t = 1, . . . ,N is assumed to be Gaussian white noise. Equation (1) is with-constant, no-trend and (2) is with-constant, with-trend. The number of lagged terms p is chosen to ensure the errors are uncorrelated.

When $\alpha_1 = 0$ the time series Y_t is non stationary so that standard asymptotic analysis cannot be used to obtain the distributions of the test statistics.

4.2.3 The Runs Test

Until Wright's (2000) work on the rank and sign VR test, the runs test was the most commonly used non-parametric test of the RWH. It does not require that return distributions are normally or identically distributed and, the condition that most stock return statistics cannot satisfy. At the same time, it eliminates the effect of extreme values often found in the return data. This provides a solid alternative to parametric serial correlation tests in which distributions are assumed to be normally distributed.

Runs test is a non-parametric test that is designed to examine whether successive price changes are independent. A run can be defined as a sequence of consecutive price changes with the same sign. The non-parametric run test is applicable as a test of randomness for the sequence of returns. Accordingly, it tests whether returns in Nifty index is predictable.

To perform this test, let, n_a and n_b respectively represent observations above and below the sample mean (or median), and *r* represents the observed number of runs, with $n=n_a+n_b$.

$$Z(r) = \frac{r - E(r)}{\sigma(r)} \qquad (5)$$

The expected number of runs can therefore be calculated by employing the following formula:

$$E(r) = \frac{n + 2\, n_a n_b}{n} \qquad (6)$$

The standard error is represented by :

$$\sigma E(r) = \sqrt{\left[2 \frac{n_a n_b (2 n_a n_b - n)}{n^2 (n-1)}\right]} \qquad (7)$$

Because returns are not normally distributed, the presence of structural breaks or outliers in the series can bias the test results. To control for such issues, we complete the runs test using a mean as a base. However, using the median can yield more reliable results when there are outliers. The null hypothesis for this test is for temporal independence in the series.

5. THE EMPIRICAL TESTS RESULTS

5.1 The Results of Auto Correlation and Ljung Box Statistics.

To analyze the randomness of the return series we used serial autocorrelation and Ljung-Box Q-statistics.. For autocorrelations, one can examine the t-statistic (T) or the Ljung-Box Q statistic (LBQ) for a particular lag to test whether or not the corresponding autocorrelation coefficient equals zero. One commonly used rule is that a t-statistic greater in absolute value than 2 indicates that the corresponding autocorrelation is not equal to zero. The t-statistic in Table 3 indicates that the null hypothesis is accepted for all lags except lag 8. If we visualize the autocorrelations at lag 2,3,4,5 & 6 which are negative for Nifty daily returns but hence over different lags it have positive values so we cannot infer that a market is a weak form efficient.

Table 3: ACF & Ljung-Box Statistics

Daily Returns			**Sample Size = 965**			**Index = Nifty**			
Lags	1	2	3	4	5	6	7	8	9
ACF	0.054	-0.01	-0.01	-0.03	-0.05	-0.06	0.039	0.092	0.016
T-St	1.706	-0.562	-0.36	-0.93	-1.57	-1.95	1.213	2.836	0.515
LBQ	2.920	3.240	3.376	4.257	6.78	10.71	12.23	20.56	20.84

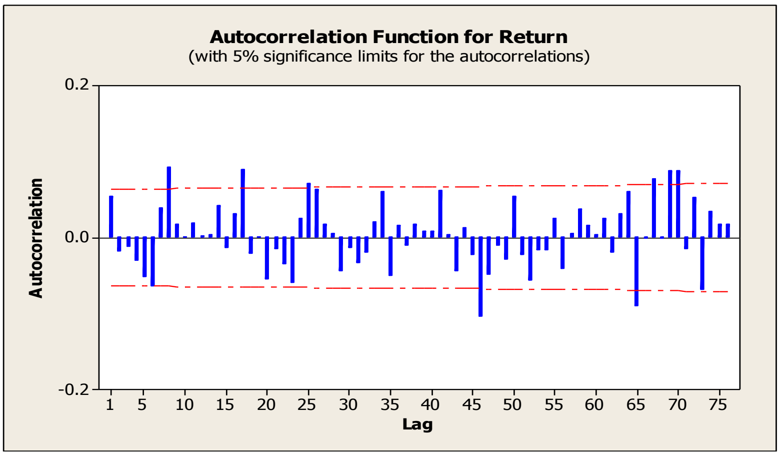


Fig. 2: Autocorrelation Graph

The further analysis requires that whether the time series is non-stationary or stationary. So the unit root test is applied to check the stationarity as a necessary condition for Random walk.

According to the Random walk hypothesis the log price series must have a unit root whereas the returns series must be stationary. For this purpose the Augmented Dickey-Fuller Test (1981) is used to test the stationary of the time series.

5.2 The Results of the Unit Root Test

ADF test was carried on the log of the index using the package SHAZAM. The test was performed in trend and without trend. The results of ADF test are reported in Table no. 4 & 5.

Table 4: ADF Root Test results on the Logarithm of the return at Level

Variable: **Return**

Dickey-Fuller Tests - No. Lags = 0 , Number Of Observations = 965

Null Hypothesis	Test Statistic	Asy. Critical Value 1%	Inference
Constant, No Trend			
A(1)=0 Z-Test	-15.251	-20.6	Do not reject
A(1)=0 T-Test	-3.3479	-3.43	Do not reject
A(0)=A(1)=0	5.6456	6.43	
Constant, Trend			
A(1)=0 Z-Test	-17.567	-29.4	Do not reject
A(1)=0 T-Test	-3.7075	-3.96	Do not reject
A(0)=A(1)=A(2)=0	4.6138	6.09	
A(1)=A(2)=0	6.8769	8.27	

Thus, accept the null hypothesis of presence of unit root in case of return series at 1% level.

Table 5: ADF Root Test results on the Logarithm of the return at Level

Variable – Closing Prices

Dickey-Fuller Tests - No. Lags = 0 , Number Of Observations = 965

Dickey-Fuller Tests

Null Hypothesis	Test Statistic	Asy.Critical Value 1%	Inference
Constant, No Trend			
A(1)=0 Z-Test	-3.8070	-20.6	Do not reject
A(1)=0 T-Test	-1.6037	-3.43	Do not reject
A(0)=A(1)=0	1.3422	6.43	
Constant, Trend			
A(1)=0 Z-Test	-2.4913	-29.4	Do not reject
A(1)=0 T-Test	-0.92118	-3.96	Do not reject
A(0)=A(1)=A(2)=0	1.2383	6.09	
A(1)=A(2)=0	1.8010	8.27	

Thus, accept the null hypothesis of presence of unit root in case of return series at 1% level.

According to Table 4 & 5, the results of ADF test in relation to the return series as well as price series evidence that the Nifty index is non-stationary at order I(0) at 1% level of significance, Therefore, the results are not consistent with the random walk hypothesis. After unit root test we further applied the runs test. The results of the runs test do not depend upon the normality of returns are displayed in Table 6, Runs test is defined as the series of consecutive price changes with the identical sign. The H_0 elucidates that the succeeding price changes are not dependent and moves randomly.

5.2 The Results of the Runs Test

As evidenced in Table 6, the runs test clearly shows that Indian equity market is weak-form inefficient. The estimated Z-values are significant at the 5% level. It implies that the Indian stock market did not follow a random walk and informational inefficient at the weak-form level.

H_0 : The sequence was produced in a random manner

H_a : The sequence was not produced in a random manner.

Runs above and below K = 4796.78

Table 6: Runs Tests with the Mean as a Base

n	n_a	n_b	E(r)	r	□$_r$	$Z_{(r)}$	Sig(2 tailed)
965	605	360	452.4	24	14.51	-29.4	0.000

For a large- sample runs test ($n_1 > 10$ and $n_2 > 10$), the test statistic is compared to a standard normal table. That is, at the 5% significance level, a test statistic with an absolute value greater than 1.96 indicates non-randomness.

Thus the findings of the Runs Test are supporting the non-randomness of Nifty Index .Hence the null hypothesis that successive price changes are independent is rejected.

6. CONCLUSION

This empirical study investigates the weak form of market efficiency in the Indian Stock Market with the help of market index nifty. The sample size consists of 965 daily closing prices. The purpose of the study is to investigate whether the Indian equity markets follows the Random Walk Model or not. No arbitrage profits can be earned if the equity markets are efficient at individual level. To verify the normal distribution of the data we performed Anderson-Darling Normality Test and visualized the skewness and kurtosis. The results reveal that the Anderson-Darling Normality Test rejects the hypothesis of a normal distribution. The skewness indicates that the data is positively skewed. To verify the weak form of efficiency Autocorrelation Test, Unit Root Test, & Runs Test were applied for this purpose. By applying unit root test the results reveal that the data series become non stationary at level. Finally the results of the Autocorrelation & Runs Test indicate that market is weak form inefficient and strongly rejects the null hypothesis of random walk. Therefore, prudent investors will realize abnormal returns by using historical sequences of stock prices, data related to trading volumes and other market generated information.

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