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ARE INDIAN STOCK MARKETS WEAK FORM INEFFICIENT?

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Abstract

The study analyzes the random walk theory by examining the S&P CNX Nifty, CNX 200, and S&P CNX 500 stock indices. Empirical findings reveals rejection of weak form efficiency, suggesting that stock prices in the Indian market do not fully incorporate historical information, rendering the market weak form inefficient. Autocorrelation function and runs test uncover biased behavior rather than randomness, with negative auto-correlation at lag 2 indicating a pattern of overreaction followed by correction. Consequently, opportunities for excess returns arise, contradicting efforts to enhance market transparency. This suggests persistent anomalies, potentially due to information disparities regarding equity holdings.

Keywords: Indian market, Stock prices, Market transparency, Equity holdings, Excess returns.

Introduction

Efficiency lies at the heart of finance, addressing a fundamental and dynamic aspect: the mechanism behind price fluctuations in security markets. Fama's work in 1965 professed that it would not be possible for any individual or institution to earn abnormal returns in an efficient market. As all the available information is already reflected in the stock prices. However, over a period of time the proclamation that no one can earn returns over and above the market returns has been challenged. A lot of empirical studies have provided evidence of existence of consistent abnormal returns. Thereby contradicting the existence of Efficient Market Hypothesis (EMH). Financial literature categorizes market efficiency into three tiers: strong form, semi-strong form, and weak form. In the context of weak-form efficiency, stock prices reflect all the historical information gleaned from market data, often likened to a 'random walk.' According to the Random Walk Hypothesis the stock prices have random patterns akin to a drunkard's erratic stroll, with successive price changes exhibiting independence over time. Consequently, this theory discounts the efficacy of technical analysis in yielding abnormal profits, as discernible trends or patterns would be absent.

In semi-strong form efficiency, the information set expands to encompass all publicly available data. This encompasses various sources such as a company's financial statements (including annual reports, income statements, SEC filings), announcements regarding earnings and dividends, disclosed merger plans, the financial standing of competitors, and anticipations concerning macroeconomic variables like inflation and unemployment. Under this framework, investors are unable to secure superior risk-adjusted returns through either fundamental or technical analysis.

This paper analyzes three popular stock indices to assess the weak-form efficiency in the Indian stock market and to explore the random walk characteristics of the market. This is achieved through the application of the the autocorrelation function ACF (k)and the run test.

1. Review of Literature

***Basu& Morey*(1998)**conducted an investigation into the impact of the economic reforms introduced during the Rajiv Gandhi administration on the Indian stock market. Utilizing non-parametric variance ratio tests over a sample period spanning from July 1957 to October 1996, the study analyzed monthly all-India market price data sourced from the International Financial Statistics (IFS). The study applied variance ratio test to two distinct sub-samples: pre-January 1985 and post-January 1985. This date was chosen as a cutoff point due to significant economic changes towards liberalization occurring in India around the mid-1980s. The findings indicated that from the mid-1980s onward, aggregate equity prices in India exhibited characteristics of a random walk, aligning with Fama's efficient market hypothesis following the onset of economic reforms. However, the study observed a partial setback in this trend following the scam that happened from 1991 to 1992. Empirical analysis suggested that Indian stock prices displayed increased efficiency in the wake of economic liberalization in the mid-1980s. The variance ratio tests, which account for time-varying volatilities, strongly indicated that stock prices began behaving akin to a random walk in the mid-1980s, despite the bulk of liberalization measures being implemented later than this period. These findings echoed Thomas' (1995) discovery of a regime shift in the mid-1980s, contributing to a more efficient financial market.

In his study, Pandey (2003) delves into an analysis of three prominent stock indices with the aim of assessing the efficiency level and discerning the random walk characteristics within the Indian stock market. Utilizing the run test and the autocorrelation function ACF (k), the investigation spans from January 1996 to June 2002, drawing upon daily and weekly closing values of the CNX Defty, CNX Nifty, and CNX Nifty Junior indices.

Through meticulous autocorrelation analysis and the application of the runs test, Pandey concludes that the stock index series in the Indian stock market exhibit attributes akin to biased random time series. Specifically, the autocorrelation analysis reveals a deviation from the random walk model in the behavior of share prices within the Indian stock market. Consequently, the identification of undervalued securities in the market suggests the potential for investors to achieve excess returns by accurately discerning them.

Sarma (2004) studies the weak form efficiency by using an active strategy on the basis seasonal return pattern in the Indian stock market. It examines existence of abnormal returns in the market on the basis of active strategy. Utilizing data from the SENSEX, NATEX, and BSE 200 indices, the study examines the consistency in mean daily log returns and reveals the existence of seasonal trends. The study finds that the 'active strategy' run on SENSEX portfolio and a 'passive strategy' run the BSE 200 portfolio give above normal returns.

Ahmad , Ashraf , Ahmed (2006) examine the weak form market efficiency for daily market index such as Nifty from the National Stock Exchange and the Sensex from the Bombay Stock Exchange spanning the period of 1999-2004. The sample data includes 1,425 observations and is tested for parametric tests such as stationarity test, sample Autocorrelation Function (ACF), Ljung-Box (Q) statistic. The volatility is modelled using GARCH. Additionally, the data was also tested for non-parametric tests such as Run test and Kolmogorov-Smirnov (K-S) test. The non-parametric tests are utilized to assess randomness and normality in stock-price time series.

The market is tested for potential change overtime and is divided into two periods. The first period being from 1999-2001 and the second period from 2002-2004. The first period encompasses events like the end of badla, use of internet, bad trader crises, whereas the second period included introduction of rolling settlement, futures and options in the merket, a bull market, inflows from Foreign Institutional Investor (FII).

The study has found evidence of market inefficiency for both the Nifty and Sensex. It witnesses increased inefficiency and volatility for both the markets. Non-parametric test results find that the distribution of underlying index return series is non-normal, with deviation from normality becoming more pronounced over time. Autocorrelation analysis has shown negative autocorrelation at lag 2, indicating that there an overreaction to information is followed by correction the next day.

The research suggests that enhancing market efficiency could be achieved through promptly disseminating information about Foreign Institutional Investor (FII) trades and equity holdings, alongside improvements in the free float of equity. Despite some deviations, the overarching evidence in the Indian context indicates that successive price changes are largely independent, thereby supporting the applicability of the random walk model in describing stock behavior.

Lo & McKinlay (1988) studied the weekly stock returns to examine weak form efficiency by computing variances from data collected. Their study was conducted from 1962 to 1985 and analysed different sub-periods, utilizing market returns indexes and sorted portfolios. They employed a simple volatility-based specification test for both homoscedastic and heteroscedastic random walks based on variance estimators. Their empirical findings strongly rejected the weak form efficiency for the entirety of the examined period and across all sub-periods. This rejection was particularly pronounced for smaller capitalization stocks. Notably, the variance-ratio test conducted on all individual stocks with complete return histories in the CRSP database for the entire 1216-week sample period revealed that daily returns of individual securities exhibit slight negative autocorrelation.

Although the rejections of weak form efficiency test were primarily driven by the results of small stocks, they couldn't be entirely attributed to factors such as infrequent trading or time-varying volatilities.

Fama (1970) is widely regarded as a key figure in advancing the Efficient Market Theory (EMT). His significant contribution lies in empirically testing EMT by categorizing security prices into three distinct information subsets. Through meticulous examination, he conducted tests for strong, semi-strong, and weak form efficiency. Remarkably, his findings predominantly support the random walk market model, with only minor exceptions. This empirical validation underscores the robustness of EMT across various dimensions of market information.

Objectives

This paper attempts to test if the historical information is reflected in the value stock index by using parametric and non-parametric tests. Testing is also done to examine if successive price changes are independent and identically distributed.

2. Data and Methodology

The period of study is from 22nd Mar. 2004 to 30th Sep. 2015. It consists of daily closing values of three leading stock indices of NSE namely S&P CNX Nifty, S&P CNX 500 and CNX 200. The data has been collected from Thomson Reuters.

The study examines weak form efficiency and tests if the daily changes in market return index are independent and identically distributed.

If successive market return index changes are not independent of one another and are not identically distributed return series, then historical price changes cannot be used to predict future price movements in any meaningful way. In this paper, Autocorrelation function and non-parametric runs test are used for testing the weak form market efficiency of the Indian stock market.

Autocorrelation Function (ACF)

Autocorrelation is used as a statistical tool to measure the dependency between successive index market returns in the given return series. It is used to measure the dependence between index market return changes. It measures the linear dependency between index market returns in a time series Ym_t that are separated by lag f. The autocorrelation function ACF(f) for the time series Ym_t and the f-lagged series Y_{t-f} is defined as:

ACF(f) $=\sum_{(t=1-f)}^{n}(y_t - y)(y_{t-f} - y)/\sum_{(t=1)}^{n}(y_t - y)^2$

The value of the standard error of ACF(f) is given by:

$$Se_{ACF(k)} = 1/\sqrt(n)$$

To test whether ACF (f) is significantly different from zero, the following distribution of 't' is used, i.e.

t=ACF (f)/ $Se_{ACF(k)}$.

For market index return, ACF (f) decline successively as the lag value (f) increases over time. Also, ACF (f) of the tested time series should be statistically insignificant when t is a random walk series. A stochastic time series goes up and down over a period of time. Also, it may be difficult to estimate if a trend exists in the given return series. To determine whether a series is stochastic or not the t-test is applied on the series of first differences. If the market index changes are independently distributed, ACF(f) will not be significant for different lag periods.

In this study autocorrelation is conducted upto lag 30 to see relation of market index with 30 consecutive days.

Run Test

The Run test, classified as a non-parametric test, focuses solely on the direction of price changes rather than their magnitude and does not necessitate specifying a probability distribution. It primarily examines the directionality of changes within a time series.

In a market index return series, three directional movements are possible: positive, negative, or neutral. As a result, three types of runs can occur. A positive run represents a sequence of consecutive positive market index changes. Conversely, a negative run signifies a sequence of consecutive negative market index changes. Similarly, a neutral run consists of a series of unchanged market index value. If the mean runsare significantly different from the observed run count, the run test shows inefficient stock market.

Also a very low count of runs means that the market initially overreacted and then subsequently corrected itself, whereas an unexpected higher count means a delayed response to information. Both the situations give opportunity for abnormal returns in the stock market. Under the first hypothesis successive runs are independent and the number of runs is normally distributed with:

Mean Run $=\frac{2N_{M1}N_{M2}}{N_M}+1$

Variance of Runs

$= 2N_{M1}\,N_{M2}(2N_{M1}\,N_{M2} - N_M)/(N_M)^2(N_M - 1)$

Where, N_M= total number of observations

N_{M1}= number of positive symbols

N_{M2}= number of negative symbols

R = total number of runs

The null hypothesis that the successive return series is independent is possible if R lies within the following confidence interval and rejects the hypotheses otherwise [Gujarati 2003]:

Prob(E(R) – 1.96σR ≤ R ≤ E(R) + 1.96σR) = 0.95

The run test uses the Z statistic to calculate the probability of difference between the actual and expected number of market index runs. If the Z value is greater than or equal to ± 1.96, the null hypothesis is rejected at 5 per cent level of significance.

3. Findings

The empirical results for autocorrelation between market index returns are presented in Table 1. The ACF of daily changes till lag 30 of the three indices are shown. For all the three stock market indices, the autocorrelation coefficient for lag 1, lag 8, lag 14 and lag 17 are larger than twice the standard error i.e 0.03934 (=2* 0.01967), 0.03743 (=2*0.018715) and 0.037444 (=2*0.018722) respectively. Thus the autocorrelation between the three market indices is significantly different from zero. From the table, it can be observed that out of all the autocorrelations for respective three stock indices, 14 values are greater than the twice the deviation i.e. differ significantly from zero. Also, the results show that for all the three market indices lags are highly auto-correlated.

Another interesting observation is the negative autocorrelation at lag 2 which indicate that the market initially has an overreaction.Result for all the three market indices show a negative autocorrelation at lag 2 across the period of study. A negative autocorrelation indicates anindex value reversal. This phenomenon can be attributed to corrections following overreactions that often manifest on the first day of information arrival. This suggests that all three indices display overreactions one day after new information emerges, followed by corrections on the subsequent day.

Ahmad, Ashraf, Ahmed (2006) also found evidence that after over-reaction in the market initially the second day a correction is observed in the market index. Similar results are also reported for other countries.

Table 1: Autocorrelations of Daily Changes in stock Indices

Lag	S&P CNX Nifty	CNX 200	S&P CNX 500
1	0.063	0.1	0.108
2	-0.044	-0.031	-0.028
3	-0.011	0.001	0.005
4	-0.002	-0.002	0
5	-0.027	-0.022	-0.022
6	-0.041	-0.037	-0.036
7	0.016	0.021	0.021
8	0.041	0.042	0.04
9	0.027	0.035	0.037
10	0.029	0.037	0.041
11	-0.021	-0.026	-0.023
12	-0.011	-0.008	-0.012
13	0.036	0.037	0.04
14	0.061	0.066	0.07
15	-0.01	-0.001	-0.006
16	-0.014	-0.012	-0.008

17	0.06	0.06	0.058
18	-0.017	-0.016	-0.007
19	-0.015	-0.011	-0.019
20	-0.051	-0.05	-0.047
21	-0.011	-0.007	-0.008
22	-0.016	-0.01	-0.013
23	-0.008	-0.011	-0.008
24	0.012	0.01	0.012
25	0.033	0.031	0.03
26	0.027	0.024	0.028
27	-0.009	-0.005	-0.014
28	0.001	0.002	0.007
29	-0.029	-0.017	-0.025
30	-0.012	-0.01	-0.01

Table 2 shows that the computed t-values of the three stock market indices.The results show that the autocorrelations between lags of all the three markets are significantly different from zero. Also, the corresponding t-values are greater than 1.96 (at 5% level of significance).

T-test rejects the hypothesis that there are zero autocorrelations between lags of all the three markets at 5 per cent level. Also ACFs Nifty are in addition to lag 1, 8 , 14 and 17 are significant at 2, 6, & 20 lags as well. S&P CNX 500 is also significant at 10, 13 & 20.Thus, it can be said that the stock market indices are biased stochastic time series and the Indian stock marketsare not weak form efficient in pricing its securities.

Table 2: ‘t’ values for stock indices given by t=ACF (k)/ SeACF(k)

Lag	S&P CNX Nifty	CNX 200	S&P CNX 500
1	3.202847	5.34322	5.768656
2	-2.23691	-1.6564	-1.49558
3	-0.55923	0.053432	0.267067
4	-0.10168	-0.10686	0
5	-1.37265	-1.17551	-1.1751
6	-2.08439	-1.97699	-1.92289
7	0.813421	1.122076	1.121683
8	2.084392	2.244152	2.136539
9	1.372649	1.870127	1.976299
10	1.474326	1.976991	2.189953

11	-1.06762	-1.38924	-1.22851
12	-0.55923	-0.42746	-0.64096
13	1.830198	1.976991	2.136539
14	3.101169	3.526525	3.738944
15	-0.50839	-0.05343	-0.32048
16	-0.71174	-0.64119	-0.42731
17	3.05033	3.205932	3.097982
18	-0.86426	-0.85492	-0.37389
19	-0.76258	-0.58775	-1.01486
20	-2.59278	-2.67161	-2.51043
21	-0.55923	-0.37403	-0.42731
22	-0.81342	-0.53432	-0.69438
23	-0.40671	-0.58775	-0.42731
24	0.610066	0.534322	0.640962
25	1.677682	1.656398	1.602404
26	1.372649	1.282373	1.495577
27	-0.45755	-0.26716	-0.74779
28	0.050839	0.106864	0.373894
29	-1.47433	-0.90835	-1.33534
30	-0.61007	-0.53432	-0.53413

To verify the above results the study also tests all the three market indices for runs test. The run test examines the hypothesis that market index changes are independent.

Table 3: Run Analysis of Daily Changes in Stock Indices

Particulars	S&P CNX Nifty	CNX 200	S&P CNX 500
Total Cases	2852	2855	2853
Number of Runs	1349	1267	1261
Z	-2.6194	-5.454524	-5.58885

The Z-statistic for Nifty does not reject the hypothesis of weak formmarket efficiency at 5 per cent. However, for other two indices it rejects the hypothesis of weak form efficiency.

4. Conclusion

The foundational assumption of the random walk theory is that the stock prices are stochastic time series and are independently and identically distributed. However, the empirical analysis conducted on the S&P CNX Nifty, CNX 200, and S&P CNX 500 stock indices challenges this notion and reject weak form efficiency during the study period. The findings of this study provide evidence that the prices do not incorporate all the historical information and the markets are weak form inefficient. Through auto-correlation analysis and runs test, it's revealed that the stock index series in the Indian market exhibit bias rather than randomness. Notably, negative auto-correlation at lag 2 suggests a pattern of overreaction one day after new information surfaces, followed by subsequent correction the next day. Consequently, opportunities for excess returns emerge as certain securities appear undervalued, allowing astute investors to capitalize on them. These results seemingly contradict recent endeavors aimed at enhancing market functionality and transparency. It implies that certain anomalies persist, potentially contributing to market inefficiency, such as disparities in information dissemination regarding equity holdings and Foreign Institutional Investor (FII) trades. While the study acknowledges limitations, such as the absence of high-frequency data, employing sophisticated econometric models could facilitate a deeper comprehension of stock market movements.

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