Indian Stock Market Efficiency Before and After the Introduction of Derivatives

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Introduction

Market efficiency has influence on the investment strategy of an investor because if the market is efficient, trying to pick up under valued or over valued stocks will not be possible, because, in an efficient market there will be no undervalued or over valued stocks. This implies that stocks will not offer higher than deserved expected returns, given their risk. On the other hand if the market is not efficient, excess returns can be made by correctly picking the stocks. In this paper an analysis of stock indices of National Stock Exchange (NSE) is carried out to test the efficiency of Indian stock market and the randomness of stock price movement in the stock market using various tests.

The Random walk Hypothesis is concerned with the question of whether one can predict the future prices from the past prices. This theory states that the price change cannot be predicted from the earlier changes in any meaningful manner. Successive price changes in the stocks are independent over the time and price changes occur without any significant trends or patterns as technicians say. This is just opposite of what technical analyst say. So we can conclude past prices contain no useful information about the future price behavior.

It says that changes in price show randomness. Attempts were made to explain the empirical results with concepts in economics and this led to the development of the more general theory of efficient markets.

Efficient Market Hypothesis (EMH) states that security prices fully reflect all available information. There are three forms of EMH, namely (A) Weak form; (B) Semi strong form; (C) Strong form based on the type of information taken for analysis namely the past prices, publicly available information and insider's information. The weak form of EMH says that the current price reflects the information implied by the past prices. This form is otherwise called as Random Walk Hypothesis (RWH). The semi strong form of EMH states that the current stock prices not only reflect the information implied in the past prices but also all publicly available information and the stock prices adjust rapidly to any new information. The strong form of EMH states that the security price, not only reflect the publicly available information but also those insiders information that have not been published.

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In an efficient market at any given point of time the prices reflect all available information, so one can expect that the current price of the security is a good estimate of its intrinsic value. In the real world situation the intrinsic value cannot be determined precisely, because of the difference of opinion among the investors, which implies the actual price lies above or below the intrinsic value randomly for a very short span of time which the investors cannot capitalize on. In a dynamic economy the intrinsic value keeps on changing as new information hit the market. As said earlier if the changes in price are instantaneous for any new information then the successive prices will be independent.

In Developing countries

It is usually believed that the markets in developing and less developed countries are not efficient in semi-strong form or strong form. It is very much convenient to test the weak form efficiency of the market rather than semi-strong form and strong-form efficiency. The test of semi strong form and strong form efficiency is very rare in less developed countries because of absence of sufficient data in a convenient form, structural profile, inadequate regulations, and lack of supervision and administrative lacks in the implication of existing rules. In addition, company's information are released and circulated before the annual report is officially available; the annual reports of some of the listed companies are mistrusted and are often result of rumors circulating in the market about the companies.

The empirical research on market efficiency can be divided into two broad categories; one is technical analysis, which is mainly concerned with testing for availability of exploitable information in past security prices, this is widely used in examining the weak form efficient market hypothesis. The other is fundamental analysis, which rests on the assumption that factors other than past security prices are relevant in the determination of the future prices. This weak form of EMH is tested to determine the existence of predictability using past return series or price information, so as to use technical trading rules to design profit making strategy. The aim of the study is to test the share price behavior in NSE. The research restricts attention exclusively for Weak form of EMH or return predictability using time-series analysis of stock return behavior in an emerging market before and after the introduction of derivatives in India.

Methodology

Tests of weak form of EMH have come from the random walk literature. So the researchers were primarily interested in testing whether or not successive price changes are independent of each other by employing statistical tools. In this study the researchers have used the following test for testing the market efficiency.

Run test analysis

Run test is a non-parametric test. This test considers the sign of the price changes and not the values as such. Statistical tests based on theory of runs do not consider the absolute values

but consider only their directions. This test does require the specification of the probability distribution.

A run is defined as a sequence of price changes of same sign, preceded or followed by price changes of different signs. In case of stock indices or stock prices there are three possible types of price changes, they are: increase or decrease or no change in prices. This implies we can have three types of runs, positive runs, negative runs and no change runs.

Under the hypothesis that the successive price changes are independent and the sample proportions of positive, negative and no change runs are unbiased estimates of the population proportions, the expected number of runs can be computed by using the following formula proposed by Wallis and Roberts(1956).

$$M = \frac{N(N+1) - \sum_{i}^{3} n_i^2}{N}$$

Where

M= Expected number of runs

n_i = Number of price changes of each sign(i=1,2,3)

N = Total number of price changes

The standard error of expected number of runs of all signs is given by

$$\sigma = \left[\frac{\sum_{i=1}^{3} n_i^2 \left(\sum_{i=1}^{3} n_i^2 + N(N+1) \right) - 2N \sum_{i=1}^{3} n_i^3 - N^3}{N^3 (N-1)} \right]^{0.5}$$

When N is sufficiently large, the sampling distribution of expected number of runs of all types is approximately normally distributed with mean M and standard error ó. The difference between the actual number of runs and expected number of runs is expressed by standard normal variable Z.

$$Z = \frac{R + 0.5 - M}{\sigma}$$

Where R is the total number of observed runs of all signs

Autocorrelations and ACF (k):

Autocorrelation is one of the statistical tools used for measuring the dependence of successive terms in a given time series. Hence it has been widely used to measure dependence in successive share price changes. Autocorrelation has been the basic tool used to test the weak form of EMH.

The **autocorrelation function** ACF(k) for the time series Yt and the k lagged series Yt-k is defined [Stephen A. DeLurgio, 1998 p- 67] as:

$$ACF(K) = \left[\frac{\sum_{t=1-k}^{n} (Y_t - \bar{Y})(Y_{t-k} - \bar{Y})}{\sum_{t=1}^{n} (Y_t - \bar{Y})^2} \right]$$

Where $\bar{Y}$ is the overall mean of the series with n observations.

The standard error of ACF (k) is given by:

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

When n is sufficiently large (n ≥ 50), the approximate value of the standard error of ACF (k) is given by:

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

To test whether ACF (k) is significantly different from zero, the following distribution of t is used;

$$T = ACF(K)/Se_{ACF(K)}$$

As it is true for random walks, trends are also characterised by extremely high autocorrelation. For both random walk series and series with trends, autocorrelation ACF (k) are very high and decline slowly as the lag value (k) increases. At the same time the ACF (k) of the first difference series (price changes or returns) are statistically insignificant when the series is a random walk series. A random walk series drifts up and down over time. In some situations it may be difficult to judge whether a trend or drift is occurring. Hence to determine whether a series has significant trend or whether it is a random walk, the t-test is applied on the series of first differences.

Variance Ratio Test

The variance ratio test (Lo and MacKinlay 1988) is used to measure the randomness of markets pre and post liberalization. The test is based on one of the properties of the random walk process, specifically that the variance of the random walk increments must be a linear function of a time interval, say q. The variance ratio is computed by dividing the variance of returns estimated from longer intervals by the variance of returns estimated from shorter intervals, (for the same measurement period), and then normalizing this value to one by dividing it by the ratio of the longer interval to the shorter interval. For independent identically distributed returns rt,q the variance Var(rt,q) must be equal to q times the variance of rt,1. A variance ratio that is greater than one suggests that the returns series is positively serially correlated or that the shorter interval returns trend within the duration of the longer interval. A variance ratio that is less than one suggests that the return series is negatively serially correlated or that the shorter interval returns tend toward mean reversion within the duration of the longer interval.

The variance ratio is calculated as:

$$VR(q) = \frac{Var(r_{t(q)})}{qVar(r_r)}$$

We need to calculate the variance of the longer and the shorter horizons using the following formulae:

$$\sigma^2(q) = \frac{1}{m}\sum_{k=q}^{nq}(P_k - P_{k-q} - q\bar{\mu})^2$$

$$\sigma^2(1) = \frac{1}{nq-1}\sum_{k=q}^{nq}(P_k - P_{k-1} - \bar{\mu})^2$$

Where

$$m = q(nq - q + 1)(1 - \frac{q}{nq})$$

$$\bar{\mu} = \frac{1}{nq}\sum_{k=1}^{nq}(P_k - P_{k-1})$$

$$= \frac{1}{nq}(P_{knq} - P_0)$$

The test statistic under the hypothesis of homoscedasticity is:

$$Z(q) = \frac{VR(q) - 1}{(\phi(q))^{0.5}}$$

Where

$$\phi(q) = \frac{2(2q-1)(q-1)}{3q(nq)}$$

The above formulation is consistent with the use of overlapping q period returns and is corrected for the correlation that arises as a result of the overlap. The test statistic robust to heteroscedasticity as defined in Urrutia (1995) is:

$$Z^*(q) = \frac{VR(q) - 1}{(\phi^*(q))^{0.5}}$$

Where

$$\phi^*(q) = \sum_{k=1}^{q-1}\left(\frac{2(q-k)}{q}\right)^2 \bar{\delta}(k)$$

Sample Period

The data required for the study would be collected for a period of ten years, from June 1996 to March 2006 i.e. Five years before the introduction of derivatives in National Stock exchange and five years after the introduction. Data could not be collected for all the indices and for all the stocks for the given period of time as a few indices came into existence much later in that case they data for those indices were taken from the date of introduction of the indices.

Interpretation of results

The run test is performed by comparing the actual number of runs with the expected number of runs. The following hypothesis is set for the analysis purpose:

H0 : The price changes are in a random manner

H1 : The series of price changes are dependent

If the observed number of runs are not significantly different from the expected number of runs one can conclude that the successive price changes are independent, and on the other hand if there is statistically significant difference between the expected and the observed runs, then one can conclude that the series of price changes are dependent.

The hypothesis was tested for the above mentioned six indices and the results for the six indices are as given below in the table:

Run test on daily closing value of stock indices of NSE before the introduction of derivatives

Index	n1	n2	n3	N	R	M	Z
CNX Nifty	508	493	1	1002	447	502.89	-1.11
Nifty Junior	509	493	0	1002	433	501.87	-1.36
CNXIT	546	456	0	1002	422	497.96	-1.52
Bank Nifty	53	57	0	110	58	55.93	0.05
CNX 500	143	113	0	256	111	127.24	-0.32

Where

N = Total Number of observations

n1= Number of increases

n2= Number of decreases

n3= Number of neither increases nor decreases

R = Total number of observed runs

M = Total number of expected runs

ó = Standard error

Z = Standardized Variable

The results show that all the indices of NSE show weak form of market efficiency as their Z value is in between -1.96 to 1.96 which is not significant at 5% significance level. Which means that the information regarding yesterday's indices are effectively absorbed by today's indices incase of all the five indices. This indicates that in case of the above five indices the component stocks are efficient in absorbing information regarding prices. The inclusion of appropriate stocks in the NSE indices, efficient functioning and widening base of the stock exchange may be reasons behind this efficiency.

Run test on daily closing value of stock indices of NSE after the introduction of derivatives

Index	n1	n2	n3	N	R	M	Z
CNX Nifty	801	655	3	1459	651	726.19	-1.51
Nifty Junior	819	638	2	1459	614	721.27	**-2.17**
CNXIT	747	697	1	1445	718	723.63	-0.10
Bank Nifty	768	691	0	1459	695	728.47	-0.66
CNX 500	826	628	3	1457	621	719.03	**-1.99**
CNX 100	481	338	0	819	355	398.02	-0.87
CNX Midcap	781	536	1	1318	531	638.22	**-2.21**

The results show that the following indices of NSE show weak form of market efficiency. They are **CNX Nifty, CNXIT, Bank Nifty, CNX 100.** While the remaining indices do not show weak form of efficiency during the period of study. The information regarding yesterday's indices are effectively absorbed by today's indices incase of the earlier four indices but not so incase of the other three indices. This indicates that in case of the above four indices the component stocks are efficient in absorbing information regarding prices. The inclusion of appropriate stocks in the NSE indices, efficient functioning and widening base of the stock exchange may be reasons behind this efficiency. which is The results regarding **Nifty Junior, CNX 500, CNX Midcap** is different, having Z value of -2.17, -1.99, -2.21 respectively significant at 5% level.

Autocorrelation

To further verify the weak form of efficiency; in this chapter autocorrelations are computed. Further standard errors of the autocorrelations are computed and significance tests are carried out after computing the corresponding t- values for the stock indices and the stocks. The population autocorrelation coefficient is estimated using the sample autocorrelation coefficient. For complete independence the population autocorrelation coefficient must be zero. Hence the variation of sample autocorrelation coefficient from zero is a significant test for dependence/independence of random variables in a series. We transform the series by taking the first difference and compute the autocorrelations. If no significant autocorrelations are found in the series, the series is considered random. Autocorrelations of the daily changes in the stock indices and stock are given below.

Auto correlation test on daily closing value of stock indices of NSE before the introduction of derivatives

Lag	Nifty	T Nifty Junior	CNXIT
1	0.577561	**3.796573**	**8.316308**
2	-0.13484	0.322345	**4.117458**
3	0.280273	0.815309	**2.109456**
4	-0.37885	-1.74995	-0.80472
5	-0.59513	0.245024	-0.32964
6	**-2.15453**	-1.30975	-1.27062
7	0.428414	0.434416	-0.47328

Lag	T Nifty	T Nifty Junior	T CNXIT
8	0.332184	1.108785	**3.39782**
9	1.146622	1.698026	**2.697704**
10	2.263441	4.327368	3.098718
11	-1.10402	0.368547	1.773094
12	-0.8566	-0.69001	1.403607
13	-0.37066	0.243073	1.074889
14	0.053916	1.494691	1.771813
15	0.004786	1.394752	0.546739
16	-0.42806	0.052808	-0.95365
17	1.2246	0.394134	0.540041
18	**-2.75495**	-0.69116	0.490586
19	-0.42448	0.258311	-1.4789
20	-0.50608	-1.03073	-0.40671
21	0.714077	-0.30183	-0.15594
22	-0.62021	1.207505	0.630663
23	0.900972	1.069466	**2.406694**
24	0.728687	1.571544	1.221302
25	0.145737	0.444476	1.365956
26	-1.81775	-1.50905	0.031586
27	-0.19596	-0.00039	1.270041
28	-0.56061	-1.01048	-0.52007
29	-1.19997	-1.15363	-0.59981
30	-0.10191	-1.81914	-0.97208

From the above table we can see that the autocorrelation differs significantly from zero for lags of 6,10 and 18 incase of Nifty, for lags of 1,10 in case of Junior Nifty, for lags of 1,2,3,8,9,10 and 23 in case of CNXIT, before the introduction of derivatives in National stock exchange. This clearly shows that the indices do not reflect weak form of efficiency and trading strategies can be formulated by investors to gain abnormal returns.

Auto correlation test on daily closing value of stock indices of NSE after the introduction of derivatives

Lag	Nifty	Nifty Junior	CNXIT	T Bank Nifty	CNX 100	CNX 500	CNX Midcap
1	**4.363159**	**6.365212**	1.390329	**4.788587**	**3.761808**	**4.378139**	**7.050705**
2	**-4.02367**	**-2.94474**	-1.51689	**-3.47164**	**-4.16414**	**-3.46637**	**-4.03229**
3	1.411313	0.891618	-0.83943	0.155997	1.279323	1.746041	1.31083
4	**3.900103**	**3.072014**	1.636434	1.030189	**2.684681**	**3.502542**	**4.168273**
5	0.867705	0.862153	-0.19575	-1.07442	-1.06737	1.097562	1.351452
6	-1.81899	-0.75672	-0.52035	**-2.23147**	-1.82335	-0.41159	-0.11646
7	-1.14022	-1.38923	-1.52284	0.766934	-0.42289	-0.75305	-1.17617
8	-0.86609	-1.24773	0.462345	-1.05994	-1.27014	-0.52446	-0.13803
9	1.146855	**2.349466**	0.192043	0.937835	0.477441	-0.12794	0.732576
10	1.912496	**3.196284**	1.490442	**3.861244**	**3.112642**	1.106798	**2.370814**
11	-0.43135	0.525654	**2.763581**	-0.86008	-0.08438	1.447041	0.683358
12	-1.44083	0.179662	-0.70732	-1.60077	-0.86482	-1.05011	-1.1229
13	0.72444	1.20073	0.985934	0.115918	0.866775	0.981105	**2.381982**
14	**2.464779**	**3.631991**	1.308177	0.682911	1.339971	**1.964997**	**2.472138**
15	-1.06508	0.080598	**-2.11208**	-1.02381	-1.90338	-0.28239	-0.22718
16	-1.76852	-0.78833	-1.10248	-0.40857	-1.84248	-1.80546	-0.86152
17	-0.03638	1.198196	0.239983	0.352462	0.340589	-0.41067	-0.09699
18	1.296096	0.402235	0.749307	0.755978	0.574056	0.883	0.614641

Lag	Nifty	Nifty Junior	CNXIT	T Bank Nifty	CNX 100	CNX 500	CNX Midcap
19	-0.1579	-0.24369	-1.92432	1.10976	0.341253	-0.40766	0.876217
20	-1.18071	-0.86074	**-2.44344**	-0.96392	0.358792	-1.53648	-1.25209
21	1.06915	1.413354	**2.813686**	-1.87517	0.860381	1.948722	1.095708
22	0.502634	-1.33939	0.263221	-0.14478	0.763831	0.583806	0.821771
23	1.217184	0.293373	0.583652	-0.44875	0.16786	-0.17753	0.887964
24	1.681255	1.263572	-0.27829	-0.36227	2.141637	0.460701	1.36336
25	-0.58135	0.509857	-0.59	1.177904	-0.39086	0.724673	0.683268
26	-0.77432	-0.41192	1.268256	-0.32857	-0.69867	-0.10977	0.793421
27	1.244717	1.532444	**2.418287**	-0.51427	1.374997	0.875293	**1.979093**
28	-0.6965	0.313734	-1.72886	0.10541	0.321103	-1.15797	1.3305
29	**-2.19705**	-1.70137	-1.79968	**-2.19072**	**-2.41591**	**-2.29189**	**-2.55651**
30	**-2.31041**	-0.71111	-1.53682	-0.62096	**-2.7608**	**-2.62298**	**-2.4017**

From the above table we can see that the autocorrelation value differs significantly from zero for lags of 1,2,4,14,29 and 30 incase of Nifty , for lags of 1,2,4,9,10,14 in case of Junior Nifty, for lags of 11, 15 20,21,27 in case of CNXIT, for lags of 1,2,4,10,24,29,30 in case of CNX100, for lags of 1,2,10,29 in case of BankNifty, for lags of 1,2,4,14,29,30 in case CNX500 and for lags of 1,2,4,10,13,14,27,29,30 incase of Midcap. This clearly shows that the indices do not reflect weak form of efficiency and trading strategies can be formulated by investors to gain abnormal returns.

Variance-Ratio Test

To further test the efficiency of the Indian stock market, I first apply the standard variance ratio test of Lo and MacKinlay (1988). If a given time series follows a random-walk process, the variance of its w-differences of overlapping stock prices is w times the variance of its first difference. Following Lo and MacKinlay (1988) as well as Campbell *et al*. (1997), I use overlapping (as opposed to non-overlapping) w-period returns in estimating the variances in order to obtain "a more efficient estimator and hence a more powerful test," Campbell *et al*. (1997, p. 52). An estimated variance ratio (VR) less than one implies negative serial correlation, while a variance ratio greater than one implies positive serial correlation.

I also employ two other related statistics: the asymptotic normal Z test statistic (assuming

homoscedasticity), and the heteroscedasticity-consistent Zc test statistic. Lo and MacKinlay (1988) demonstrate that both test statistics asymptotically follow standard normal distributions and they are thus amenable to conventional statistical inferences. Extensive Monte Carlo results reported in Lo and MacKinlay (1989) suggest that, under the heteroscedastic random-walk null, the Zc test performs better than either the Box-Pierce test of serial correlation or the Dickey- Fuller test of unit roots.

6.2 Indices

Variance ratio test on daily closing value of stock indices of NSE before the introduction of derivatives

W	VR		
	Nifty	Nifty Junior	CNXIT
2	1.017956	1.115954	1.2768
3	1.023866	1.159286	1.465037
4	1.033393	1.197984	1.605717
5	1.036038	1.198266	1.696917
6	1.03097	1.204482	1.762602
7	1.007384	1.198656	1.805238
8	0.995805	1.198426	1.849337
9	0.98998	1.211096	1.913651
10	0.990407	1.2301	1.982296
11	1.004168	1.269531	2.061911
12	1.00986	1.307542	2.152969
13	1.01156	1.339232	2.244697
14	1.010673	1.368344	2.333131
15	1.011319	1.402302	2.422595
16	1.011288	1.437229	2.509449

W	VR		
	Nifty	Nifty Junior	CNXIT
17	1.009143	1.464653	2.592691
18	1.01117	1.486796	2.678307
19	1.003677	1.503325	2.758751
20	0.995798	1.520921	2.834026
21	0.98616	1.534573	2.905584
22	0.979571	1.548174	2.971099
23	0.973471	1.563784	3.032508
24	0.969988	1.577739	3.090979
25	0.968159	1.593739	3.14419
26	0.967328	1.60943	3.191789
27	0.963048	1.619319	3.233952
28	0.958536	1.627407	3.283694
29	0.952765	1.632251	3.331188
30	0.945077	1.637259	3.381621
50	0.949894	1.771229	4.816083
100	0.902851	1.686945	5.040501
200	1.055053	1.992307	5.555309

Across these intervals, the variance ratio tests for both CNXIT and NIFTY JUNIOR indices indicate the presence of positive serial correlation in the daily returns. For example, the variance ratio for the NIFTYJUNIOR (CNXIT) market corresponding to w=2 is 1.12 (1.28). This implies a 12% (28%) first-order autocorrelation in the daily returns and hence a percentage of next day's return variance can be predicted by the current day's return. The evidence from the Z and Zc test generally concurs with the variance-ratio results. In case of NIFTY the variance ratio is closer to unity, which means the market shows weak form of efficiency generally. This is the market scenario before the introduction of derivatives.

Variance ratio test on daily closing value of stock indices of NSE after the introduction of derivatives

w	Nifty	Nifty Junior	CNXIT	VR Bank Nifty	CNX 100	CNX 500	CNX Midcap
2	1.10871	1.157266	1.001289	1.121497	1.122743	1.110079	1.186264
3	1.078173	1.160453	0.996438	1.106678	1.076969	1.097022	1.180348
4	1.085339	1.175026	0.9934	1.106129	1.082887	1.096226	1.196992
5	1.127405	1.213757	1.025476	1.114517	1.118355	1.12608	1.251645
6	1.160193	1.245366	1.048974	1.112474	1.130614	1.15156	1.300433
7	1.170461	1.262549	1.061794	1.09636	1.124923	1.166873	1.336648
8	1.173275	1.271181	1.075144	1.091726	1.119525	1.178042	1.3582
9	1.172215	1.27124	1.12226	1.08243	1.105675	1.18203	1.375382
10	1.178104	1.283799	1.120847	1.080434	1.101902	1.185664	1.393423
11	1.191988	1.308802	1.114499	1.097179	1.117223	1.195939	1.419219
12	1.202703	1.331581	1.114648	1.107478	1.129495	1.210666	1.443582
13	1.207155	1.352316	1.116779	1.112524	1.137714	1.220879	1.462172
14	1.213973	1.375424	1.11523	1.118279	1.149094	1.232016	1.488382
15	1.22702	1.405878	1.110948	1.123122	1.162736	1.247287	1.51763
16	1.235432	1.433528	1.104284	1.125679	1.169367	1.260903	1.544077
17	1.238023	1.455122	1.098737	1.127253	1.16892	1.2687	1.56539
18	1.241344	1.478095	1.094841	1.130012	1.169173	1.273556	1.585485
19	1.247351	1.499573	1.093559	1.134559	1.170866	1.278703	1.605016
20	1.251757	1.51798	1.091956	1.142024	1.173772	1.283109	1.624583
21	1.253389	1.53378	1.091345	1.146473	1.177956	1.285527	1.640325
22	1.257338	1.55202	1.090425	1.146693	1.185452	1.291917	1.65868
23	1.262488	1.566229	1.088594	1.147363	1.195519	1.299447	1.67778
24	1.269304	1.57951	1.08387	1.146494	1.204938	1.306473	1.69787

w	Nifty	Nifty Junior	CNXIT	VR Bank Nifty	CNX 100	CNX 500	CNX Midcap
25	1.279485	1.594827	1.078962	1.144391	1.219732	1.314481	1.720347
26	1.289177	1.610604	1.074368	1.145496	1.232652	1.323033	1.743126
27	1.29734	1.62542	1.070364	1.146894	1.24389	1.331621	1.766306
28	1.30746	1.642356	1.067022	1.147733	1.258226	1.341013	1.79222
29	1.316275	1.65938	1.06282	1.14881	1.272749	1.348979	1.819648
30	1.321291	1.673444	1.058682	1.14559	1.280411	1.353232	1.841585
50	1.382817	1.820018	1.081686	1.08254	1.429353	1.3623	2.087741
100	1.846574	2.618626	1.01529	1.235538	1.954258	1.815027	2.686179
200	2.162152	4.135916	1.222351	1.513183	2.109283	2.433175	3.413201

Across these intervals, the variance ratio tests for all the indices indicate the presence of positive serial correlation in the daily returns. For example, the variance ratio for the NIFTY (CNX100) market corresponding to w=2 is 1.11 (1.12). This implies a 11% (12%) first-order autocorrelation in the daily returns and hence a percentage of next day's return variance can be predicted by the current day's return. The evidence from the Z and Zc test generally concurs with the variance-ratio results. This is the market scenario after the introduction of derivatives

Conclusion

The assumption that the stock prices are random is basic to the Efficient Market Hypothesis and Capital Asset Pricing Models. The study carried out here has presented evidence against the weak form of efficiency of the Indian stock market. Runs test, autocorrelation test and variance ratio test are used to test the efficiency of the market. From these tests we are able to conclude that the series of stock indices in the Indian stock market are biased random time series. The autocorrelation analysis and variance ratio test indicates that the behavior of share prices does not confirm the applicability of the random walk model in the Indian stock market. Thus there are undervalued securities in the market and the investors can always make excess returns by correctly picking them.

Reference

- Barua S.K and Ragunathan V.(1987) "Inefficiency and speculation of the Indian Capital Market," *Vikalpa,* Jul-Sept.
- Chowdhury S.K. (1991) Shorn run Share price behavior: New evidence on Weak Form Market Efficiency, *Vikalpa,* Vol. V

- Kularni S.N (1978) " Share price behavior in India: A spectral analysis of Random walk hypothesis", Sankhya.Vol.40.
- Obaidullah M. (1990) "Stock market efficiency: A statistical Inquiry", *CFA*
- Sharma J.L. And Robert E. Kennedy (1977) "A comparative analysis of stock price behavior on the Bombay, London and New York stock exchanges", *Journal of finance and quantitative analysis.* Sep 1977.
- Sunil Posakwale(1996) " Evidence of weak form efficiency and the day of the week effect in the Indian stock market." *Finance India*, Vol X No.3
- Branes Paul, (1986), "Thin trading and stock market efficiency: A case of the Kuala Lumpur Stock Exchange", *Journal of Business Finance & Accountin* , volume 13(4) winter , pp. 609-617.
- Butler, K.C., and Malaikah, S.J., (1992), "Efficiency and inefficiency in thinly traded stock markets: Kuwait and Saudi Arabia", *Journal of Banking and Finance*, vol. 16, pp. 197-210.
- Chan Kam C. Gup Benton E., and Pan Ming-shiun, (1992) , "An Empirical Analysis of Stock Prices in Major Asian Markets and United States", *The financial Review*, vol-27, no-2, May1992, pp-289-307.
- Chou, Y. L., (1969), *Statistical Analysts*. London: Holt Rinehart and Winston.Chow, V.K., and Denning, K.D., (1993), "A simple multiple variance ratio test", *Journal of Econometrics,* vol., 58, pp. 385-401.
- Claessens Stijin, Dasgupta Susmita, and Glen Jack, (1995); "Return behaviour in emerging Stock Market", *The world Bank economic Review*, vol.9, no.1, Pp. 131-151.
- Cootner, P., (1962), "Stock Prices: Random vs. Systematic Changes", *Industrial Management Review,* vol. 3, spring, pp.24-45.
- Damodar N. Gujarati, (1988), *Basic Econometrics*, second edition, Mcgraw –Hill Book company, P.691.
- Dickinson and Muragu , (1994), " Market Efficiency in Developing Countries: A case study of the Nairobi Stock Exchange", *Journal of Business Finance & Accounting*, volume 21(1) January, pp. 133-150.
- Fama, E. (1965), "The behavior of Stock Market Prices", *Journal of Business*, vol 38 , p.34-105. (1970), " Efficient Capital Markets: A review of theory and Empirical Work", *Journal of Finance*, vol-25, no-2(May,1970), Pp.383-417.
- Fama, Eugune F.,and Kenneth R.French, (1988), "Permanent and temporary components of stock market prices", *Journal of Political Economy*, vol. 96, pp-246-273.
- Fishe, R.,T.Gosnell, and D. Lasser, (1993), "Good news, bad news, volume and the Monday effect", *Journal of Business Finance & Accounting* 20, 881-892.
- Ghandi, D.K. , A. Saunders and R. S. Woodward (1980) , "Thin Capital Markets: A case study of the Kuwait Stock Market " *Applied Economics*, vol-12, (1980). pp.341-349.
- Goldsmith, Raymond W. "Capital Markets and Economic Development", *National*

symposium on Development of Capital Markets, September 1971.

- MA. Hudson, Robert. Dempsey, Michael and Keasey, Kevin., "A note on the weak-form efficiency of capital markets: The application of simple technical trading rules to UK Stock prices-1935 to1994", *Journal of Banking & Finance*, vol.20, Pp. 1121-1132.
- Hussain, Fazal, (1996), " Stock price Behaviour in an Emerging Market: A case Study of Pakistan", *Ph D thesis*.The Catholic University of America.
- Jagadeesh, N., (1990), "Evidence of predictable behavior of security returns", *Journal of Finance*, vol.45, no-3,Pp.881-898.
- Kendall, M. G., (1943), *The advanced Theory of Statistics*, Vol.1, London: Griffin.