EMPIRICAL STUDY OF WEAK FORM OF EFFICIENCY IN THE INDIAN STOCK MARKET AT INDEX LEVEL AND SCRIP LEVEL

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ABSTRACT

This paper makes an attempt to critically analyze the market efficiency in its weak-form. The data were abstracted from official website of BSE and NSE of India, for the period from 1 April, 2002 to 31 March, 2010. The study is done at index level viz. SENSEX and Nifty, and at scrip level. The battery of most popular tests has been used to arrive at its conclusion. The batteries of popular test intensively used for the study are Autocorrelation Test, Unit Root Tests (ADF Test and PP Test) and Runs Test. The results of the study lead us to conclude that the Indian stock market is representing the weak-form of efficiency in either index or at scrip level.

INTRODUCTION

Stock market being described as a barometer of the economy, has been attracting considerable attention especially during the post reform period per se. Trading activities in the stock market is extremely sensitive owing to the formidable function of stock market that it efficiently allocates capital through setting prices which reflect the legitimate values of securities traded. In an economy like India, efficient allocation of scarce capital and encouragement of foreign investments are both of vital importance. The success of increasing adaptation of liberalized policies and increased liberalization of the economy will depend on the presence of an active and efficient stock market.

A market is said to be efficient if it preludes the share price in relation to new information. The expected price of a security at the end of one period from today, given today's stream of information, is equal to today's price compounded at some expected return in commensurate with the risk level of the security. Expected Price / Information = Current Price + Return for Risk. There are three types of market efficiency construed on the basis of information as weak-form of efficiency later documented as random walk model, semi-strong form of efficiency known as event-study model and third form of efficiency is strong-form of efficient market.

On the ground work of past recorded data, the potential market is defined that is termed as weak-form level of efficiency. In other words, past price movements of the share price is reflected over forthcoming share prices is known as weak form of market efficiency as it provides the past back information which merely everybody knows well in advance. Efficient Market Hypothesis is one of the controversial issues in the financial literature.

LITERATURE REVIEWS

In India, some empirical studies emphasized market inefficiency- Chaudhuri (1991), Belgaumi (1995), Poshakwale (1996), Dash (1998), Madhusoodanan (1998), Kamath (2002), Pant and Bishnoi (2002), Sarkar and Mukhopadyay (2002), Marisetty (2003), Pandey (2003), Verma (2005), Khan, Ashraf and Ahmed (2006), Gupta and Basu (2007), Gupta and Siddiqui (2009) Mishra and Pradhan (2009), on the contrary some emphasized market efficiency- Barua (1981), Sharma (1983), Gupta (1984), Yalawar (1986), Ranganathan and Subramanian (1993), Vaidyanathan and Gali (1994) Rao and Geetha (1996), Vigg et al (2008), Padhan (2009).

Turning to international stock markets, there are some practical evidences supporting the efficient market hypothesis- Seiler and Rom (1997), Chaudhuri

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(2003), Gillette (2005), Joshi et al (2005), Bechev and Gechev (2006), Simons and Laryea (2006), Worthington (2006), Bogdan et al (2007), Cooray and Wickremasinghe (2007), Aga and Kocaman (2008), Marashdeh and Shrestha (2008), Torun and Kurt (2008); while some does not- Law (1982), Lo and Mackinlay (1988), Maxym (2000), Mobarek and Keasey (2000), Hassan (2003), Nagayasu (2003), Islam (2005), Chakraborty (2006), Frimpong et al (2008), Magnus et al (2008).

A brief review of literatures mentioned above illustrates that even when one group fails to reject random walk hypothesis, the others may actually reject it. Therefore, execution of research applying a variety of tests to different types of data will improve the accuracy of the study and further the understanding about informational efficiency.

OBJECTIVES AND HYPOTHESES

The main objective of the study is to empirically test the weak-form of efficiency of Indian stock market. In India, there are two prominent stock exchanges namely, the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). Therefore, the specific objectives of the study are as follows:

(i) to study the weak form of efficiency of Bombay Stock Exchange;
(ii) to study the weak form of efficiency of National Stock Exchange and
(iii) to study the weak form of efficiency at firm level for fifteen companies chosen purposively from the list of companies representing S&P CNX Nifty during the study period.

For the purpose of studying the above objectives, two sets of hypothesis have been developed and tested for entire sample data that successive stock price changes are independent and the price changes are identically distributed random variable. In other words, the joint null hypothesis and alternative hypothesis is given below:

(a) H0 = the share price series is weak-form efficient.
(b) H1 = the share price series is not weak-form efficient.

If successive price changes are independent of one another and are identically distributed random variable, then, historical price changes cannot be used to predict future price movements in any meaningful way. Thus, past stock price movements would not be useful for improving investment performance.

DATA AND METHODOLOGY

The span of data covers the period from 1 April, 2002 to 31 March, 2010. The data for the purpose of study have been collected from the official websites of the Bombay Stock Exchange and the National Stock Exchange. To maintain uniformity, the data of fifteen companies have been chosen out of fifty companies which maintained their respective positions in the constituent of the S&P CNX Nifty throughout the sample period.

The first and second objectives of index level study are jointly taken as first portion of the analysis and the third objective of firm level study is considered under second portion. Further, the second portion is aimed to examine the weak-form of efficiency in two segments (i.e. from April 2002 to July 2004 and from August 2004 to March 2010) on the basis of introduction of facility of electronic data interface in the site of National Stock Exchange. For testing the hypothesis whether the BSE's SENSEX and NSE's NIFTY indices are efficient in the weak form, the present study makes use of the runs test, and Serial Correlation test. For testing the hypothesis whether the scrips are efficient in the weak form, the present study makes use of the unit root test (i.e. ADF test and PP test), Serial Correlation test and runs test at firm level.

EMPIRICAL RESULTS

(1) Test of Runs and Serial Correlation Applied on Returns of Two Market Indices of Indian Stock Market

The two main indices of the Indian stock market are BSE-Sensex and NSE-Nifty. Table 1 summarizes the output of runs test for BSE-Sensex and NSE-Nifty respectively. Test value, total cases, number of runs and z-statistics with p-value are reported for BSE-Sensex and NSE-Nifty respectively.

Table 1: Outputs of Runs Test for SENSEX and NIFTY

	BSE	NSE
Test Value	-0.00016	0.000622
Total Cases	1262	1996
Number of Runs	638	936
Z-statistics	0.338	-2.82097
P- Value	0.735	0.004788

In Table 1 the run test transforms the total number of runs into a z-statistics. The z-statistics for BSE is 0.338 with p-value of 0.735. The result of the runs test for the SENSEX reveals that null hypothesis is accepted as the value of z-statistics is less than critical value of 2.58 whereas for instance of NSE, the value of z-statistics is -2.82097 is more than the critical

value of 2.58 with significant p-value thereby rejecting the null hypothesis.

Table 2: Outputs of Autocorrelation and Q-Statistics of SENSEX

Lags	AC	Q-Stat	Prob.
1	-0.067	5.7505	0.016
2	0.015	6.0474	0.049
3	-0.016	6.3583	0.095
4	-0.019	6.815	0.146
5	-0.017	7.2032	0.206
6	-0.064	12.439	0.053
7	0.041	14.542	0.042

Table 3: Outputs of Autocorrelation and Q-Statistics of NIFTY

Lags	AC	Q-Stat	Prob.
1	0.067*	9.0252	0.003
2	-0.049	13.773	0.001
3	0.011	14.017	0.003
4	0.015	14.481	0.006
5	-0.022	15.467	0.009
6	-0.058*	22.152	0.001
7	0.024	23.338*	0.001

** Significant at 1% level.*

In the Table 2 and Table 3, the outputs of autocorrelation and LB statistics (Q-Statistics) are mentioned for the SENSEX and NIFTY respectively. From the above it is clear that when the absolute value of serial correlation coefficient is less than twice the standard error, the null hypothesis is accepted and the market can be concluded as weak-form efficient. The standard error for Sensex and Nifty are 0.028 and 0.022 respectively. The serial correlation coefficient for SENSEX at Lag 1 and at Lag 6 exceeds twice the standard error showing significance at 5% level but is insignificant for 99% confidence interval which is significantly not different from zero. Thus, the autocorrelation coefficients for the seven days lag showed not significantly different from zero.

Moreover, the joint null hypothesis of LB statistics from Lag 1 through Lag 7 is 14.542 which is less than 18.48 at 99% confidence limit of Chi-squared distribution. Thus, the null hypothesis that the index return series is weak-form efficient is accepted for the BSE's SENSEX. Further, Nifty is also exceeding twice of standard error (0.022) at Lag 1 and Lag 6. The autocorrelation coefficients are significantly different from zero at Lag 1 and Lag 6 respectively, as the 99% confidence interval does not contain zero.

The LB-Statistics for Lag 1 through Lag 7 is also significant at 99% confidence limit. Thus, the null hypothesis is not accepted for NSE's NIFTY. In nutshell, the BSE's SENSEX is following the weak-form efficiency of the market but the same is not true in regard to NSE's Nifty.

(2) Test of Unit Roots, Serial Correlation and Runs Applied on Returns of Individual Scrips of the NSE-Nifty

One of the basic assumptions of weak form of efficiency is that the distribution of the return series should be normal. In order to test the distribution of return series, the descriptive statistics of log returns are presented in Table 4. Descriptive tests are good measures to investigate the return series confirming to normal distribution where skewness and kurtosis should be equal to 0 and 3 respectively.

Table 4: Descriptive Statistics of Scrips Returns (April 2002 - March 2010)

Variable	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
ABB	-0.00023	0.012353	0.743093	12.26807	7327.473	0
BPCL	-0.00078	0.012751	0.23981	9.404794	3430.743	0
CIPLA	-0.00082	0.01061	0.616639	16.323	14888.76	0
GAIL	-0.00089	0.01265	0.193746	12.5698	7628.976	0
HEROHONDA	-0.00017	0.011022	0.733743	9.144098	3318.637	0
JINDALSTEL	8.23E-05	0.016433	0.156088	13.41824	9034.993	0
KOTAKBANK	-0.00103	0.015509	0.111362	7.741875	1874.16	0
RELCAPITAL	-0.00116	0.01527	-0.09067	6.765296	1181.827	0
SAIL	-0.00123	0.016482	0.01306	7.784698	1904.019	0
SBIN	-0.00045	0.01117	0.177136	7.149803	1442.64	0
SIEMENS	-0.0004	0.013199	0.145351	7.13208	1427.023	0
TATAMOTOR	-0.00086	0.012894	0.28292	9.686474	3744.92	0
TATAPOWER	-0.0004	0.012152	0.26612	9.775511	3841.537	0
TATASTEEL	-0.00098	0.014013	-0.17319	7.364527	1594.228	0
WIPRO	-0.00077	0.012482	0.648736	11.86639	6677.978	0

Table 4 presents a summary of descriptive statistics of the daily returns for fifteen scrips listed in the S&P CNX NIFTY. Sample means, standard deviations, skewness, kurtosis, Jarque-Bera statistics and p-values are reported. The lowest mean returns are in SAIL (-0.00123), RELCAPITAL (-0.00116) and KOTAKBANK (-0.00103) and the highest means returns are for JINDALSTEL (8.23E-05), HERHONDA (-0.00017) and ABB (-0.00023). The standard deviations of the returns range from CIPLA (0.01061) to SAIL (0.016482). On the basis, of the fifteen companies the returns in CIPLA, HEROHONDA and TATAPOWER are the least volatile, with KOTAKBANK, JINDALSTEL and SAIL being the most volatile. By and large, the distributional properties of all fifteen return series appear non-normal.

The skewness coefficient, in excess of unity is taken to be fairly extreme. High or low kurtosis value indicates extreme leptokurtic or extreme platykurtic. Generally, values for zero skewness and kurtosis at 3 represents that the observed distribution is perfectly normally distributed. The negatively skewed companies indicate that the greater probability of large decreases in returns than increases as the case with TATASTEEL and RELCAPITAL and the positively skewed companies signifying the greater likelihood of large increase in returns than decreases. The kurtosis or degrees of excess, in all return of scrips is also large, ranging from 6.765296 for RELCAPITAL to 16.323 for CIPLA, thereby indicating leptokurtic distributions. The Jarque-Bera statistics and corresponding p-values in Table 4 are used to test the null hypotheses that the daily distribution of market return is normally distributed. All the p-values are smaller than the 0.01 level of significance suggesting that the null hypothesis is rejected. None of these scrips returns are then well approximated by the normal distribution.

Table 5: Outputs of Unit Root Tests on Returns of Scrips at Level

Variable	ADF TEST STATISTICS		PP TEST STATISTICS	
	First Period	Second Period	First Period	Second Period
ABB	-0.21616	-1.45234	-0.2058	-1.45386
BPCL	-1.21438	-2.54307	-1.27386	-2.64513
CIPLA	-0.87511	-2.16118	-1.03164	-2.20796
GAIL	-0.44455	-2.09233	-0.46211	-1.90763
HEROHONDA	-0.8538	-0.3977	-0.82177	-0.13173
JINDALSTEL	-2.12256	-2.17211	-2.12311	-2.22203
KOTAKBANK	-0.78604	-1.51245	-0.71916	-1.57631
RELCAPITAL	-0.54362	-2.02841	-0.58655	-2.04081
SAIL	-1.22263	-1.27411	-1.18965	-1.23811
SBIN	-1.05313	-1.78094	-1.05729	-1.73433
SIEMENS	-0.14864	-1.30926	-0.22602	-1.33222
TATAMOTOR	-0.62085	-1.29447	-0.609	-1.2183
TATAPOWER	-0.53242	-1.41116	-0.60263	-1.37905
TATASTEEL	-0.75058	-1.74251	-0.75584	-1.71148
WIPRO	-1.48719	-1.81198	-1.34046	-1.77411

Table 6: Outputs of Unit Root Tests on Returns of Scrips at First Difference

Variable	ADF TEST STATISTICS		PP TEST STATISTICS	
	First Period	Second Period	First Period	Second Period
ABB	-24.3427	-37.0595	-24.3458	-37.1104
BPCL	-19.8899	-36.659	-26.4039	-36.655
CIPLA	-22.8338	-37.2009	-22.8107	-37.3001
GAIL	-19.3361	-41.1931	-23.9918	-41.1937
HEROHONDA	-23.2596	-36.1315	-23.2441	-36.1854
JINDALSTEL	-23.7654	-33.8776	-23.7654	-33.738
KOTAKBANK	-21.8791	-38.1266	-21.8835	-38.1332
RELCAPITAL	-19.2715	-37.5674	-23.4976	-37.5696
SAIL	-18.9511	-38.4473	-22.8202	-38.5261
SBIN	-23.8628	-37.1938	-23.8634	-37.1966
SIEMENS	-11.4072	-35.2352	-23.8442	-35.2248
TATAMOTOR	-24.4605	-35.2976	-24.474	-36.1286
TATAPOWER	-21.2843	-24.661	-22.4343	-38.8973
TATASTEEL	-24.7014	-35.9692	-24.7014	-36.3279
WIPRO	-20.8183	-38.9984	-28.045	-38.9946

The outputs of unit root tests for sample scrips at level and at first difference have been presented in Table 5 and Table 6 respectively. From Table 5, it can be seen that the test values are less than table values at 1% level of significance having critical value of -3.44122 for the first period and -3.4348 for the second period. Thus, the null hypothesis of presence of unit root is accepted i.e. randomness in the series. In contrast, similar results applied to the continuously compounded stock return series as measured by the logarithmic of first difference of stock prices indicate that the null hypotheses of unit roots are rejected as represented in Table 6. That is, the data series are non-stationary in price series but not in returns form.

Again, the weak-form of efficiency can be further validated by using the serial correlation and Q-statistics. The following tables, i.e. Table 7(i), Table 7(ii), Table 8(i) and Table 8(ii) consecutively presents the value of autocorrelation and Q-statistics for two periods of the study respectively. According to Schwarz criterion, the lag chosen for the first period is lag 18 whereas for the second period, the lag chosen is lag 23.

Table 7(i): Outputs of Autocorrelation Function (First Period)

LAG	ABB	BPCL	CIPLA	GAIL	HERO HONDA	JINDAL STEL	KOTAK BANK	RELCA PITAL
1	-0.004	-0.085	0.06	0.018	0.044	0.019	0.102	0.038
2	-0.038	-0.088	-0.002	-0.127	0.002	-0.037	0.063	-0.137
3	0.076	0.067	-0.016	0.024	-0.057	0.05	-0.027	-0.036
4	-0.027	0.081	0.034	0.05	0.018	-0.057	-0.007	0.047
5	-0.02	-0.005	-0.098	-0.044	-0.032	-0.015	-0.053	-0.032
6	0.001	0.023	0.041	0.03	-0.031	-0.082	0.013	0.002
7	-0.026	0.021	-0.004	-0.016	-0.052	0.032	0.061	-0.089
8	-0.016	-0.075	0.051	-0.01	0.005	0.002	0.014	0.001

9	-0.011	-0.036	-0.001	-0.017	0.024	-0.055	0.074	0.006
10	-0.037	0.081	-0.009	0.039	0.053	-0.046	0.049	-0.025
11	0.041	-0.024	-0.022	-0.12	-0.02	0.029	0.054	-0.027
12	0.004	-0.054	-0.028	-0.057	-0.05	-0.074	-0.082	-0.003
13	-0.03	0.034	0.045	0.01	-0.043	-0.037	-0.014	0.02
14	0.034	-0.029	0.016	0.037	-0.018	0.015	-0.009	-0.012
15	0.093	-0.047	-0.062	-0.042	-0.068	-0.047	-0.018	-0.013
16	-0.02	0.039	-0.016	0.014	0.027	-0.056	-0.05	0.026
17	-0.038	-0.047	0.054	-0.013	0.029	0.035	-0.011	-0.004
18	0.002	-0.052	-0.054	0.02	-0.021	0.05	0.005	-0.06
Q-Stat.	15.04 (0.65)	32.7 (0.018)	19.45 (0.36)	27.66 (0.06)	15.05 (0.65)	22.53 (0.21)	25.65 (0.19)	23.35 (0.18)

Table 7(ii): Outputs of Autocorrelation Function (First Period)

LAG	SAIL	SBIN	SIEMENS	TATA	TATA MOTO	TATA POWE	WIPRO STEEL
1	0.058	0.021	0.022	-0.008	0.074	-0.019	-0.137
2	-0.129	-0.023	0.072	-0.078	-0.244	-0.01	-0.11
3	0.05	0.056	0.145	0.027	0.031	-0.034	0.095
4	0.017	0.002	-0.029	0.007	0.151	-0.021	-0.006
5	-0.076	-0.02	-0.03	0.02	-0.02	0.04	-0.024
6	0.017	-0.054	0.079	0.007	-0.062	-0.014	-0.015
7	-0.002	-0.002	-0.002	0.041	0.067	-0.01	0.001
8	0.009	-0.024	0.071	-0.091	0.034	-0.006	0.012
9	-0.007	0.026	0.055	0.016	-0.069	0.013	-0.004
10	0.048	0.123	0.067	0.01	0.014	0.008	0.016
11	-0.03	-0.037	0.054	-0.041	-0.038	-0.044	0
12	-0.04	-0.026	0.074	-0.01	-0.005	0.003	-0.073
13	0.036	0.041	-0.021	0.067	0.066	0.029	0.061
14	0.046	-0.072	-0.005	-0.054	0.03	0.027	0.015
15	-0.003	0.042	-0.008	-0.061	0	-0.025	-0.073
16	-0.088	0.001	0.045	-0.105	-0.031	-0.007	0.044
17	0.001	0.029	0.007	-0.016	-0.02	-0.021	-0.009
18	0.056	0.015	0.005	0.011	0.059	-0.014	-0.006
Q-Stat.	28.81	21.46	34.89	25.37	68.77	5.43	34.54
	(0.05)	(0.26)	(0.01)	(0.12)	(0.000)	(0.99)	(0.011)

The above two tables, Table 7(i) and Table 7(ii) represents the coefficients of autocorrelation function together with Q-statistics for the period from April 2002 to July 2004 taken as first period. Serial correlation coefficients reported reveals that out of 270 coefficients, 20 (about 7.4 percent) were significant at 5% levels, 9 (about 3.33 percent) were even at 1% level. With regard to the direction, 142 (about 52.6 percent) coefficients were negative, 126 (about 46.7 percent) were positive and remaining 2 (about 0.7 percent) were zero. The dominance of negative values signals a depressed stock market conditions during the first period of the study. Also it can be concluded that 219 (about 81.11 percent) were smaller than the respective standard error. However, certain serial correlation coefficients values were considerably large at varying lags to indicate serial dependence of stock prices.

For testing the autocorrelation the null hypothesis again considered to be not significantly different from zero. For testing the acceptance of null hypothesis the serial correlation coefficient must be less than twice the standard error and further for testing at 99% confidence limit the interval 2.57 (standard error) must contain zero. The standard error for the first period is 0.041 and the serial correlation coefficient must contain zero within the limit of 0.105.

Table 7(i) and Table 7(ii) shows that GAIL at lag 2 (-0.127 0.105 does not contain zero), RELCAPITAL at lag 2 (-0.137 0.105 does not contain zero), SAIL at lag 2 (-0.129 0.105 does not contain zero), SBIN at lag 10 (0.123 0.105 does not contain zero), SIEMENS at lag 3 (0.145 0.105 does not contain zero), TATAMOTORS at lag 16 (-0.105 0.105 does not contain zero), TATAPOWER at lag 2 (-0.244 0.105 does not contain zero) and lag 4 (0.151 0.105 does not contain zero) and WIPRO at lag 1 (-0.137 0.105 does not contain zero) significantly different from zero. Hence, eight out of fifteen companies showed significantly different from zero at their respective lags.

Further, the joint null hypothesis of LB statistics is significant for SIEMENS and TATAPOWER. The significance of LB Statistics is measured by the value of Q-Stat. more than 34.81 at 0.990 level of confidence. Thus, for the instance of thirteen out of fifteen companies are following the weak form of efficient market hypothesis whereas two out of fifteen of companies are found to be significant for the first period.

Table 8(i): Outputs of Autocorrelation Function (Second Period)

LAG	ABB	BPCE	CIPLA	GAIL	HERO HONDA	JINDA LSTEL	KOTAK BANK	RELCA PITAL
1	0.011	0.022	0.007	-0.095	0.034	0.101	-0.018	-0.003
2	0.05	0.045	0.023	-0.002	0.046	-0.02	0.005	0.013
3	0	0.039	-0.009	0.023	-0.063	-0.006	0.026	0.01
4	0.031	-0.043	-0.025	0.011	0.011	-0.043	-0.003	0.008
5	0.029	-0.044	-0.036	-0.041	0.013	-0.026	-0.017	-0.001
6	-0.082	0.014	-0.082	-0.022	0.015	0.012	-0.032	-0.008
7	0.047	-0.041	0.015	0.047	0.049	-0.003	-0.014	0.009
8	0.023	-0.024	-0.013	0.01	0.004	-0.021	-0.036	0.035
9	-0.009	-0.036	-0.016	-0.017	0.001	0.016	0.05	0.011
10	0.004	0.012	0.043	0.057	0.029	0.009	-0.058	0.049
11	-0.005	0.003	-0.039	-0.017	0.015	-0.082	-0.01	-0.036
12	-0.024	-0.012	0.008	-0.029	0.023	-0.011	0.047	0.005
13	-0.055	-0.019	-0.029	-0.005	0.006	-0.002	0.016	0.009

LAG	ABB	BPCE	CIPLA	GAIL	HERO HONDA	JINDA LSTEL	KOTAK BANK	RELCA PITAL
14	-0.054	0.016	0.046	-0.029	0.048	0.039	0.015	0.043
15	0	0.029	0.02	0.044	-0.028	0.053	0.065	0.007
16	-0.012	0.024	0.013	-0.03	-0.071	0.023	0.043	0.024
17	0.052	0.013	0.059	0.026	-0.037	0.036	0.048	0.069
18	0.011	0.023	-0.007	-0.001	0.005	0.048	-0.021	-0.014
19	0.029	-0.027	0.008	-0.059	-0.046	0.041	-0.043	-0.017
20	0.044	-0.03	-0.022	-0.008	0.013	0.037	-0.023	-0.009
21	-0.017	-0.056	-0.005	0.001	-0.002	0.033	-0.001	0
22	0	-0.04	-0.025	-0.066	-0.026	0.044	-0.045	0.011
23	-0.005	-0.04	-0.036	0	-0.021	0.005	0	-0.026
Q-Stat.	37.72	32.08	32.54	43.82	35.05	50.55	36.34	20.47
	(0.02)	(0.09)	(0.09)	(0.006)	(0.05)	(0.001)	(0.04)	(0.61)

Table 8(ii): Outputs of Autocorrelation Function (Second Period)

LAG	SAIL	SBIN	SIEMENS	TATA MOTO	TATA POWE	TATA STEEL	WIPRO
1	-0.026	0.007	0.061	0.059	-0.022	0.04	-0.04
2	0	-0.012	-0.013	0.034	-0.056	0.056	0.011
3	-0.033	0	0.009	-0.01	-0.086	0.023	0.012
4	-0.012	0.039	0.069	-0.042	-0.009	-0.017	-0.042
5	0.025	-0.053	-0.003	0.041	0.035	0.014	0.028
6	-0.022	-0.018	0.001	0.045	-0.009	0.041	0.006
7	-0.033	-0.031	-0.025	0.098	-0.004	0.024	0.005
8	0.042	0.04	0.05	0.078	-0.045	0.07	0.044
9	-0.01	0.011	0.033	0.061	0.025	0.071	0.008
10	-0.008	-0.028	-0.008	0.032	0.004	-0.005	0.026
11	-0.039	0.016	-0.028	0.005	-0.08	-0.037	0.025
12	0.007	0.035	0.012	0.056	-0.056	0.002	-0.042
13	0.046	-0.02	-0.003	0.023	0.016	0.019	-0.035
14	0.039	-0.019	0.021	0.04	0.033	-0.012	0.008
15	0.037	-0.018	-0.002	0.037	0.037	0.02	-0.033
16	0.05	0.007	0.004	0.007	-0.013	0.035	-0.003

LAG	SAIL	SBIN	SIEMENS	TATA MOTO	TATA POWE	TATA STEEL	WIPRO
17	0.032	-0.002	0.051	0.055	0.01	0.05	0.087
18	-0.054	0.002	0.018	0.017	0.015	-0.015	-0.027
19	-0.028	-0.022	0.013	0.023	0.025	0.006	0.029
20	-0.004	0.055	0.027	0.005	-0.014	-0.026	0.026
21	-0.021	0.039	-0.015	-0.007	-0.009	-0.004	0.005
22	0.022	0.018	-0.007	-0.014	-0.011	0.003	0.017
23	-0.012	-0.035	-0.028	0.017	0.02	-0.013	0.017
Q-Stat.	29.62	24.73	27.34	58.83	41.23	35.73	31.93
	(0.16)	(0.36)	(0.24)	(0.00)	(0.01)	(0.04)	(0.102)

The above two tables, Table 8(i) and Table 8(ii) represents the coefficients of autocorrelation function together with Q-statistics for the period from August 2004 to March 2010 taken as second period. Serial correlation coefficients reported reveals that out of 345 coefficients, 36 (about 10.43 percent) were significant at 5% levels, 14 (about 4.06 percent) were even at 1% level. With regard to the direction, 153 (about 44.35 percent) coefficients were negative, 184 (about 53.33 percent) were positive and remaining 8 (about 2.32 percent) were zero. The dominance of positive values signals an elated stock market conditions during the second period of the study. Also it can be had that 259 (about 75 percent) were smaller than the respective standard error. However, certain serial correlation coefficients values were considerably large at varying lags to indicate serial dependence of stock prices.

The null hypothesis for the second period is again considered to be not significantly different from zero. For testing the acceptance of null hypothesis the serial correlation coefficient must be less than twice the standard error for 95% confidence limit and further for testing at 99% confidence limit the interval 2.57 (standard error) must contain zero. The standard error for the second period is 0.026 and the serial correlation coefficient must contain zero within the limit of 0.066.

In Table 8(i) and Table 8(ii) the autocorrelation coefficients are significant for the given lags are ABB at lag 6 (-0.082 0.066 does not contain zero), CIPLA at lag 6 (-0.082 0.066 does not contain zero), GAIL at lag 1 (-0.095 0.066 does not contain zero) and lag 22 (-0.082 0.066 does not contain zero), HEROHONDA at lag 16 (-0.071 0.066 does not contain zero), JINDALSTEL at lag 1 (0.101 0.066 does not contain zero) and lag 11(-0.082 0.066 does not contain zero), RELCAPITAL at lag 17 (0.069 0.066 does not contain zero), SIEMENS at lag 4 (0.069 0.066 does not contain zero), TATAMOTORS at lag 7 (0.098 0.066 does not contain zero) and lag 8 (0.078 0.066 does not contain zero), TATAPOWER at lag 3 (-0.086 0.066 does not contain zero), TATASTEEL at lag 9 (0.071 0.066 does not contain zero) and WIPRO at lag 17 (0.087 0.066 does not contain zero). Thus, eleven out of fifteen companies showed significantly different from zero at their respective lags.

Further, the joint null hypothesis of LB Statistics is found to be significant for GAIL, JINDALSTEL and TATAMOTORS. The significance of LB Statistics is measured by the value of Q-Stat. more than 41.64 at 0.990 level of confidence. Thus, during the second period with the introduction of electronic data interface the level of efficiency comes down to twelve out of fifteen companies.

Table 9: Outputs of Runs Test of Scrips (First Period)

Variables	Test Value	Total Cases	Number of Runs	Z-statistics	P-value
ABB	-0.00067	590	298	0.16	0.86908
BPCL	-0.00121	590	300	0.33	0.74167
CIPLA	-0.00091	590	271	-2.06	0.03937
GAIL	-0.00116	590	270	-2.14	0.03214
HEROHONDA	-0.00145	590	283	-1.07	0.28402
JINDALSTEL	-0.00084	590	268	-2.30	0.02103
KOTAKBANK	-0.00144	590	259	-3.05	0.00229
RELCAPITAL	-0.00166	590	291	-0.41	0.6803
SAIL	-0.00316	590	281	-1.23	0.21641
SBIN	-0.00019	590	312	1.32	0.18732
SIEMENS	-0.00044	590	299	0.25	0.80473
TATAMOTORS	-0.00043	590	309	1.07	0.28402
TATAPOWER	-0.00108	590	268	-2.31	0.02103
TATASTEEL	-0.00058	590	283	-1.07	0.28402
WIPRO	-0.00147	590	302	0.49	0.62098

Table 10: Outputs of Runs Test of Scrips (Second Period)

Variables	Test Value	Total Cases	Number of Runs	Z-statistics	P-values
ABB	-0.00076	1406	641	-3.36	0.00077
BPCL	-0.00087	1406	712	0.43	0.66948
CIPLA	-0.00124	1406	667	-1.97	0.04835
GAIL	-0.00082	1406	726	1.17	0.24045
HEROHONDA	-0.00037	1406	672	-1.7	0.08774
JINDALSTEL	-0.00034	1406	613	-4.85	1.2E-06
KOTAKBANK	-0.00144	1406	681	-1.23	0.21974
RELCAPITAL	-0.00121	1406	725	1.12	0.2625
SAIL	-0.00116	1394	700	0.107	0.915
SBIN	-0.00067	1406	729	1.33	0.18222
SIEMENS	-0.00081	1406	695	-0.48	0.63107
TATAMOTORS	-0.00094	1406	705	0.05	0.95744
TATAPOWER	-0.00023	1406	688	-0.85	0.39326
TATASTEEL	-0.00069	1406	706	0.11	0.91501
WIPRO	-0.00112	1406	694	-0.53	0.59363

The results of runs test applied to fifteen scrips are shown in Table 9 and Table 10 for first and second period respectively. A perusal of this table would indicate that the 'rejection' of the null hypothesis occurs either at the 5% level of significance or at the 1% level of significance. For the first period, the runs test reported reveals that out of 15 scrips, 5 scrips (about 33.33 percent) were significant at 5% levels and single scrip (about 6.67 percent) was even at 1%. The single scrip is KOTAKBANK. Moreover, observed runs fall short of those expected for 9 scrips (about 60 percent). Further, it is noteworthy that the mean absolute value of z-statistics is 1.28. This would indicate virtually no difference between actual and observed number of runs. Thus, the analysis of runs carried out here would indicate that, in general, successive price changes appear to follow a random walk model in respect most of the series analyzed except KOTAKBANK.

For the second period, the runs test reported reveals that out of 15 scrips, 3 scrips (about 20 percent) were significant at 5% levels and 2 scrips (about 13.33 percent) were at 1%. The significant scrips are ABB and JINDALSTEL. Moreover, observed runs fall short of those expected for 8 scrips (about 53.33 percent). Further, it is noteworthy that the mean absolute value of z-statistics is 1.29. This would indicate virtually no difference between actual and observed number of runs. Thus, the analysis of runs carried out here would indicate that, in general, successive price changes appear to follow a random walk model in respect of most of the series analyzed except ABB and JINDALSTEL.

On the basis of the observations, we can say that as we move from period-1 to period-2 the randomness is reduced. Apparently, we can conclude that after introducing electronic data interface the efficiency of the Indian Stock Market has reduced. On the whole, the daily movements of individual returns of scrips for both periods are consistent with the random walk hypothesis.

SUMMARY :

This study has comprehensively tested the random walk hypothesis to determine the validity of weak form of efficiency for both the Bombay Stock Exchange and the National Stock Exchange. Firstly, the study documented evidence by applying two popular tests viz. serial correlation coefficient tests and runs test to support (or reject) the weak form of efficiency in two main market indices. Secondly, the study has also focused on individual share prices to find whether the individual scrip returns are supporting (or rejecting) the weak form of efficiency by applying descriptive statistics, unit root tests, serial correlation coefficient test and runs test. The foregoing abundant result leads to the following main.

CONCLUSIONS:

1. The empirical evidence pertaining to both indices of the BSE-Sensex and NSE-Nifty are in contrary to follow the assumption of random walk model. First of all, the runs test is conducted for both indices to measure the direction of prices movements which revealed the fact that BSE-Sensex is following the independent assumptions of price movement as well as expected number of runs fall short of actual numbers. In contrast to BSE-Sensex, NSE-Nifty showed significant result with high expected number of runs than to their actual.
2. In support of runs test, the serial correlation coefficient test is also conducted for both indices to measure whether or not the returns and the lagged return in the same time series are correlated. The seven days lags are chosen to reveal the presence of non-zero serial correlation in both indices. At 1% level of significance, the NSE-Nifty is found significant at lag 1 and at lag 6. The joint null hypothesis of Q-Statistics is also significant for NSE-Nifty.
3. The above results of runs test and serial correlation coefficient test lead us to conclude that BSE-Sensex is weak form efficient but NSE-Nifty is not weak form efficient.
4. The descriptive study is applied to test the normal distribution of data and the test result of descriptive statistics showed that the returns of share prices are not normally distributed.
5. The unit root tests showed that the logarithmic price series of scrips are non-stationary whereas the residuals are stationary in 1st difference for both periods.
6. The serial correlation coefficients test showed that about 96.67 percent of coefficients in the first period and 95.94 percent in the second period are not significant at 1% level of significance.
7. The test result of LB statistics for the first period, had accepted the null hypothesis for thirteen scrips and for the second period scrips are found to be random for twelve scrips.
8. Further, the runs test applied to both periods

showed insignificant z-statistics for 93.3 percent cases during first period and 86.7 percent during second period at 1% level of significance.

9. The result based on above studies lead us to conclude that the market is weak form efficient during both periods.
10. The study has also revealed that the introduction of electronic data interface could not improve the level of efficiency in the stock market.

In brief, we may conclude that the Indian stock market is representing the weak-form of efficiency in either index or at scrip level.

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