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Informational Efficiency of Indian Capital Market: A Study on Stock Market Indices for the Period 1995-96 to 2004-05

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Abstract

In an informationally efficient market, stock prices fully reflect all available information. The present study examines whether the Indian stock market is informationally efficient in the weak form. The study attempts to test whether the information contained in the past stock prices fully reflected in the present prices. The ADF unit root test, DW test to measure the autocorrelations in the residuals, autocorrelation and cross correlation tests on the returns tests of the four major stock price indices viz., Sensex, Nifty, S&P CNX 500 and BSE 100 for the 10 year period (1-4-1995 to 31-3-2005) have been conducted. The test results overwhelmingly vouch for the existence of the stock market efficiency in the weak form.

Key words: ADF unit root test, Autocorrelation, Cross correlation

1. Introduction

The study of capital market efficiency can be broadly categorised into three. Viz., Allocational Efficiency, Investment Efficiency and Informational Efficiency. Allocational efficiency refers to the effectiveness with which a market channels capital is not to its most productive use. It is a process whereby society's scarce resources are allocated between competing real investments. Investment efficiency deals with the distribution of wealth between consumption and savings. It is a function of risk, return and total cost of an investment management structure. Informational Efficiency refers to a market environment wherein stock prices fully reflect all available information. It is a function of the speed, accuracy and quantum of new information translated into price. In this study we use the concept of informational efficiency to evaluate the efficiency of Indian capital market.

For the past four decades, the finance literature on capital market efficiency focused on informational efficiency. Though Louis Bachelier, Halbrook Working, Maurice Kendall, and Roberts have made pioneering contribution, it was Eugene Fama (1970) who laid the foundations for a systematic study of market efficiency. Initially he had categorised the study of market efficiency into three. Viz., Weak form, Semi-strong form and Strong form of market efficiency. Weak form of efficiency states that current stock prices fully reflect all the information contained in the history of past prices. If the market is weak form efficient, stock prices are not predictable based on the past price data. The investors cannot gain abnormal returns by evolving trading rules based on past price data. Hence, the analysis of patterns in past price movement, popularly known as 'technical analysis' is redundant.

This study aims at evaluating the efficiency of Indian capital market using daily closing values of four major indices viz., Sensex, Nifty, S&P CNX 500 and BSE 100. This study employs econometric tools to investigate whether the market stands the tests for weak form of efficiency.

2. Review of Literature

The random nature of share prices and returns has been suspected by various researchers for a long time. One of the earliest and the most often cited works is by Louis Bachelier. In his pioneering study on the commodity prices 'Theorie de la Speculation' way back in 1900, he concluded that the price of a commodity today is the best estimate of its price in the future. However, the credit for the first systematic study on whether stock prices behaved in a random fashion goes to Maurice G. Kendall (1953). He analysed the behaviour of weekly changes in the indices of shares on the London stock market and of the prices of cotton and wheat on American commodity markets. He concluded that the price movements were random.

Osborne (1959) found a high degree of conformity between movements in share prices and the law governing Brownian motion. Although Osborne's findings were generally consistent with the thesis of weak form efficiency, he noted that the daily closing prices tended to be concentrated either at the day's highs or lows. In a later study, Niederhoffer and Osborne (1966) noted the reversals (pairs of price changes in the opposite direction) tended to be much more common than continuations (price changes in the same direction).

Alexander (1961) using filter technique attempted to show that historic price movements could be used to earn abnormal returns. However, when transaction costs were taken into account, the excess gains disappeared. Cootner (1962) argued that professional investors can observe the random walk in security prices produced by non-professional market participants, until the price wanders sufficiently far away from the intrinsic value of the security. At this point, the professionals can trade in such a way as to make abnormal gains.

Granger and Morgenstern (1963) used spectral analysis in an attempt to find cycles in share prices. They found no significant relationship between security returns in previous periods. Moore (1964) examined serial correlation between successive price changes and individual securities. He concluded that historic weekly price changes cannot be used to predict future price changes.

Fama (1965) studied the daily price changes of 30 stocks making up the Dow Jones Industrial Average for 5 years from 1957 to1962. He concluded that there is very little evidence of dependence. Samuelson (1965) proved that prices move in a random manner in a market in which all have similar time horizons and expectations, provided that all information is available to all market participants at a zero cost.

The bulk of the weak form tests have been concerned with examining the serial correlations between successive returns. Serial correlation (or autocorrelation) measures the coefficient between numerical observations in the same time series; i.e., the extent to which each observation is determined by its predecessors.

3. Tests of Market Efficiency in the Indian Scenario

In Indian market the first work on testing the hypothesis of independence of price changes was by Krishna Rao and Mukherjee (1971). They analysed the weekly averages of daily closing quotations of the Indian aluminium company's shares for the period of fifteen years (1955-1970). Spectral analysis of the data supported the hypothesis of randomness of price changes. Later, Sharma and Kennedy (1977) used spectral analysis to study the behaviour of NYSE, LSE and BSE. Spectral densities estimated for each index used confirmed the randomness of the series and no systematic cyclical component or periodicity was present.

Ray (1976) constructed index series for 6 industries as well as for all industries, and tested the hypothesis of independence on these series. He obtained mixed results, tilting towards rejection of the hypothesis. Barua (1983), Obaidullah (1990), Belgaumi (1995), Bodla (2005) used

Runs test and Auto correlation test to see whether the successive price changes are independent. The results supported the hypothesis of serial independence of price changes of securities. Chaudhuri (1991, 1991a) applied similar tests on price quotations of 13 industries and daily price quotations of 93 actively traded shares. His findings rejected the hypothesis.

Sharma (1983) and Karmekar (2003) applied Box-Jenkin's (ARIMA) methodology and concluded that the random walk model is an adequate model to represent the price behaviour of individual stocks traded at BSE. Gupta (1987) observed that Indian Capital Market is excessively speculative rather than inefficient, mainly because of low margins in carry forward transactions. In responding to the study of Barua and Raghunathan (1986), he was of the opinion that the violation of risk – return parity might be due to the excessive speculation and not due to the inefficiency of the market. On the other hand, Rao (1988) had employed serial correlation, Runs tests and Filter Tests on the week-end share price data of 10 blue chip companies between the years 1982-87. His results supported the weak form efficiency of the Indian capital market.

Raghunathan and Subramanian (1993) used frequency domain approach of spectral analysis. Their study shows that there are some periodic cycles in the price movements which run counter to the assertion of weak form of market efficiency. Using unit root test and variance ratios Barman and Madhusoodanan (1993) analysed the permanent and temporary components of Indian Stock market returns. They found that the fluctuations in returns were permanent in the long run, while for short and medium term they were temporary. The results indicate lack of efficiency.

Arumugham (1998) made a comprehensive study on the day of the week effect by taking 19 year data (April 1979 to March 1997) of daily returns based on the closing prices of BSE Sensex. The study examined the causes of the anomaly and implications for the efficiency of the stock market. Parimal (2001) found interday as well as intraday volatility as non-random. Hence he concludes that the markets are not efficient. He asserts that there is discernable "day of the week effect" on the daily returns depending upon the trading cycles of the respective bourses. Thiriplraju and Amanulla (2001) investigated whether the CAPM along with week-end effect explain the stock return variations across the week in Indian stock market. Their result supports the traditional form of week-end effect during the period of ban on badla transactions, but followed a different pattern of week-end effect in the rest of the sub-sample periods.

Ramasastri (2001) used daily returns of Sensex for a period of 3 years (January 1996-December 1998) applied Correlogram and Spectral analysis to conclude that Indian capital market is efficient in weak form. Barman and Samanta (2001) used martingale tests, volatility test and cointegration tests between real price index and real dividend to test the efficient market hypothesis in the Indian capital market and concluded that the Indian stock market as inefficient. Sehgal (2003) made a study on the common factors in stock returns. The study shows that there are market size and book to market equity factors in stock returns. Pandey (2003) investigated the existence of seasonality in Indian stock market. He used the monthly return data of BSE Sensex for the period April 1991 to March 2002 for analysis. The results of the study imply that the stock market in India is not informationally efficient, and hence, investors can time their share investments to earn abnormal returns.

Deb (2003) applied a series of parametric and non-parametric tests on daily closing values of five market indices viz., Nifty, Junior Nifty, Sensex, BSE 100 and BSE 200 and observed that Indian Capital Market does not follow random walk model. Using the ADF unit root test, the study also showed that all these indices were non-stationary. Similarly Alimov, Chakraborthy, Cox and Jain (2004) used the daily closing values of indices BSE 500, BSE 100, and the daily closing price of 14 stocks data and found the data is non-stationary. On the other hand, Ramasastri (2000) applied the same test on daily closing data of BSE Sensex for 8 years, Panda and Narasimahan (2005) for a 10 year period and found that data as stationary.

4. Rationale of the Present Study

In the era of financial liberalisation where there is a free flow of capital beyond the geographical and political boundaries, it is necessary to have an efficient capital market to attract investors around the globe. The researchers of the developed economies in the West, the United States and Australia have done substantial work in the field of testing capital market efficiency. In the Indian context, the studies in this direction are very minimal.

After eighteen years of experiment on financial liberalisation, the atmosphere in the capital market has certainly changed. The Indian capital market is on its march towards occupying a place among the leading capital markets of the world. Testing of market efficiency is not a 'timeless' study; continuous research is required to keep the market informationally efficient. Hence it is necessary to test its efficiency.

5. Objectives of the Study

1. To study the return distribution pattern in the select indices viz., Sensex, Nifty, S&P CNX 500 and BSE 100.
2. To test the Random Walk Hypothesis with reference to the select stock price indices
3. To study cross-correlation between the returns of the select indices
4. To evaluate the "lead-lag" relationship amongst the major stock price indices

6. Scope of the study

The study is to assess the efficiency of the Indian capital market in the liberalisation era. Hence the study is based on the daily closing values of four major stock price indices viz., Sensex, Nifty, S&P CNX 500 and BSE 100 for the 10 year period (1-4-1995 to 31-3-2005)

7. Research Methodology

7.1 . Sources of Data and Sample

The daily closing values of the four indices for the 10 year period starting from April 1, 1995 to March 31, 2005 has been procured from CMIE's Prowess data base. There are a total of 2501 observations representing all the trading days during the period under study. The daily compounded logarithmic returns were calculated for the analysis.

$$R_{it} = \log I_t - \log I_{t-1}$$

Where

R_{it} = return of the index on day t

I_t = Closing value of the index on day t

I_{t-1} = Closing value of the index on day t-1

7.2 . Statistical and Econometric tests employed

The continuously compounded log returns of daily closing prices of indices taken as the basis for all the statistical and econometric analysis. The following tests have been employed.

a. **Augmented Dickey Fuller unit root test** to verify the stationarity of the data.

b. **Durbin-Watson** statistics to test the autocorrelations in the returns of the indices.

c. Test of **autocorrelation** in the daily returns of the indices upto 10 lags.

d. Test of **cross correlation** between the returns of the indices upto 10 lags between the four indices for all the 2501 trading days under study.

8. Important Findings of the Study

8.1 . Descriptive Statistics of the daily compounded log returns of the indices:

The examination of the summary statistics of daily compounded log returns of all the four indices under study viz., Sensex, Nifty, BSE 100 and NSE 500 **(table no. 1A, B, C, D)** reveals that the values of skewness and kurtosis are high. These values indicate that the series is not normally distributed. The series is negatively skewed and heavy tailed i.e., leptokurtic. Jarque-Bera test statistic also confirms the non-normality of the distribution of the series. When we categorise the data into annual sub-periods and examine the summary statistics, it is evident that during six out of the ten years the skewness has been negative. The leptokurtic trend in the distribution of the data could be seen in all the annual sub-periods.

The standard deviations of returns are ranging between 0.010 and 0.024 during the 10 year period under study. The standard deviation was highest (0.024) in the year 2000-01 and lowest (0.010) in the year 2001-03. This also indicates that the markets were highly volatile in the year

2000-01 and relatively moderate in the year 2002-03. The high volatility in the market in the year 2000-01 is further strengthened by the fact that the returns were ranging between a high of 0.070 and a low of -0.074. In the year 2004-05 though the returns were fluctuating between a high of 0.079 and a low of -0.118, the standard deviation was moderate 0.015.

8.2. Stationarity of the data

The ADF test carried on daily closing values of four indices at varying time periods viz., all ten years' data under study, first five years, last five years, last three years and 10 year annual data. In all sub-periods, the ADF test values show that the series is non-stationary at 1%, 5% and 10% level of significance with the exception of BSE 100 annual data of the year 1995-96 and CNX 500 annual data for the year 2000-01 where the series appears to be stationary at 5% and 1% level of significance respectively. (Cf. Table No.2). Thus the ADF unit root test on daily closing values of the select indices for various time periods indicates that the closing values of the indices are non-stationary; in other words, they follow random walk.

If a time series is non-stationary, we can study its behaviour only for the time period under consideration. Each set of time series data will therefore be for a particular episode. As a consequence, it is not possible to generalise it to other time periods. Therefore, for the purpose of forecasting, non-stationary series are of little practical use. Hence, the daily compounded log returns of the indices were put to the ADF test. The result overwhelmingly suggested that the data is stationary (Cf. Table No.3). Therefore for all the statistical/econometric tests, the daily compounded log returns of the select indices have been used.

8.3. Durbin-Watson test results

Durbin –Watson statistics which measures the serial correlation in the residuals is computed as

$$DW = \frac{\sum_{t=2}^{T}(\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=1}^{T}\varepsilon^2_t}$$

In the table No 4 it could be observed that the DW statistic is almost 2. For Sensex it is ranging between 1.9150 and 1.9982 and for the Nifty it is ranging between 1.8915 to 1.9924 Similarly the DW values of CNX 500 and BSE 100 indices are very close to 2 (except for the year 1995-96). Thus the Durbin-Watson test overwhelmingly suggests no evidence of first order autocorrelation in the continuously compounded log returns on select stocks as well as the returns on the select indices. Hence the DW test statistics clearly indicate that the residuals are not correlated.

8.4. Autocorrelation of Returns on the Indices

One of the ways to test the randomness in the price changes in the indices is to look at their autocorrelations. The autocorrelation coefficient provides a measure of relationship between the value of a random variable ( ) in time t and its value k period earlier. In other words, it tells whether the price changes in one period are correlated with the price changes in some other earlier period. In the present context, it will indicate whether the changes in the value of index on day t are influenced by the changes in the value of the index k days earlier, where the k = 1, 2, 3, ….If such autocorrelations are negligible, the price changes are said to be serially independent. In this study we have considered the time lag of 10 trading days. i.e., k = 1, 2, ….16

The autocorrelation function

$$r_k = \frac{\text{cov}(y_t, y_{t-k})}{\sigma_y^2}$$

Alternatively,

$$r_k = C_k / C_o$$

where

$$C_k = \frac{1}{n}\sum_{t=1}^{n-k}(y_t - \overline{Y})\ (y_{t+k} - \overline{Y}) \qquad k = 1, 2, 3, \ldots \text{upto } 10$$

C_o = variance of y_t i.e., $\sigma^2_{y_t}$

$$\overline{Y} = \frac{1}{n}\sum_{t=1}^{n} y_t$$

$$t \text{ value} = \frac{r_k}{S.E.of\ r_k}$$

$$S.E.of\ r_k = \frac{1}{\sqrt{n-k}}$$

The t values of the autocorrelations of the continuously compounded log returns of the daily closing values of the select indices viz., Sensex, Nifty, CNX 500 and BSE 100 have been calculated upto 10 lags and the t values of the same are tabulated. **(Cf. Table Nos. 5)**

The **table No.5** affirms that the returns of the indices for various lags is not autocorrelated. Though a few t values are significant at 1% degree of freedom, their respective values are negligible. Hence the results vindicate the findings of the DW test.

8.5. Cross correlation between the indices

The cross correlations between the two series x and y

$$r_{xy} = \frac{C_{xy}(l)}{\sqrt{C_{xx}}\sqrt{C_{yy}}} \text{ where } l = 0, \pm 1, \pm 2, \ldots\ldots$$

And

$$C_{xy}(l) = \begin{cases} \sum_{t=1}^{T-l}((x_t - \overline{X})(y_{t+l} - \overline{Y}))/T & l = 0, 1, 2, \ldots. \\ \sum_{t=1}^{T+l}((y_t - \overline{Y})(x_{t-1} - \overline{X}))/T & l = 0, -1, -2, \ldots. \end{cases}$$

t value = $\frac{r_{xy}}{S.E.of\ r_{xy}}$

$$S.E.of\ r_{xy} = \frac{1}{\sqrt{n-l}}$$

Cross correlation among the four indices under study viz., Sensex, Nifty, CNX 500 and BSE 100 is presented in **table No.6**. Obviously, at lag 0 there is a high degree of correlation between the indices. What is significant to note is that with regard to the indices Sensex, Nifty and BSE 100 the explanatory power of the independent variable is very high. It ranges between 77.3% and 89.3%. But with regard to the correlation between the NSE 500 and other three indices at lag 0 though statistically significant, the independent variable's explanatory power is only about 22%. Conversely, at lag 1, there is a very high degree of correlation between the Sensex & NSE 500 and Nifty & NSE 500, and the explanatory power of the independent variables viz., the Sensex and Nifty is also very high, 33.8% and 35.9% respectively. This phenomenon is not observed in the cases of other indices. Hence, the CNX 500 emerges as the lagger compared to the other three indices under study when we take into consideration cross correlations between the daily returns for the ten year period.

9. Conclusion

The ADF unit root test on the daily closing values of the four indices under study viz. Sensex, Nifty, CNX 500 and BSE 100 indicates that the time series data is non-stationary. In other words, it follows random walk. For all other tests such as DW test for testing the first order correlation of the residuals, testing for Autocorrelation at various lags and Cross-correlation tests between the indices, the daily compounded log returns were used (the data was tested for stationarity) and all the test results lead us to conclude that the Indian capital market as represented by the indices data, is informationally efficient at weak form.

The results of the study lead us to conclude the futility of technical analysis for the Indian capital market. The technical analysis is founded on the premise that the stock prices move in trends that persist. The present study overwhelmingly affirms that no patterns are found in the indices return data, and they are not autocorrelated. Therefore there is no point in studying the historical price movements of Indian stock market in order to form trading strategies.

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11. APPENDIX

Table 1A : Descriptive Statistics of daily compounded log returns of Sensex											
	1995-2005	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Mean	0.000	0.000	0.000	0.000	0.000	0.001	-0.001	0.000	-0.001	0.002	0.001
Median	0.001	-0.001	0.000	0.000	0.000	0.002	0.001	-0.001	0.000	0.004	0.001
Std. Deviation	0.016	0.013	0.016	0.015	0.019	0.019	0.022	0.015	0.010	0.013	0.015
Skewness	-0.249	0.602	0.380	-0.372	-0.031	0.208	-0.361	-0.487	0.155	-0.302	-1.918
Kurtosis	6.363	5.103	4.372	7.342	4.128	4.013	3.986	5.154	4.266	2.928	21.610
Jarque-Bera Stat	1204.20	59.941	25.604	197.311	13.355	12.689	15.629	57.503	17.773	3.910	3806.01
Probability	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.142	0.000
No. of observations	2501	245	250	244	251	254	251	247	251	254	253

Table 1B : Descriptive Statistics of daily compounded log returns of Nifty											
	1995-2005	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Mean	0.000	0.000	0.000	0.001	0.000	0.001	-0.001	0.000	-0.001	0.002	0.001
Median	0.001	-0.001	0.000	0.000	-0.001	0.001	0.002	-0.001	0.000	0.005	0.002
Std. Deviation	0.016	0.013	0.017	0.015	0.018	0.019	0.020	0.014	0.010	0.014	0.016
Skewness	-0.272	0.706	0.432	-0.266	0.036	0.084	-0.279	-0.566	0.092	-0.349	-2.249
Kurtosis	7.920	5.580	9.347	7.180	4.245	5.108	4.544	5.354	3.710	3.121	22.323
Jarque-Bera Stat	2553.29	88.296	427.374	180.511	16.266	47.308	28.207	70.193	5.629	5.312	4149.17
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.070	0.000
No. of observations	2501	245	250	244	251	254	251	247	251	254	253

Table 1C : Descriptive Statistics of daily compounded log returns of CNX 500											
	1995-2005	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Mean	0.000	-0.001	0.000	0.000	0.000	0.002	-0.002	0.000	0.000	0.003	0.001
Median	0.001	-0.001	-0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.005	0.003
Std. Deviation	0.017	0.010	0.014	0.014	0.018	0.020	0.023	0.018	0.011	0.016	0.017
Skewness	-0.407	0.694	1.237	-0.351	-0.057	-0.011	-0.551	-0.631	-0.241	-0.507	-1.600
Kurtosis	7.117	5.936	10.609	7.142	4.003	4.176	4.448	6.839	3.273	3.339	13.844
Jarque-Bera Stat	1835.07	107.695	666.837	179.390	10.658	14.642	34.645	168.042	3.206	12.115	1347.48
Probability	0.000	0.000	0.000	0.000	0.005	0.001	0.000	0.000	0.201	0.002	0.000
No. of observations	2501	245	250	244	251	254	251	247	251	254	253

Table 1D : Descriptive Statistics of daily compounded log returns of BSE 100											
	1995-2005	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Mean	0.000	0.000	0.000	0.000	0.000	0.002	-0.002	0.000	-0.001	0.003	0.001
Median	0.001	-0.001	-0.001	0.000	-0.001	0.004	0.000	0.000	0.000	0.005	0.002
Std. Deviation	0.016	0.011	0.015	0.015	0.019	0.020	0.024	0.016	0.010	0.015	0.015
Skewness	-0.326	0.574	1.042	-0.283	-0.036	-0.077	-0.323	-0.566	0.123	-0.442	-2.119
Kurtosis	6.823	5.224	9.542	6.822	4.196	3.880	3.673	5.662	4.163	3.605	21.953
Jarque-Bera Stat	1567.70	63.930	491.142	151.728	15.011	8.452	9.105	86.118	14.772	12.157	3975.80
Probability	0.000	0.000	0.000	0.000	0.001	0.015	0.011	0.000	0.001	0.002	0.000
No. of observations	2501	245	250	244	251	254	251	247	251	254	253

Table No. 2 : ADF test τ values on the daily closing values of indices					
	No. of observations	Sensex	Nifty	CNX 500	BSE 100
1995-2005	2501	-0.7896	-0.5854	0.1349	-1.7235
1995-2000	1245	-1.2168	-0.8940	0.7621	-2.3369
2000-2005	1256	-0.2459	-0.2444	-0.0099	-0.2831
2002-2005	758	0.0264	-0.1039	-0.0754	0.0394
1995-96	246	-1.7704	-1.7496	-1.6875	**-10.4333**
1996-97	250	-1.4357	-1.4356	-1.0687	-1.2434
1997-98	244	-1.7567	-1.9731	-1.4996	-1.6677
1998-99	251	-1.6047	-1.6526	-1.1983	-1.5551
1999-00	254	-1.6248	-1.4271	-0.5792	-0.7346
2000-01	251	-2.1615	-2.1759	**-2.9055**	-2.4474
2001-02	247	-1.6764	-1.5885	-1.4214	-1.3095
2002-03	251	-2.0404	-1.9211	-1.8879	-1.8396
2003-04	254	-0.8707	-0.8613	-1.1355	-0.8576
2004-05	253	-0.6224	-0.7483	-0.7025	-0.6124
Critical values		**10 Years**	**5 years**	**3 years**	**1 year**
	1% level	-3.4328	-3.4354	-3.4388	-3.4570
	5% level	-2.8625	-2.8637	-2.8651	-2.8731
	10% level	-2.5673	-2.5679	-2.5687	-2.5730

Table No. 3 : ADF test τ values on the Continuously compounded daily returns on the indices				
	All 10 years data (1-4-1995 to 31-3-2005)			
	Sensex	**Nifty**	**CNX 500**	**BSE 100**
ADF test t values	-46.0281	-46.2357	-45.6486	-44.3840
R-squared	0.4589	0.4611	0.4548	0.4409
Adjusted R-squared	0.4587	0.4609	0.4546	0.4407
S.E. of regression	0.0161	0.0160	0.0166	0.0163
Sum squared residuals	0.6445	0.6398	0.6867	0.6654
Log likelihood	6781.83	6791.06	6702.54	6741.93
Durbin-Watson stat	1.9952	1.9915	1.9902	1.9928
Mean dependent variable	0.0000	0.0000	0.0000	0.0000
S.D. dependent variable	0.0218	0.0218	0.0225	0.0218
F-statistic	2118.59	2137.74	2083.79	1969.94
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
Critical Values	1%	5%	10%	
	-3.4328	-2.8625	-2.5673	

Table No. 4 : Durbin-Watson Test Statistics				
Year	**Sensex**	**Nifty**	**CNX 500**	**BSE 100**
1995-96	1.9150	1.9324	1.8586	1.8808
1996-97	1.9982	1.9044	1.9986	1.9938
1997-98	1.9133	1.9772	1.9196	1.9207
1998-99	1.9900	1.9924	1.9915	1.9889
1999-00	1.9794	1.9908	1.9728	1.9882
2000-01	1.9161	1.8915	1.9876	1.9632
2001-02	1.9841	1.9724	1.9743	1.9784
2002-03	1.9830	1.9769	1.9969	1.9738
2003-04	1.9906	1.9771	1.9837	1.9791
2004-05	1.9891	1.9570	2.0149	1.9701

Table No. 5 : Autocorrelations of Daily Compounded Log Returns of the Closing Values of the Indices						
	Sensex (1-4-1995 to 31-3-2005)			**Nifty (1-4-1995 to 31-3-2005)**		
lag	r	t values	R^2	r	t values	R^2
1	0.082	***4.100**	0.007	0.078	***3.900**	0.006
2	-0.024	-1.200	0.001	-0.046	-2.300	0.002
3	0.015	0.750	0.000	0.022	1.100	0.000
4	0.051	2.550	0.003	0.049	2.450	0.002
5	-0.021	-1.050	0.000	0.011	0.550	0.000
6	-0.062	***-3.100**	0.004	-0.057	***-2.850**	0.003
7	0.014	0.700	0.000	-0.008	-0.400	0.000
8	0.022	1.100	0.000	0.005	0.250	0.000
9	0.030	1.500	0.001	0.036	1.800	0.001
10	0.026	1.300	0.001	0.059	***2.950**	0.003

	CNX 500 (1-4-1995 to 31-3-2005)			**BSE 100 (1-4-1995 to 31-3-2005)**		
lag	r	t values	R^2	r	t values	R^2
1	0.090	***4.500**	0.008	0.118	***5.900**	0.014
2	-0.046	-2.300	0.002	-0.016	-0.800	0.000
3	0.064	***3.200**	0.004	0.033	1.650	0.001
4	0.053	***2.650**	0.003	0.040	2.000	0.002
5	-0.003	-0.150	0.000	0.001	0.050	0.000
6	-0.033	-1.650	0.001	-0.038	-1.900	0.001
7	0.007	0.350	0.000	0.016	0.800	0.000
8	0.046	2.300	0.002	0.028	1.400	0.001
9	0.045	2.250	0.002	0.051	2.550	0.003
10	0.056	***2.800**	0.003	0.054	***2.700**	0.003

*significant at 1% degree of freedom

Table No.6 : Cross Correlation between the Indices on the Daily Compounded log returns (1-4-1995 to 31-3-2005)									
	Sensex & Nifty			**Sensex & CNX 500**			**Sensex & BSE 100**		
lags	r	t values	R^2	r	t values	R^2	r	t values	R^2
0	**0.906**	***45.300**	0.821	**0.453**	***22.650**	0.205	**0.945**	***47.250**	0.893
1	0.135	**6.750**	0.018	0.581	***29.050**	0.338	0.117	***5.850**	0.014
2	-0.024	-1.200	0.001	0.045	2.250	0.002	-0.017	-0.850	0.000
3	0.015	0.750	0.000	0.005	0.250	0.000	0.023	1.150	0.001
4	0.044	2.200	0.002	0.040	2.000	0.002	0.049	2.450	0.002
5	-0.002	-0.100	0.000	0.024	1.200	0.001	0.004	0.200	0.000
6	-0.054	***-2.700**	0.003	-0.025	-1.250	0.001	-0.051	-2.550	0.003
7	0.001	0.050	0.000	-0.015	-0.750	0.000	0.013	0.650	0.000
8	0.008	0.400	0.000	0.026	1.300	0.001	0.019	0.950	0.000
9	0.031	1.550	0.001	0.015	0.750	0.000	0.036	1.800	0.001
10	0.037	1.850	0.001	0.041	2.050	0.002	0.039	1.950	0.002
	Nifty & Sensex			**Nifty & CNX 500**			**Nifty & BSE 100**		
lags	r	t values	R^2	r	t values	R^2	r	t values	R^2
0	**0.906**	***45.300**	0.821	**0.447**	***22.350**	0.200	**0.879**	***43.950**	0.773
1	0.095	***4.750**	0.009	0.599	***29.950**	0.359	0.138	***6.900**	0.019
2	-0.028	-1.400	0.001	0.025	1.250	0.001	-0.036	-1.800	0.001
3	0.029	1.450	0.001	-0.002	-0.100	0.000	0.041	2.050	0.002
4	0.050	2.500	0.003	0.040	2.000	0.002	0.047	2.350	0.002
5	-0.028	-1.400	0.001	0.033	1.650	0.001	-0.004	-0.200	0.000
6	-0.045	-2.250	0.002	-0.011	-0.550	0.000	-0.041	-2.050	0.002
7	0.006	0.300	0.000	-0.028	-1.400	0.001	0.004	0.200	0.000
8	0.027	1.350	0.001	0.018	0.900	0.000	0.028	1.400	0.001
9	0.026	1.300	0.001	0.021	1.050	0.000	0.033	1.650	0.001
10	0.038	1.900	0.001	0.047	2.350	0.002	0.047	2.350	0.002

Table No.6 (Contd.) : Cross Correlation between the Indices on the Daily Compounded log returns (1-4-1995 to 31-3-2005)									
	CNX 500 & Sensex			CNX 500 & Nifty			CNX 500 & BSE 100		
lags	r	t values	R^2	r	t values	R^2	r	t values	R^2
0	**0.453**	***22.650**	0.205	**0.448**	***22.400**	0.201	**0.469**	***23.450**	0.220
1	-0.020	-1.000	0.000	-0.034	-1.700	0.001	0.001	0.050	0.000
2	0.006	0.300	0.000	0.026	1.300	0.001	0.014	0.700	0.000
3	0.067	***3.350**	0.004	0.061	***3.050**	0.004	0.070	***3.500**	0.005
4	-0.009	-0.450	0.000	0.003	0.150	0.000	0.004	0.200	0.000
5	-0.028	-1.400	0.001	-0.021	-1.050	0.000	-0.020	-1.000	0.000
6	-0.007	-0.350	0.000	-0.015	-0.750	0.000	-0.008	-0.400	0.000
7	0.025	1.250	0.001	0.014	0.700	0.000	0.032	1.600	0.001
8	0.046	2.300	0.002	0.030	1.500	0.001	0.047	2.350	0.002
9	0.033	1.650	0.001	0.050	2.500	0.003	0.047	2.350	0.002
10	0.010	0.500	0.000	0.010	0.500	0.000	0.011	0.550	0.000
	BSE 100 & Sensex			BSE 100 & Nifty			BSE 100 & CNX 500		
lags	r	t values	R^2	r	t values	R^2	r	t values	R^2
0	**0.945**	***47.250**	0.893	**0.879**	***43.950**	0.773	**0.469**	***23.450**	0.220
1	0.083	***4.150**	0.007	0.123	***6.150**	0.015	0.620	***31.000**	0.384
2	-0.024	-1.200	0.001	-0.017	-0.850	0.000	0.061	***3.050**	0.004
3	0.025	1.250	0.001	0.024	1.200	0.001	0.017	0.850	0.000
4	0.041	2.050	0.002	0.029	1.450	0.001	0.041	2.050	0.002
5	-0.019	-0.950	0.000	-0.003	-0.150	0.000	0.021	1.050	0.000
6	-0.046	-2.300	0.002	-0.039	-1.950	0.002	-0.016	-0.800	0.000
7	0.018	0.900	0.000	0.008	0.400	0.000	-0.016	-0.800	0.000
8	0.029	1.450	0.001	0.017	0.850	0.000	0.025	1.250	0.001
9	0.044	2.200	0.002	0.041	2.050	0.002	0.034	1.700	0.001
10	0.038	1.900	0.001	0.042	2.100	0.002	0.050	2.500	0.003

* significant at 1% degree of freedom