CHAPTER VII
EFFICIENCY IN INDIAN STOCK MARKET
DURING POST REFORM ERA

7.1 Introduction

The impact of stock market development on economic growth depends to a great extent on the operational efficiency of stock markets. Efficiency is concerned with how successful the stock markets are in establishing security prices that reflect the worth of the securities; success being defined in terms of whether the market incorporates all information in its security prices in a rapid and unbiased manner. Efficiency, therefore, refers to the two aspects of a price adjustment to new information, direction and magnitude (the speed and quality), of the adjustment. The evaluation of this efficiency in stock market is very critical on framing policy measures for influencing stock market development to suit the development needs of the economy. The present chapter tries to decipher various dimensions of stock market efficiency and empirically evaluate the nature of existing efficiency in Indian stock market particularly Bombay Stock Exchange (BSE).

7.2 Efficient market hypothesis (EMH) in stock markets

The positive impact of stock market development on economic growth is possible only when the stock market is efficient. In other words, stock market induces economic growth only when the former is efficient. The stock market is said to be efficient when all the available information is instantaneously absorbed and reflected on its price. Such a rapid processing mechanism will not provide any opportunity to the market participants to forecast the future price.

If a stock market is operationally efficient there is little, or no, friction in the trading process. Information on prices and volumes of past transactions is widely available and price sensitive information is both timely and accurate; thus information dissemination is fast and wide. Liquidity is such that it enables market participants to
buy or sell quickly at a price close to the last traded price. Also, there is price continuity, such that prices do not change much from one transaction to another unless significant new information becomes available.

According to the Efficient Market Hypothesis (EMH), an operationally efficient stock market is expected to be externally and informationally efficient; thus “security prices at any point in time are an unbiased reflection of all the available information” on the security’s expected future cash flows and the risk involved in owning such a security. Such a market provides accurate signals for resource allocation as market prices represent each security’s intrinsic worth. Market prices can at times deviate from the securities’ true value, but these deviations are completely random and uncorrelated. (Fama, 1965).

Price changes are only expected to result from the arrival of new information. Given that there is no reason to expect new information to be non-random, period-to-period price changes are expected to be random and independent. It is expected that the more efficient a market, the more random the sequence of its price movements, with the most efficient market being the one in which prices are completely random and unpredictable (Fama, 1965; Lo, 1997).

In an efficient market, information gathering and information based trading is not profitable as all the available information is already captured in the market prices. This may leave investors with no incentive as to the gathering and analyzing of information, for they begin to realize that market prices are an unbiased estimate of the shares’ intrinsic worth.

‘Noise’ trading or imperfect information aggregation may lead to the breakdown of the informational, and therefore allocative, efficiency properties of a competitive market. If more and more market participants stop investing in information then less information will be incorporated in prices and the prices will therefore be ‘noisy’ (Fama, 1970; Samuelson, 1965). However, in an open market, where there are numerous profit maximising participants, arbitrage is expected to cause the market to return to efficiency. The numerous investors in the market will exploit the even smallest informational
advantage at their disposal, thereby incorporating their information into market prices and eliminating the profit opportunities that may have been presented by the information. In a market where there are no barriers to trade this must occur instantaneously so that no profits can be garnered from information based trading because such profits will have already been arbitraged away. Investors should therefore choose among the shares that represent ownership of the firm’s activities under the assumption that the prevailing market prices are an unbiased estimate of a share’s intrinsic value (Black, 1986; Lo, 1997).

According to Fama (1976) the theory of the Efficient Market Hypothesis (EMH) of financial markets holds that the security prices tend to fluctuate randomly around their intrinsic values, return quickly towards equilibrium, and fully reflect the latest information available. This means that in such markets investment strategies based on past information cannot consistently earn positive abnormal returns over extended periods of time.

7.3 The Need for Stock Market Efficiency

There are many characteristics which make the securities markets in general and stock markets in particular, unique and potentially more efficient than other markets. Though these characteristics are not sufficient in themselves to ensure an efficient market, they go a long way into making the stock market a perfectly competitive market, as would be defined by an economist, and therefore efficient. These characteristics are as follows:

(1) Informational Support

The primary role of the securities market is allocation of ownership of the economy’s capital stock. In general terms, the ideal is a market in which prices provide accurate signals for resource allocation. One of the most outstanding features of the securities market is the highly organized and elaborate information machinery that services it.(Keane, 1983). It is not only superior in terms of quality and quantity of information, but also in the rapidity with which the information is disseminated to market participants. All the securities markets invest sizable amounts in their efforts to
provide real time information to their members. Even though some markets also provide information to their participants, information provision is not as critical and as extensive as in the securities market (Lo, 1997).

(2) **Homogeneity**

The securities market, unlike other markets, comprises substantially of the same product – the claim to future returns subject to risk. The underlying operations of the companies may be diverse and individualistic, but the share prices are primarily determined by the expected future claims subject to the associated risk, a feature that provides a fair degree of comparability. This causes different shares to be basically the same product making them highly substitutable (Damodaran, 1996).

(3) **Taste independence**

Securities are unlike other products, such as paintings, where tastes and not pricing models play a huge role in the pricing. Individual investors may have different ‘tastes’, or rather preferences, with regard to risk, but this taste only affects the portfolio mix in terms of risky and riskless assets and not the value of individual securities relative to each other (Keane, 1983; Damodaran, 1996).

(4) **Location independence**

While the value of many other commodities is dependent on physical location, the value of securities is substantially independent of location. With dual listings on the increase and substantial reduction in foreign exchange barriers, traders have access to all markets, irrespective of their normal place of business (Keane 1983).

The object of the Efficient Market debate is not necessarily to determine whether share prices can be demonstrated to be correct, but whether the evidence relating to past prices and available information is sufficient to warrant the assumption that current prices are correct. The correct price should not necessarily predict the future, but should give an unbiased estimate of the returns expected from holding a security, while capturing the risks involved in holding such a security. The accuracy of the prediction depends on the efficient use of the information at the time of the pricing decision, and
not necessarily upon the final outcome. The validity of this ‘correctness’ is not diminished by the fact that at the critical stage of making the investment decisions, the correctness, or otherwise, of the share price is essentially a subjective assessment.(Keane, 1983).

7.4 Forms of efficiency

Following Fama(1970), the Efficient Market Hypothesis is categorised into three major levels depending on the type of information assumed to be used by the market in setting prices. These are:

(i) **Weak-form efficiency:**

The weak form of the theory also known as the ‘Random Walk’ says that the current price of the stocks already fully reflect all the information that is contained in the historical sequence of the prices. The weak-form of the EMH states that the sequence of past price returns contains no information about future price returns. Successive price returns are random and no trading strategies based on a study of past prices can yield abnormal returns. If the market is efficient in the weak form, prices reflect all past security market information; hence information on past prices and trading volumes cannot be used for profit. Investigating the presence of any statistically significant dependence (autocorrelation or price runs), or any recognizable trend in share prices changes, is traditionally used to directly test weak form efficiency. Research has also tested whether any trading rules could be demonstrated to be superior to a passive buy and hold strategy. (Dryden, 1970)

Weak form efficiency tests are the most numerous in terms of both frequency and research target, and the results mainly support weak form efficiency. In some cases, statistically significant dependence in return series has been found, but Fama (1970) maintains that “some of [the dependence] is consistent with the fair game model and the rest does not appear to be sufficient to declare market[s] inefficient.” In any case, most
of the profit opportunities presented by the trends tend to fall away when transaction costs are taken into account.

(ii) **Semi-strong form efficiency:**

The semi-strong form of the EMH states that the security prices fully reflect all available public information. Under the semi-strong form of the EMH, no trading strategies based upon the release of any publicly available information, for example, accounting earnings, will enable an investor to generate abnormal returns except by chance. The basic conclusion being that, if the market is semi-strong efficient, then it will instantaneously impound all information as it becomes publicly available into security prices. This form is concerned with both the speed and accuracy of the market’s reaction to information as it becomes available. Event studies that examine how stock prices adjust to specific significant economic events have been used to directly test semi-strong form efficiency. Events normally tested are stock splits, initial public offerings (IPO), company announcements (especially earnings and dividend announcements) and other unexpected economic and other world events.

Various other methods have been employed to test the semi-strong efficiency. Researchers have tested the significance of price to earnings (P/E) and other ratios, the effect of firm size and many other characteristics that can be derived from publicly available information. Other researchers have performed time series analyses on returns as well as on the cross sectional distribution of returns of individual stocks to find if any profit opportunities exist (Damodaran, 1996).

Most studies support the Efficient Market Hypothesis for developed markets but reject it for developing markets. The reason for this is that most of the developed markets have far more advanced systems of information disclosure and processing as compared to the developing markets (Keane, 1983). However there are several studies that provided evidence of inefficiency. All in all, the results on semi-strong tests may be best described as mixed, depending not only on the market tested but also on the testing methods employed.
(iii) **Strong-form efficiency:**

The strong-form of the EMH states that the security prices reflects all the information available both public and private at each point in time. The consequence of it is that no investor, even where such investor has inside information, may be able to device trading strategies based on such information to consistently earn abnormal returns.

Tests for the strong form efficiency are mainly centered on finding whether any group of investors, especially those who can have access to information otherwise not publicly available, can consistently enjoy abnormal returns. Groups normally tested are corporate insiders, stock exchange specialists, security analysts and professional asset managers. The results are mixed especially when professional money managers are involved but the bulk of the evidence does not support the hypothesis of strong form efficiency (Damodaran, 1996). Also the strong form efficiency is not as theoretically robust as the other two; intuition suggests that prices are not expected to capture information before it is published (Keane, 1983).

The levels of efficiency are nested. Strong-form efficiency implies semi-strong form efficiency, and semi-strong efficiency in turn implies weak-form market efficiency.

The concept of efficient securities markets has gained prominence in both the academic and business world of today. The concept is now supported by empirical evidence from many of the world’s markets. Today, it is not only widely accepted by academicians but it also permeates investment practice and Government policy towards the security markets.

If one agrees with the view that the stock markets are at present one of the best barometers for indicating changes in economic activity then we may expect, other things held constant, that the imperfections in the economy will be reflected by imperfections in the stock markets. The stock market will not respond in an instantaneous and unbiased...
manner to changes in economic activity. Price returns in an efficient market are independent over time. Inefficiency will be reflected in non-randomness of price returns.

There is consensus among academicians that capital markets in developed countries, for example, USA, Britain and Japan, nearly achieve these objectives because they are efficient at operation and information levels. This is supported by a tremendous amount of research evidence. The consensus seems to break down when the debate is extended to stock markets of developing countries. There are those who believe that these markets are not efficient because of their operating characteristics and the nature of the investors.

7.5 Reasons for Stock Market Inefficiency

At the operational level the markets are argued to be inefficient because of the following:

1) Small size, resulting in them being “thin” with an inadequate number of traders/dealers to ensure competition and insufficient securities to enable them to hold diversified portfolios of their choosing. (Keane, 1983)
2) Inadequate market regulation and standards of disclosure by companies. (Keane, 1983)
3) Poor communication systems so that some investors have an advantage over others.
4) Significant costs of obtaining investment information. (Keane, 1983)
5) A lack of competent analysts and professional advisers, resulting in differing expectations about the performance of securities. (Keane, 1983)
6) Significant transactions costs which may deter small investors, thereby limiting the number of market participants and restricting the market to infrequent large bargains. (Keane, 1983)

Considerable research energy has been expended in empirical tests of the Efficient Market Hypothesis. A rejection of the EMH may have the implication that the
market is not a reliable price setter and that it often, and sometimes significantly, misinterprets the economic signals it receives.

7.6 Review of literature stock market efficiency

Fama (1970) surveys the empirical evidence for the weak-form, semi-strong-form and strong-form efficient markets hypothesis (EMH). The author gives relatively wider coverage to the weak-form EMH. Empirical studies prior to 1970 generally employ serial correlation tests and technical trading rules, and their findings strongly suggest that stock markets are weak-form efficient. Two decades later, Fama (1991) conducts a second review of the market efficiency literature. Instead of focusing on past returns, the author expands the coverage of weak-form EMH to tests of return predictability using other variables such as the dividend-price ratio, earnings-price ratio, book-to-market ratio and various measures of the interest rates. The tests for the semi-strong-form and strong-form EMH are renamed as event studies and tests for private information, respectively. His review shows mounting evidence of return predictability from past returns, dividend yields and a number of term-structure variables, but the author argues that these findings might be spurious and should be met with skepticism.

7.6.1 Review on weak form efficiency

Vaidyanathan and Gali (1994) attempts to test the weak form of efficiency in the Indian Capital market. The test is based on the daily closing prices of ten shares actively traded on the Bombay Stock Exchange over four different period of time using Runs Test, Serial Correlation Tests, Filter Rule Tests. The evidence from all the three tests support weak form of efficiency.

Abeyratna and Power (1995) attempted to test whether Colombo Stock Exchange is weak form efficient using a sample of 20 shares. The paper examines the weak form of the efficient market hypothesis using Random Walk model, Serial correlation test and Runs Test. The results of the serial correlation test revealed that majority of the coefficients were negative although not statistically significant. The results of the runs
test showed evidence of positive persistence in share price changes for 40% of the securities while 60% did not reject the hypothesis of independence. Hence it could not be concluded that Colombo Stock Exchange is weak form efficient.

Belgaumi(1995) attempted to test the weak form of efficient market hypothesis in the Indian Stock Market and to examine whether share price movements over short periods such as week are independent for the April 1991 to March 1992 using Random Walk model, Serial Correlation test and Runs Test. The study used data from Economic Times All India Index of ordinary shares, with the base year 1985=100 and individual weekly share price series of selected companies. The study has found that the behaviour of share prices over a short period does not display any apparent pattern and it would be difficult to predict share prices from their historical price movements and that exchanges are weak.

Poshakwale(1996) examines the weak-form efficiency and the day of the week effect on the Bombay Stock Exchange using daily BSE national index data for the period from 1987 to 1994 using Kolmogorov Smirnov Goodness of Fit Test, Runs Test and Serial Correlation Test. The results of the Runs test and Serial correlation test indicate non-random nature of the series and the violation of the weak form of efficiency in the BSE.

Mobarek and Keasey(2000) attempted to test the weak form of efficiency in Dhaka Stock Exchange(DSE) for the period from 1988 to 1997 using Kolmogrov-Smirnov normality test, Runs test, Autocorrelation test, Auto regression test, ARIMA model. The study used the daily price index of all listed securities on the DSE. The results of the study show that the returns on DSE do not follow random walk model and is not weak form efficient.

Pant and Bishnoi(2001) analyzed the behavior of daily and weekly returns of 5 Indian stock market indices, namely, BSE Sensex, BSE-100, BSE-200, Nifty and NSE-500, for random walk during the period from 1996 to 2001. The indices were tested for
normality, autocorrelation using Q-statistic and Dickey-Fuller test and analyzed variance ratio using homoscedastic and hetroscedastic test estimates. The results of the study show that Indian stock market indices do not follow random walk. The results confirm the mean reverting behavior of stock indices and overreaction of stock prices in unitary direction in India.

Hall and Urga(2002) tests whether the Russian stock market, the transition economies market, has evolved towards some degree of efficiency since its foundation using two main indexes, namely, RTS Index and ASP General Index, at daily frequency from 1995 to 2000 using GARCH- M approach. The results of the study show that RTS Index is initially inefficient and it takes two and half years to become efficient and the ASP General Index shows signs of ongoing efficiency.

Magnusson and Wydick(2002) examined the weak form of market efficiency with returns characterized by random walk for 8 African countries sing Random Walk. Also, the study compares the efficiency of African Stock Markets with established stock markets such as South Korea, Taiwan, Argentina, Brazil, Chile, and Mexico along with newer markets such as the Guayaquil Stock Exchange in Ecuador and the Asian markets in Thailand and Indonesia. The results indicate that test results for weak-form efficiency in the emerging African stock markets compare favorably with those performed on other emerging stock markets.

Bhatnagar(2003) examines the efficiency and integration of the Indian Stock Market using Unit Root Test, Granger Causality test, Augmented Engle- Granger test and Cointegrating Regression Durbin-Watson Test. The proxy for the Indian Stock Market was the MSCI Price Index and the emerging stock markets were MSCI EMF Index. The results of the study show that the Indian stock markets is efficient in the weak form and follows a random walk and inefficient in the semi strong form. Also, it is seen that there exists causality between MSCI Price Index of India and MCSI EMF index and the direction of causality is unidirectional from MCSI EMF index to MCSI price Index.
Pandey(2003) attempts to test the efficiency level in Indian stock market in three popular stock indices and the random walk nature of the stock market by using the run test and the autocorrelation function for the period from January 1996 to June 2002. The data consists of daily and weekly closing price of three indices, namely, CNX Nifty, CNX Nifty Junior. The results show evidence of weak form of efficiency of the Indian Stock Market. From autocorrelaion analyses and runs test it was concluded that the series of stock indices in the India Stock Market are biased random time series. The auto correlation analysis indicates that the behaviour of share prices does not confirm the applicability of the random walk model in the Indian stock market.

Worthington and Higgs(2003) tests for random walks and weak-form market efficiency in European equity markets. The daily returns for sixteen developed markets, namely, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom and four emerging markets, namely, Czech Republic, Hungary, Poland and Russia are examined for random walks using a combination of serial correlation coefficient and runs tests, Augmented Dickey-Fuller ADF, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin unit root tests and multiple variance ratio (MVR) tests. The results, which are in broad agreement across the approaches employed, show that of the emerging markets only Hungary is characterized by a random walk and hence is weak-form efficient, while in the developed markets only Germany, Ireland, Portugal, Sweden and the United Kingdom comply with random walk criteria.

Abbas(2004) attempted to test the random walk of Efficient Market Hypothesis of Karachi Stock Exchange 100(KSE-100) for the period from 1994 to 2004 using autocorrelation test, Qstatistic and Augmented Dickey-Fuller test. The results support that KSE-100 index follow random walk in both weekly and monthly return series.

Moustafa(2004) examines the behavior of stock prices in United Arab Emirates (UAE) stock market for the period from 2001 to 2003 using the daily prices of the 43
stocks included in the Emirates market index. Since the returns of all the 43 sample stocks do not follow the normal distribution, the study utilizes only the nonparametric test (serial correlation and Runs test) for randomness. Hence, the empirical study supports the weak-form EMH of UAE stock market. The results of the study indicate that the prices of the stocks traded in UAE stock market behave in a manner consistent with the weak-form of EMH.

Islam et al. (2005) proposed a theory-free paradigm of non-parametric tests of market efficiency for an emerging stock market, the Thai stock market, consisting of two tests which are run-test and autocorrelation function tests (ACF), to establish a more definitive conclusion about EMH in emerging financial markets. The result of this study demonstrated that an autocorrelation on Thai stock market returns exists particularly during the post-crisis period. The inefficiency of the Thai stock market follows on from the violation of the necessary conditions for an efficient market with a developed financial system and also implies financial and institutional imperfections.

Hanclova and Rublikova (2006) attempted to test the weak form of market efficiency of Czech and Slovak Stock Market for the period from 2000 to 2004 using Correlation tests, Runs Test, Simulation test, Distribution models and Returns modeling. The study used the daily returns representing index PX50 index and SAX30 share price index. The results of the study showed that Czech Stock Market is weakly efficient while the Slovak Stock Market is more or less inefficient.

Simons and Laryea (2006) examined the weak form of efficient market hypothesis for four African Stock Markets- Ghana, Mauritius, Egypt and South Africa using weekly and monthly data from 1990 to 2003. The study employs both parametric (autocorrelation test and variance ratio test) and non-parametric tests (Kolmogrov-Smirnov normality test and the Runs test) to test the validity of the Efficient Market Hypothesis. The results of the study showed that South African Market was weak form efficient whereas the stock markets of Ghana, Mauritius and Egypt were weak form inefficient.
Worthington and Higgs (2006) examines the weak form market efficiency of Asian Equity Markets for 10 emerging (China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Taiwan and Thailand) and 5 developed countries (Australia, Hong Kong, Japan, New Zealand and Singapore) using serial correlation and Runs Test, Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin Unit Root Test and multiple variance ratio tests. The results of the serial correlation and Runs Tests show that all of the markets are weak form inefficient. The unit root tests suggest weak form efficiency in all markets, with the exception of Taiwan and Australia. The results of the variance ratio tests indicate that none of the emerging markets and developed markets except Hong Kong, Japan and New Zealand is weak form efficient.

Worthington and Higgs (2006) examines the weak-form market efficiency of the Australian stock market for the period from 1875 to 2006 using serial correlation coefficient and runs tests, Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski, Phillips, Schmidt and Shin unit root tests and multiple variance ratio tests. The serial correlation tests indicate inefficiency in daily returns and borderline efficiency in monthly returns, while the runs tests conclude that both series are weak-form inefficient. The unit root tests suggest weak-form inefficiency in both return series. The results of the variance ratio tests indicate that the monthly returns series follows the random walk, but the daily series violates weak-form efficiency because of the short-term autocorrelation in returns.

Cooray and Wickramasighe (2007) examines the efficiency (weak and semi strong) of the emerging stock markets from the South Asian Region, namely, India, Sri Lanka, Pakistan and Bangladesh for the period from 1996 to 2005. To examine weak form of efficiency, Augmented Dickey Fuller Test, Phillips-Perron test, Dickey- Fuller Generalised Least Square and Elliot- Rothenberg- Stock tests are used and to examine semi-strong form of efficiency Co-integration and Granger causality tests are used. Weak form of efficiency is supported by the classical unit root tests. However, it is not
supported for Bangladesh under Dickey-Fuller Generalised Least Square and Elliot-Rothenberg-Stock tests. Semi-strong efficiency is not supported by the tests.

Gupta and Basu(2007) attempted to test the weak form efficiency in the framework of random walk hypothesis for the two major equity markets in India for the period 1991 to 2006 using Augmented Dickey-Fuller test, Phillips-Perron test and KPSS test. The results of all the three tests suggest that the series do not follow random walk model and there is an evidence of autocorrelation in both markets rejecting the weak form efficiency hypothesis.

Sharma and Mahendru(2009) attempted to investigate the validity of the Efficient Market Hypothesis on the Indian Securities Market using a sample of 11 securities listed on the Bombay Stock Exchange (BSE), using the Runs tests and the Autocorrelation tests. The Autocorrelation test when directly applied to share prices gave conflicting results with Runs test. Then, the autocorrelation test was applied to first differenced series, which gives satisfactory results. Thus, the results of the study indicated that BSE is weak form efficient.

Abdmoulah(2010) examines the weak form of efficiency of 11 Arab stock markets using GARCH-M approach along with state-space time-varying parameters for the period from 1999 to 2009. The results of the study show that all markets show high sensitivity to the past shocks and are found to be weak-form inefficient. Moreover, the efficiency does not clearly improve towards the first quarter of 2009 and negatively reacts to contemporaneous crises, except temporary subperiods of efficiency improvement for the largest markets. This contrasts with mature markets and reveals the ineffectiveness of the reforms so far undertaken.

Hamid et al(2010) attempts to test the weak form market efficiency of the stock market returns of 14 Asia Pacific countries, namely, Pakistan, India, Sri Lanka, Indonesia, Malaysia, Thailand, Taiwan, Hong Kong, Singapore, Philippine, China, Korea, Japan and Australia for the period from 2004 to 2009 using Autocorrelation,
Ljung-Box, Q-statistics Test, Runs Test, Unit Root Test and Variance Ratio. The results of the study show that monthly prices do not follow random walks in all the countries of the Asian-Pacific region.

Lasrado and Rao (2010) examines whether the Indian stock market is informationally efficient in the weak form and whether the information contained in the past stock prices fully reflect in the present prices in the liberalization era (1995 to 2005). The study uses Augmented Dickey Fuller unit root test, Durbin-Watson test, Autocorrelation test and cross correlation test on the daily closing values of four major stock price indices, namely, Sensex, Nifty, S & P CNX 500 and BSE 100. The results of the test indicate that Indian Stock Markets is informationally efficient in the weak form.

Siddiqui and Gupta (2010) attempts to test the weak form efficient market hypothesis using the daily data for stock indices of the National Stock Exchange for the period of 1 January 2000 to 31 Oct 2008 using non-parametric (Kolmogrov –Smirnov normality test and run test) test and parametric test (Auto-correlation test, Auto-regression, ARIMA model). The results show that Indian Stock markets do not exhibit weak form of market efficiency.

Venkatesan (2010) attempted to examine the random walk behaviour of stock market returns in India using Ordinary Least Squares (OLS) method over the period from 2008 to 2009. The study uses the daily closing prices price returns of S&P CNX Nifty for the analysis. The results of the study suggest that the Indian stock markets are found to be efficient and support the random walk behaviour.

Al-Jafari (2011) examines the random walk hypothesis by testing the weak form efficiency of Bahrain Securities Market for the period from 2003 to 2010 using the Augmented Dickey-Fuller(unit root) test, Runs test and Phillips Perron test. The study uses daily observations of Bahrain all share index and employs parametric and nonparametric tests to examine the randomness and behavior of Bahrain Stock
Exchange. The results of the test show that Bahrain Stock Exchange is informationally inefficient at the weak level.

Al-Jafari(2011) examines the weak form efficiency of Kuwait Equity Market for the period from 2001 to 2010 using parametric and non parametric tests, namely, the Augmented Dickey-Fuller(unit root) test, Runs test and Phillips Perron test. The study uses daily observations of Kuwait Stock Exchange Index. The results of the test show that Kuwait Stock Exchange is informationally inefficient at the weak level.

Al-Jafari and Altaee(2011) examines the weak form efficiency in Egyptian Stock Market by testing the random walk hypothesis using unit root, runs test and variance ratio test on the daily price of EGX 30 Index for the period from 1998 to 2010. The result of the variance ratio test, unit root test and runs test show that Egyptian Stock Market did not follow random walk and informational inefficient at the weak-form level.

Khan et al(2011) tests the efficiency of the Indian market efficiency of Indian Capital Market in its weak form based on the indices of two major stock exchanges of India viz; National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) using the daily closing values of the indices of NSE and BSE for the period from 2000 to 2011 by employing Runs Test, which is a nonparametric test. The results of runs test shows that Indian Capital market neither follow random walk model nor is a weak form efficient.

Sapate and Ansari(2011) attempted to empirically test the weak form efficiency of Indian Stock Markets using Autocorrelation test, Ljung-Box Statistics and Runs Test. The study used the daily closing price of BSE-200 Index for the period from 2000 to 2010. The results of the study suggest that Indian Stock Markets returns follow random walk and support the weak form of market efficiency.

Jaradat and Al-Zeaud(2011) examines the validity of the random walk model for Amman Stock Exchange (ASE) using daily observation of ASE for the period from
1999 to 2009. The study used parametric and non-parametric methods to test the random walk hypothesis (RWH) through employing three different procedures run test, autocorrelation test, and unit root test. The results suggest that the behavior of the ASE return series is inconsistent with random walk model, which implies informationally inefficient.

Ajao and Osayuwu (2012) attempts to test the weak form of efficient market hypothesis in the Nigerian capital market for the period from 2001 to 2010 using serial correlation test, Runs Test and Box-Pierce Test. The study uses the data of all securities traded on the floor of the Nigerian Stock Exchange and the month end value of the All Share Index. The result of the serial correlation shows that the correlation coefficients did not violate the two-standard error test. The Box-Ljung statistic shows that none of the serial correlation coefficients was significant and the Box pierce Q statistics shows that the overall significance of the serial correlation test was poor while the result of the distribution pattern shows that stock price movements are approximately normal. The study concluded that successive price changes of stocks traded on the floor of the Nigerian Capital Market are independent and random therefore, the Nigerian Capital Market is efficient in the weak-form.

Al-Ahmad (2012) examines the weak form of efficiency of the Damascus Securities Exchange (DSE) for the period from 2009 to 2011 using Autocorrelation Test, Runs Test, Unit Root Test, Variance Ratio Test and GARCH Model. The results of the study show that DSE is inefficient in the weak form.

Budd (2012) examines the Efficient Market Hypothesis and Random Walk Hypothesis (RWH) for 17 sectors of the Saudi Arabia Tadawul Stock exchange for the period from 2007 to 2011 using the Variance-ratio test and Runs Test. The results of the study indicate evidence of weak-form efficiency in Saudi capital market and that prices do not fully reflect available information and prices changes are not independent nor distributed randomly.
Harper and Jin (2012) tests whether Indian stock markets are efficient and whether stock returns follow a random walk using auto correlation, Box-Ljung test statistics and Runs test. The data used in the study is index returns for the Bombay Stock Exchange for the period from 1997 to 2011. The results of the study indicate that the Indian stock market is not efficient in the weak form during the test period and do not reflect all information in the past stock prices.

Jana and Meher (2012) examined the weak form of efficiency in Indian Stock Markets for the period from 2006 to 2011. The study uses Runs Test, GARCH test and Serial Correlation Test to examine the daily closing prices of four indices and BSE (Sensex, BSE-100, BSE-200 and BSE-500) and four indices of NSE (S&P CNX Nifty, CNX-100, CNX-200 and S&P CNX-500). The results of the Runs test do not provide any conclusive returns. The results of the serial correlation test and GARCH test show that the return data are non-random and persistent in nature. Hence there will be volatility clustering and the markets will be inefficient.

Kumar and Kumar (2012) attempts to test the efficiency of Indian Capital Market in its weak form for the period from 2003 to 2011 using Runs Test. The data used in this study is the daily closing price of S&P CNX Nifty. The results show that NSE Nifty does not follow random walk model. This implies that the movement of stock price index cannot be determined by Random Walk Model.


Asal (2000) attempted to investigate the efficiency of the Egyptian stock market using daily stock prices for the period from 1992 to 1997. The paper examines the weak
form of the efficient market hypothesis using Random Walk model, Serial Correlation test and Q-statistic. The results show that up to 1996 the market was inefficient, but the inefficiency manifested itself through non-linear behavior. However, the results show that in 1997 the market is not characterized by predictability and is therefore informationally efficient.

### 7.6.2 Review on semi strong and strong form efficiency

Ormos, Mihaley (2002) empirically tested the efficiency of Hungarian Capital Market in its semi-strong form. The investigation was based on the capital market data over the period 1991 to 2000, which was analyzed by employing event study. The study concluded that strong form of efficiency of capital market does not completely hold true, thereby supporting that Hungarian Capital Market is semi-strong form efficient.

Asbell and Bacon(2010) attempted to test the semi-strong form efficient market hypothesis by analyzing the effects of insider trading on the risk adjusted rate of return of the firms’ stock prices for a sample of 25 firms. Using standard event study methodology in the finance literature, this study tested the impact of a random sample of insider purchases on the risk adjusted rate of return of the firms’ stock prices. The results show slight positive reaction prior to the announcement and a significant positive reaction after the announcement.

Khan and Ikram(2010) attempted to test the efficiency of the Indian Capital Market in its semi-strong form of Efficient Market Hypothesis (EMH) using . The study attempted to test the relation between the movement of FII and two major stock exchanges of India, BSE and NSE. The study used the monthly averages of NSE & BSE for the period from 2000 to 2010. The study used the Karl-Pearsons’ Product Moment Correlation Coefficient (Simple Correlation) and linear regression equations to analyze and determine the degree and direction of the relationship between the variables involved. The results suggest that the FII’s do have significant impact on Indian Capital
Market, which leads to the conclusion that Indian Capital Market is semi-strong form efficient.

Ananthi and Dinesh(2012) attempted to test the efficiency of Indian stock market with respect to corporate announcement by LIC housing finance limited. The major objectives of this study are to assess the pricing behavior of the events in LIC housing finance limited, to evaluate the risk of the stocks in in particular index, to identify the effect of those events in the whole market. The study carried as event study under the semi strong form of market efficiency using rate of return, beta, excess return, and average excess return, pivot point, and t-statistics as tool to test market efficiency. The major findings of the study are Indian overseas bank has identified the high return security during the period of December 2010 and the security of LIC housing finance limited has earned high market return among the selected securities during February 2011.

7.7 Testable Hypotheses, Data and Methodology

The weak form efficiency is tested for BSE in India. One of the conditions for weak form efficiency is that the stock returns must follow a random walk model; and thus, the testable hypotheses are:

**H0**: Stock return on BSE follows the random walk model.

**H1**: Stock return on BSE does not follow the random walk model.

As highlighted earlier, thin trading is an inherited problem in emerging markets that could taint the results obtained from the empirical tests of the EMH. To be more specific, due to thin trading, the results may suffer from spurious autocorrelation which could indicate inefficiency in the market (Lo and MacKinlay, 1988). To reduce the problem of thin trading, the daily returns of the BSE Sensex index are used to test the EMH in the DSE. The period of BSE sensex index is between April 1, 1991 and March 30 and the number of observation is 4100.
To examine the randomness of stock returns, the daily returns are calculated as follows:

\[ R_t = \ln \left( \frac{P_t}{P_{t-1}} \right) \]  

\[ \text{---------}(7.1) \]

Where \( R_t \) are the market returns at period \( t \), \( P_t \) is the price index at period \( t \), \( P_{t-1} \) is the price index at period \( t-1 \), and \( \ln \) is the natural log. The natural logarithm is used as it is more likely to be normally distributed.

7.8 Methodology

First, we examine whether the Indian Stock Markets is weak form efficient using autocorrelation test, the runs test, the unit root test, Augmented Dickey-Fuller test (ADF), Phillips –Perron (PP) tests, The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test the variance ratio test, and the GARCH (1,1) test. The tests here are designed to show that successive price returns are random and no trading strategies based on a study of past prices can yield abnormal returns. The information set used in empirical tests is the vector of past security prices. In this section the method of conducting each test and the rational behind it are explained.

If the Indian Stock markets are found to be weak form efficient, then we proceed to test whether the stock markets are semi-strong efficient. Semi Strong form of efficiency is tested using event studies like stock splits, earnings announcement and analysts’ recommendations and cross sectional return prediction. The empirical tests used to examine the semi-strong form of efficiency are designed to show that no trading strategies based upon the release of any publicly available information, for example, accounting earnings, will enable an investor to generate abnormal returns except by chance.

If Indian Stock Markets are found to be weak form and semi strong form efficient, then strong form of market efficiency will be tested. The consequence of it is that no investor, even where such an investor possesses inside information, may be able
to device trading strategies based on such information to consistently earn abnormal returns.

Strong-form efficiency implies semi-strong form efficiency, and semi-strong efficiency in turn implies weak-form market efficiency. The empirical implications of efficiency with respect to a particular information set are that the current price of the security embodies all the information in that set. Since the categories of information set are nested, rejection of a weaker type of efficiency implies the rejection of all stronger forms.

The following tests are used in this context.

(i) The Autocorrelation Test

Testing for serial correlation is a straightforward test of random walk. Autocorrelation, the serial correlation coefficient, measures the relationship between the value of a variable at the current period and its value in the previous period. Rather than testing the statistical significance of individual autocorrelation coefficients, the joint hypothesis that all of the autocorrelation coefficients up to certain lags are simultaneously equal to zero can be tested by using the Ljung-Box Q statistic. This test is designed to test for autocorrelation in small samples and it does not require normality of returns. It is distributed as a chi-square with degrees of freedom equal to the number of autocorrelations k (Gujarati, 2003). The null hypothesis of the test of lag k is that all autocorrelation coefficients up to order k are equal to zero whereas the alternative hypothesis is that they deviate from zero. The Ljung-Box Q statistic test is calculated as:

\[ Q_{LB} = N(N+2) \sum_{j=1}^{k} \frac{p_j^2}{N-j} \]

Where \( p_j \) is the \( j^{th} \) autocorrelation and \( N \) is the number of observations.

(ii) The Runs Test

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

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

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

\[
Z(r) = \frac{r - E(r)}{\sigma(r)} \quad \text{-----------------(7.3)}
\]

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

\[
E(r) = \frac{n + 2n_an_b}{n} \quad \text{-----------------(7.4)}
\]

The standard error represented by:

\[
\sigma E(r) = \left[ \frac{2n_an_b(2n_an_b-n)}{n^2(n-1)} \right]^{1/2} \quad \text{-----------------(7.5)}
\]

The runs test is a nonparametric test that is widely used for testing the independence assumption of random walk. The runs test compares the actual number of runs to the expected number of runs assuming price-change independence. Too many runs and too few runs give an indication of non randomness in the returns where too many runs indicate negative autocorrelation and too few runs indicate positive autocorrelation. The test for serial dependence is carried out by testing the null
hypothesis of no significant differences between the actual number of runs in the price series and the expected one in a random series.

(iii) The Unit Root Tests

Unit root tests are widely used in the literature to examine whether the variable of interest follows a random walk. If the time series of the variable has a unit root that means that the series is non stationary; and hence, it follows a random walk. In this study three different unit root tests are employed to test the null hypothesis of a unit root. These tests are the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test. (Details are explained in Chapter I).

(vii) The Variance Ratio Test

Campbell et al. (1997) report that unit root tests are not designed to test the predictability in stock price series. The Lo and Mackinlay variance ratio test is believed to be more powerful than the Dickey-Fuller unit root or the autocorrelation Q tests for testing the predictability in stock price series (Lo and Mackinlay, 1989). According to this test, the variance ratio statistics is based on the assumption that the variance of increments in the random walk series is linear in the sample interval. That is to say, if a series follows a random walk, the variance of a qth differenced variable is q times the variance of its first differenced variable.

\[
Var(R_t - R_{t-q}) = q \, Var(R_t - R_{t-q}) \tag{7.6}
\]

The variance ratio is then calculated as:

\[
VR(q) = \frac{\frac{1}{q} Var(R_t - R_{t-q})}{Var(R_t - R_{t-q})} = \frac{Var[R_t(q)]}{q \, Var[R_t]} = 1 \tag{7.7}
\]
The null hypothesis of the test is that the variance ratio at lag \( q \) is defined as the ratio of the variance of the \( q \)-period return to the variance of the one-period return divided by \( q \), which should equal to one under the random walk hypothesis. If any of the estimated variance ratios differs significantly from one, then the random walk hypothesis is rejected. Lo and MacKinlay (1988) developed two test statistics to test the null hypothesis, one is with the assumption of homoscedasticity increments \( Z(q) \) and the other is with the assumption of heteroscedasticity increments \( Z^*(q) \).

For performing this test, we first calculate the compounded daily returns on the BSE return series, find its variance and repeat the procedure for 2, 4, 8, 10, 16 and 32-day returns. We then calculate the variance ratios for all five times intervals, and test the following null hypothesis:

\[ H_0: \text{The VR at lag } q \text{ is defined as the ratio of the variance of the } q \text{-period return to the variance of the one-period return divided by } q, \text{ which is unity under the random walk hypothesis.} \]

An estimated variance ratio of less than one implies negative serial correlation, while a variance ratio of greater than one, or high \( Z \) value implies positive serial correlation. The rejection of single or more therefore rejects the null hypothesis of the random walk.

(viii) The GARCH (1,1) Model

Bollerslev (1986) extended the Engle (1982) model of Autoregressive Conditional Heteroscedasticity (ARCH) into the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) one. Although various extensions to the GARCH model have been introduced to account for asymmetry effects, Brooks and Burke (2003) suggest that the basic GARCH (1,1) model is sufficient to capture all of the volatility clustering that is present from the data.

The basic of the GARCH (1,1) model is that forecasts of time varying variance depend on the lagged variance of the asset. And thus, an unexpected increase or decrease
in the returns in the current period will lead to an increase in the expected variability in the next period. The basic model GARCH(1,1) can be expressed as:

\[ r_t = \mu + \phi h_t^2 + \epsilon_t \]  \hspace{1cm} (7.8)

\[ \epsilon_t/\phi_{t-1} \sim N(0, h_t) \]  \hspace{1cm} (7.9)

\[ h_t = \omega + \alpha \epsilon_{t-1}^2 + \beta h_{t-1} \]  \hspace{1cm} (8.0)

Where \( h_t \) is the variance, \( \omega \) is equal to \( \gamma V_L \) where \( V_L \) is the long run average variance rate, \( \epsilon_{t-1}^2 \) is a shock from the prior period measured as the lag of the squared residual from the mean equation (the ARCH term), \( h_{t-1} \) is the conditional variance from last period; \( \omega, \alpha \) and \( \beta \) are parameters to be estimated where \( \omega > 0, \alpha \geq 0 \) and \( \beta \geq 0 \).

The GARCH (1,1) is considered as weakly stationary if the summation of \( \alpha \) and \( \beta \), which measures the persistence of volatility, is less than 1. If the summation of \( \alpha \) and \( \beta \) is very close to one, then this indicates that the market is inefficient as it shows high persistence in volatility clustering (Bahadur, 2010).

### 7.9 Results and interpretations

#### 7.9.1 Descriptive statistics for BSE index

Table 7.1 displays general information about the daily series of the BSE return index. As is shown in the Table, the daily returns of the BSE have a mean and a median that are equal to zero. The fact that the returns are negatively skewed implies that the returns are more flat to the left than is the case in a normal distribution; and thus, investors are more likely to have frequent small gains and few extreme losses. That is to say, the large negative returns that investors may get are greater but less frequent, than the large positive returns.

The Table also reveals that the returns series have a kurtosis that is greater than three. The leptokurtic distribution means that the return a distribution is more “peaked”
and have “fatter tails; and hence greater risk of extreme outcomes, than is the case in the normal distribution.

Consistent with the skewness and kurtosis findings, the Jarque-Bera statistic is highly significant (P=0.000) thereby rejecting the hypothesis that the returns series of BSE are normally distributed.

**Table 7.1 Descriptive statistics of the BSE**

<table>
<thead>
<tr>
<th>Descriptive statistics</th>
<th>BSE Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.000634</td>
</tr>
<tr>
<td>Median</td>
<td>0.000937</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.159900</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.136607</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.017909</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.038140</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>8.193864</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>6521.783</td>
</tr>
<tr>
<td>Probability</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

**Figure 7.1**

Return Series of BSE Index

The randomness of the return series are assessed again with the help of serial autocorrelation and Ljung-Box Q-statistics. The test was run for 15 lags. If P value <0.05 of Q-statistics and the null of the entire autocorrelation is significant together
equal to zero may be rejected at 0.05 level of significance. It is inferred from the result that the historical returns can be used to predict future returns and this elements indicates that the weak form of market efficiency does not hold. The null hypothesis of no autocorrelation of return series is rejected for BSE.

<table>
<thead>
<tr>
<th>Autocorrelation Coefficient</th>
<th>Q-Stat</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.085</td>
<td>41.899</td>
</tr>
<tr>
<td>2</td>
<td>-0.025</td>
<td>45.637</td>
</tr>
<tr>
<td>3</td>
<td>0.014</td>
<td>46.762</td>
</tr>
<tr>
<td>4</td>
<td>0.003</td>
<td>46.804</td>
</tr>
<tr>
<td>5</td>
<td>-0.007</td>
<td>47.092</td>
</tr>
<tr>
<td>6</td>
<td>-0.025</td>
<td>50.637</td>
</tr>
<tr>
<td>7</td>
<td>-0.003</td>
<td>50.696</td>
</tr>
<tr>
<td>8</td>
<td>0.030</td>
<td>55.946</td>
</tr>
<tr>
<td>9</td>
<td>0.032</td>
<td>61.987</td>
</tr>
<tr>
<td>10</td>
<td>0.018</td>
<td>63.823</td>
</tr>
<tr>
<td>11</td>
<td>0.020</td>
<td>66.063</td>
</tr>
<tr>
<td>12</td>
<td>0.017</td>
<td>67.683</td>
</tr>
<tr>
<td>13</td>
<td>0.009</td>
<td>68.178</td>
</tr>
<tr>
<td>14</td>
<td>0.015</td>
<td>69.485</td>
</tr>
<tr>
<td>15</td>
<td>0.013</td>
<td>70.536</td>
</tr>
</tbody>
</table>

7.9.2 Results of the Runs test

Table:-7.3 reports the results of the runs test. The Z statistic that tests the significance of the differences between the expected number of runs and actual number of runs. In the present case, the difference of these values is highly significant (P=0.000); and thus, the runs test rejects the null hypothesis of randomness in stock returns. The table also shows that the results remain the same when the mean is used rather than the median. The fact that the number of actual runs is less than that of the expected ones suggests that there is a positive serial correlation in the data. That is to say, the market over-reacts to information whereby a share price change tends to be followed by further changes in the same direction.
Table: 7.3
Runs Test Result

<table>
<thead>
<tr>
<th>Run Test Based on Median</th>
<th>BSE Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median value</td>
<td>.00</td>
</tr>
<tr>
<td>Cases &lt; median</td>
<td>2900</td>
</tr>
<tr>
<td>Cases &gt;= median</td>
<td>2901</td>
</tr>
<tr>
<td>Total Cases</td>
<td>5801</td>
</tr>
<tr>
<td>Number of Runs</td>
<td>2648</td>
</tr>
<tr>
<td>Z</td>
<td>-6.657</td>
</tr>
<tr>
<td>P value</td>
<td>.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Run Test Based on Mean</th>
<th>.0006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases &lt; mean</td>
<td>2847</td>
</tr>
<tr>
<td>Cases &gt;= mean</td>
<td>2954</td>
</tr>
<tr>
<td>Total Cases</td>
<td>5801</td>
</tr>
<tr>
<td>Number of Runs</td>
<td>2656</td>
</tr>
<tr>
<td>Z</td>
<td>-6.423</td>
</tr>
<tr>
<td>P value</td>
<td>.000</td>
</tr>
</tbody>
</table>

7.9.3 Unit Root Test Results

Table: 7.4 reports the results of the unit root tests. It is instructive to note that while the null hypothesis for the ADF and the PP tests is that there is a unit root (the series is random); the null hypothesis for the KPSS test is that there is no unit root (the series is stationary).

As reported in the table, the T statistics for the ADF and the PP tests are highly significant. This implies that the null hypothesis of a unit root cannot be accepted. The results of the KPSS test show that the null-hypothesis of stationarity (or no unit root) cannot be rejected as the LM test value is less than the critical values at the 10%, 5% and 1% level. Overall, the results of the three tests confirm the rejection of the presence of unit root, and thus the series does not follow the random walk model.
TABLE:-7.4

Unit Root Test Result of BSE Returns

<table>
<thead>
<tr>
<th></th>
<th>ADF</th>
<th>PP</th>
<th>KPSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T test</td>
<td>P value</td>
<td>T test</td>
</tr>
<tr>
<td>BSE</td>
<td>69.9282</td>
<td>0.0001</td>
<td>69.9312</td>
</tr>
</tbody>
</table>

7.9.4 Results of Variance Ratio Test

Table:-7.5 reports the results of the variance ratio test. The null hypothesis that is tested here is that, if the series follows a random walk, then the variance ratio at each lag should equal to unity. As the table reveals, the results from the variance ratio analysis confirm the rejection of the random walk hypothesis under the assumptions of both homoscedasticity and heteroscedasticity and that is valid for all q lags. The Z(q) and the Z*(q) statistics are highly significant (at the 1% level) indicating that the variance ratio at the q lags are significantly different from one; and thus, the null hypothesis of randomness in the return series cannot be accepted and the weak form efficiency of the BSE is rejected.

Table:-7.5

Variance Ratio Test of Return Series for Lag periods in BSE

<table>
<thead>
<tr>
<th>BSE Index</th>
<th>Time horizon (Lags)</th>
<th>Var. Ratio</th>
<th>Zg</th>
<th>Zg*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>0.560475</td>
<td>-33.4732*</td>
<td>-16.8777*</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.272686</td>
<td>-29.6075*</td>
<td>-15.7934*</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.132747</td>
<td>-22.3283*</td>
<td>-12.5089*</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>0.089823</td>
<td>-18.4891*</td>
<td>-10.6875*</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0.067738</td>
<td>-16.1299*</td>
<td>-9.57356*</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>0.033705</td>
<td>-11.537*</td>
<td>-7.38807*</td>
</tr>
</tbody>
</table>
Zg statistics are the asymptotic normal test statistics under homoscedasticity. Zg* are the asymptotic normal test statistics under heteroscedasticity and ‘*’ indicates the rejection of the null hypothesis of no autocorrelation at the 0.01 percent level of significance.

7.9.5 Result of the GARCH (1,1) Model

Results of the GARCH (1,1) model are reported in Table:-7.6. The table reveals that the summation of α and β is almost equal to one. As discussed earlier, this is usually perceived as an indication of high persistence of volatility clustering; and thus, suggesting that the market responses to shocks in a way that is likely to die slowly. That is to say, the implications of a new shock on stock returns will last for a longer period in this market as old information appears to be more important than recent one. This result is consistent with the findings reported earlier in the serial correlation and runs test and confirms the rejection of the Efficient Market Hypothesis in the BSE.

<table>
<thead>
<tr>
<th>Coefficient in Garch model</th>
<th>Value of coefficient</th>
<th>Z-statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ω</td>
<td>5.64E-06</td>
<td>8.693044</td>
<td>0.00</td>
</tr>
<tr>
<td>α</td>
<td>0.107389</td>
<td>18.22844</td>
<td>0.00</td>
</tr>
<tr>
<td>β</td>
<td>0.877606</td>
<td>147.6836</td>
<td>0.00</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>-0.00108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.017919</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schwarz Criterion</td>
<td>-5.46853</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The finding that the BSE is inefficient in the weak form has very profound implications for both investors and policy makers. As for investors, the finding indicates that based on the historical information about the market, investors can develop profitable investment strategies if they do a proper analysis. That is to say, they could be better off by adopting a strategy that aims at outperforming the market rather than by adopting a “buy and hold” one. As for policy makers, the finding implies that they should take on more serious actions in order to enhance the efficiency of the market.
7.10 Conclusion

The main aim of this chapter was to test the efficiency of the Indian Stock markets using the daily closing value of SENSEX during the post reform period. The weak form of efficiency of the Indian Stock Market was tested employing the autocorrelation test, the runs test, the unit root test, Augmented Dickey-Fuller test (ADF), Phillips –Perron (PP) tests, The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test the variance ratio test, and the GARCH (1,1) test. The results of these tests support the notion that the Indian Stock Market is not weak form efficient. The results are in support of the notion that stock markets in emerging economies are not efficient. Thus, it implies that an investor can reap profits by using the share price data as the current share prices already do not reflect the effect of past share prices.

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