Recent Financial Crisis and Market Efficiency: An Empirical Analysis of Indian Stock Market

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Abstract

The present paper adds to the literature of market efficiency by studying the impact of recent financial crisis on stock market efficiency in emerging stock markets such as India. The data for last 10 years were collected from both Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) in India. The data was divided into two sub-periods, i.e. before financial crisis period (period-I) and during financial crisis period (period-II). The study concludes that Indian stock markets do not exhibit weak form of market efficiency and thus do not follow random walk in both period-I and period-II. The study implies that the recent financial crisis did not impact the behavior of Indian stock markets to a great extent. The results of the study might be useful for investors, corporate executives, portfolio managers and policy makers in framing business policies and for the appraisal and management of present portfolios.

Keywords: Market Efficiency, Recent Financial Crisis, Indian Stock Market.

1. Introduction

The evidence from past research has shown that the healthy functioning of stock markets have considerable effect on growth of an economy in a developing country. There have been large numbers of studies, conducted around the globe by many researchers since last few decades, on the subject of stock market efficiency. But the results of these studies are conflicting, which makes it difficult to comment on the status of stock market of a particular country. As a result, the stock market behavior in developing countries deserves more attention. Therefore, it would be interesting to investigate how the recent financial crisis has affected the Indian stock market over time.

The term "stock market efficiency" is used to explain the association between the information and share prices in the market. The term market efficiency was first defined by Eugene Fama in 1970, where he has defined market efficiency as the efficiency in stock markets as the condition when the security prices in that market adjust rapidly to the introduction of new information. Therefore, it is believed that in an efficient market, current prices of securities reflect all the information useful for price prediction of securities in the stock market. The efficiency of the market depends upon the extent of absorption of information, the time taken for absorption and the type of information absorbed. Fama (1970) suggested that the efficient market hypothesis can be divided into three categories. These are weak form, semi-strong form and strong form. In the 'weak form efficient market' hypothesis, he states that current prices fully reflect all the information contained in the historical prices. In 'semi-strong form', the current prices of stocks reflect all informational content of historical prices as well as all publicly available information. In the 'strong form', the prices of securities fully reflect all available information i.e., both public as well as private. The strong form maintains that not only the publicly available information is useless to the investor or analyst but all information is useless.

Financial crisis is a situation in which the value of financial institutions or assets drops rapidly and it is often associated with a panic or a run on the banks, in which investors sell off assets or withdraw money from savings accounts with the expectation that the value of those assets will drop if they remain at a financial institution (Investopedia). The end of 2007 and beginning of 2008 observed the arrival of global financial crisis which had bought the havoc to the financial markets around the world. The turbulence began in the global stock market scenario with a liquidity shortfall in US banking system and continual

fall in stock prices on information that Lehman Brothers, Merill Lynch and many other investment bankers and companies are collapsing. The stock markets around the globe suffered huge losses and Indian stock market was not an exception. The SENSEX which had reached historically high levels in the beginning of 2008, turned down to its level about three years back and the S&P CNX NIFTY also followed the similar trend.

Several investment policies can be adopted after making a decision about stock market's efficiency when stock markets were affected by financial crisis shocks. The research on this subject matter are very few, particularly in the frame of stock markets in India. Hence, this paper is an attempt to provide some empirical evidence on efficiency in Indian stock market as a result of recent global financial crisis.

The remaining paper has been organized as follows. Section II briefly explains the review of past literature, sections III gives the rationale and scope of the study, sections IV and V are devoted to objective and hypothesis part respectively, section VI clarifies the data and research methodology adopted and finally section VII concludes with the findings of the study.

2. Review of Literature

Various researchers have given their observations and views regarding different worldwide stock markets. The results given by these social scientists were not similar but contradictory. There were two different schools of thought, the first declared the presence of weak form market efficiency in some international stock markets but at the same time few researchers did not find any evidence of random walk in same or the other stock markets at the global level.

The initial part of review includes the studies supporting weak form market efficiency in various stock markets around the world, whereas the later part includes the studies which do not accept random walk hypotheses in same or other stock markets in the world.

2.1. Studies Supporting Weak Form Market Efficiency

There are a number of studies which supported weak form market efficiency like Sharma and Kennedy (1977), who evaluated the stock indices of Bombay, London and NYSE during the period 1963 to 1973 using run test and spectral analysis and both the tests confirmed the random movement of stock indices for all the three stock exchanges. Then, Barnes (1986) tested weak form market efficiency for Kaula Lumpur Stock Exchange (KLSE). The data consisted of thirty companies and six sectors for the time period of six years ended in 1980 by using serial correlation coefficient test, run test and spectral analysis and concluded that the KLSE exhibits a high degree of efficiency in the weak-form. Though the findings suggest the market is generally weak form efficient, patches of inefficiency observed for shares that suffer liquidity problem. In another study, Annuar et al. (1991) also investigated KLSE over the period from January 1977 to May 1989 using monthly and weekly data by employing serial correlation and unit root test. The results of the study were found to be consistent with unit root, therefore concluding that the KLSE is efficient in weak form. Lee (1992) examined the random walk process for the period 1967-1988 for weekly stock returns of the US and ten other industrialized countries. A variance ratio test was employed for the analysis and found that the random walk model is appropriate for majority of countries forming sample of research. Urrutia (1995) observed four Latin American emerging markets for both market efficiency and random walk hypotheses using monthly data of index prices from the period of December 1975 to March 1991. He used LOMAC's single variance ratio test for the purpose and based on the results, he concluded that all the four Latin American emerging stock markets were weak form efficient and exhibit dynamics that were inconsistent with the random walk hypothesis. Similarly, Al-Loughani and Chappell (1997) studied the London stock market using GARCH model, BDS test and autocorrelation function. The random walk hypothesis was rejected for London stock market. However, the hypothesis of

weak form market efficiency cannot be rejected. Karemera et al. (1999) examined the random walk hypothesis for fifteen emerging stock markets using multiple variance ratio tests and run test. Their results supported the evidence provide by Urrutia (1995) who found Argentina, Brazil and Mexico to be weak form efficient.

Rahman et al. (2004) evaluated Dhaka Stock Exchange (DSE) for the existence of weak form for the period of January 31, 1990 to September 30, 2003 using monthly index time series. For such evaluation, unit root tests (ADF and PP) were used and the results supported the hypothesis that DSE index time series contains unit root which implies the existence of weak form market efficiency in DSE. Akinkugbe (2005) explored Botswana stock exchange (BSE) for weak form of efficient market hypotheses using 738 weekly observations for the period of June 1989 to December 2003. Autocorrelation and unit root (ADF and PP) were used to test the weak form efficiency in BSE. The autocorrelation test does not evidenced serial correlation and the result of both unit root tests indicated a stationary process for stock returns. Therefore, it implied that stock markets in Botswana were efficient in weak form. Omran et al. (2006) investigated the validity of the random walk hypothesis and tested for calendar effects in five major Middle Eastern emerging markets, by applying a range of statistical and econometrics techniques such as run test, autocorrelation function, box-pierce test and unit root test for testing the random walk and kruskal-wallis test for testing the calendar (day of the week) effect. The results confirmed that Israel's TA-100 stock market shows greater support for the random walk hypotheses (RWH) compared with the other markets in the sample. With regard to calendar effects, there were anomalies found related to day of the week effects which do not appear to be related to the pattern of trading days over the week, and which might be accounted for by other institutional factors specific to the countries in the sample. Asiri (2008) used cross sectional time series data for forty listed companies in Bahrain Stock Exchange (BSE) over the period from June 1, 1990 to December 31, 2000 to study the behavior of stock prices in BSE. Random walk models such as unit root and dickey-fuller test were used as basic stochastic tests for non-stationarity of daily prices for all listed companies in BSE and autoregressive integrated moving average (ARIMA) and exponential smoothing method were also used. The results confirmed random walk for all daily stock prices and thus the market is considered efficient in weak form. Chigozie (2009) investigated whether the Nigerian stock market, from period 1984 to 2006, follows random walk. To carry out the investigation the GARCH model was employed and the result showed that the Nigerian stock market follows a random walk and therefore weak form efficient. Mahmood et al. (2010) tried to examine the impact of recent financial crisis on the efficiency of Chinese stock market by dividing the stock price data from Shanghai and Shenzhen stock market for the period of six years, starting from January 2004 to December 2009, into two sub-periods, i.e. before crisis and during crisis period. The sample data was analyzed by applying Runs test, Variance Ratio test, Durbin-Watson test and Unit Root (ADF) test and it was concluded that the Chinese stock market was weak form efficient and global financial crisis has no significant impact on the efficiency of Chinese stock market.

There are number of studies wherein researchers tried to test the Indian stock market's behavior in terms of stock market efficiency. Such researches includes the studies done by Bhaumik (1997), Rao and Shankaraiah (2003), Samanta (2004) and Sharma and Mahendru (2009), who have tested BSE in India by means of various econometric tests and concluded that the BSE is weak form efficient and returns of BSE follows random walk. Ramasastri (1999) as well as Pant and Bishnoi (2002) have also used autocorrelation function, unit root test and variance ratio to examine the random walk hypothesis for Indian stock market. On the basis of the test results, they concluded that Indian stock market follows random walk and thus efficient in weak form.

2. 2. Studies Not Supporting Weak Form Market Efficiency

Gandhi et al. (1980) used monthly data for shares and industrial indices from Kuwait Stock Exchange (KSE) for the period starting from December 1975 to May 1978 and found that both, simple linear regressions of returns on lagged returns and run test for autoregression rejected the random walk hypothesis for KSE. Laurence (1986) tested both on the Kuala Lumpur Stock Exchange (KLSE) for the period from June 1973 through December 1978 and the Stock Exchange of Singapore (SES) for January 1973 to February 1979. Serial correlation and run test were employed for the purpose of testing weak form market efficiency and the results of these tests suggested that both markets are not weak form efficient. There are very few studies done on African markets which do not support random walk hypotheses such as the study done by Parkinson (1987), who examined the validity of the weak-form efficiency for the Nairobi Stock Exchange (NSE) using monthly prices of individual companies for the period 1974 to 1978 and found that the random walk hypothesis was rejected for NSE. Lo and MacKinlay (1988) strongly rejected random walk model for a sample of 1216 weekly observations of firms in the NYSE-AMEX over the period 1962-1985. Frennberg and Hansson (1993) examined the random walk hypothesis on set of monthly data for the Swedish stock market for 1919-1990 using variance ratio test and autoregression of multiperiod returns. They found that the Swedish markets have not followed random walk in past 72 years and strong evidences of positive autocorrelated returns were also found for short investment horizons whereas, for long investment horizons indication of negative autocorrelation was there. In the same manner, Al-Loughani (1995) employed variance ratio test, run test and autocorrelation test with weekly data for the Kuwait Stock Exchange (KSE) for the period beginning on August 27, 1986 to August 1, 1990. The results of run test and autocorrelation test were found to be consistent with the random walk hypothesis, whereas this hypothesis was rejected for variance ratio test. Darrat and Zhong (2000) investigated Chinese stock exchanges (Shanghai and Shenzhen) for random walk model. Two different approaches, the standard variance ratio test and a model comparison test were used for such investigation, and the random walk hypothesis was rejected for both Chinese stock markets.

Abraham et al. (2002) studied three major Gulf stock markets including Kuwait, Saudi Arabia, and Bahrain using the variance ratio and run test for October 1992 to December 1998 for weak-form stock market efficiency in these markets. The results obtained from variance ratio test rejected the random walk hypothesis in all the three stock markets while same hypothesis was not rejected for the Saudi Arabia and Bahrain markets but for Kuwaiti composite index. Filis (2006) tested weak form efficiency for Athens Stock Exchange (ASE) for the years 2000-2002 using 500 daily observations of the FTSE/ASE 20 index. He had used run test, unit root test (ADF test) and Wilcoxon rank test. GARCH test was also used to check volatility clustering. The results support the evidence of weak form efficiency in ASE. In addition, evidences for volatility clustering were also found as the GARCH effect was significant. Mobarek et al. (2008) studied Bangladesh's Dhaka Stock Exchange (DSE) for the period 1988 to 2000. Non-parametric (KS and run test) and parametric (Autocorrelation, autoregressive model and ARIMA model) tests were used for testing the efficiency in DSE. Based on the results of these test, it was concluded that DSE is an independent market and follows the random walk. DSE was also tested for efficiency by Uddin and Khoda (2009) using daily closing prices of twenty three companies from pharmaceutical sector. They have employed unit root test, ADF test and PP test for the purpose and on the basis of analysis the null hypothesis for weak form has been rejected and it was concluded that the returns of DSE do not follow random walk. Awad and Daraghma (2009) examined the Palestine Security Exchange (PSE) at weak-level for 35 stocks listed in the market using serial correlation, unit root test (ADF and PP) and run test for the time period from January 1998 to October 2008 and suggested the weak form inefficiency in the return series of PSE.

Amongst number of studies conducted on stock markets in India that have rejected the null hypothesis

for weak form market efficiency are given as follows.

Choudhari (1991) used the serial correlation and run test on the 93 actively traded shares on Bombay Stock Exchange (BSE) for the period January 1988 to April 1990. The test study by Choudhari concluded that the market was not weak form efficient. Similar results were given by Poshakwale (1996), who examined the Bombay Stock Exchange (BSE) in India for weak form efficiency and day of the week effect using daily prices of BSE national index from January 1987 to October 1994. The author used KS one sample test, run test and serial correlation coefficient to test BSE and the results indicated that the sample distribution was not normal and the prices on BSE did not follow random walk. The day of week effect was also observed in BSE which shows that the average returns are different on each day of the week and the returns achieved on Friday are significantly higher compared to rest of the days of the week. Ahmad et al. (2006) obtained similar results on testing the weak form efficiency for two major equity markets in India i.e. BSE and NSE for the period of 1999-2004. The data was divided into two sub-periods to have better results and various econometric techniques are used like unit root test (ADF and PP), Autocorrelation function, Ljung-Box (Q) statistics, GARCH model, run test and KS test. The random walk hypothesis for the Nifty and the Sensex stock indices is rejected and it was found that both the stock markets have become relatively more inefficient in the recent periods, and have high and increasing volatility. On testing the weak form efficiency in framework of random walk hypothesis for the two major equity markets in India i.e. BSE and NSE for the period 1991 to 2006, Gupta and Basu (2007) found that the series do not follow random walk model and thus the hypothesis for weak form market efficiency was rejected. Runs test, LOMAC variance ratio test and unit root test (ADF, PP, KPSS) were used to test the weak form efficiency and random walk hypothesis.

3. Rationale and Scope of Study

Since there are three forms of market efficiency, but working on all the three forms is not possible in this paper because of unavailability of the data and usefulness of the results for attaining the objectives of the study. Testing the strong form of market efficiency is not possible on account of data unavailability because it considers private or insider information which is not easily accessible, and the results of testing semi-strong form does not measures the randomness in the market returns, which is only possible through testing the weak form of market efficiency. Our objective is to test the effect of financial crisis on the randomness in the market returns, which is possible by testing market efficiency in weak form. Moreover, valuation of securities is an important function of financial markets which leads to the formation of trading strategies for the traders and investors dealing in these markets. The valuation of securities is required to identify the behavior of the markets, which is again possible by knowing the status of efficiency in the stock market. Furthermore, arbitrage is possible only if the markets are inefficient. If the markets are efficient in weak form, buying the undervalued securities and selling them into the markets, where securities are fairly valued or overvalued, is not possible. This makes it difficult for the investors to earn abnormal profits on trading in such markets. Hence, weak form market efficiency leads to the decisions related to buying and selling of the undervalued or overvalued securities on right time.

4. Objective

The aim of this paper is to understand the nature of the Indian stock market by testing the randomness in the daily market returns and to study the impact of recent financial crisis. Randomness in stock returns is possible only if market is efficient in weak form. Hence, the objective of this paper is to check whether Indian stock market follows random walk which can be confirmed by testing weak form market efficiency. For this purpose, daily closing prices of S&P CNX Nifty from NSE and BSE Sensex from BSE are taken. The BSE and NSE are considered for the studying the Indian stock market because of their popularity around the world so as to represent the Indian

financial market. We have used the daily closing prices of S&P CNX Nifty from NSE and BSE Sensex from BSE for the period of 10 years. In order to see the impact of recent financial crisis and have time varying results, the total data is divided into two equal sub-periods. We assume the sample period is sufficient to evaluate the information asymmetry especially after the huge Foreign Institutional Investors investments in stock markets, sub-prime crisis disorder and the recent financial crisis.

5. Data and Research Methodology

The Indian capital markets are represented by the one index each from National Stock Exchange (NSE) and the Bombay stock Exchange (BSE). The data for the present study consist of daily closing prices of the indices taken for the study. The data is collected for last ten years starting from 01/11/2000 to 31/10/2010. The data set is obtained from the PROWESS, the CMIE database. In order to determine the state of efficiency in Indian stock market, with special reference to recent financial crisis, the total time period is divided into two sub-periods: one before global financial crisis (Period-I from 01/11/2000 to 31/10/2005) and another one during financial crisis (Period-II from 01/11/2005 to 31/10/2010).

Following methods shall be used to test the time series data for normality, random walk, stationarity and autocorrelation function:

Jarque-Bera (JB) Test is used to measure the normality of the distribution. The results of skewness and kurtosis, which are also used to test the normality, are verified by the JB test. So, JB test is the test of joint hypothesis that skewness and kurtosis are zero and three respectively. The value of JB statistic is calculated by using the following equation:

$$JB = n\ [S^2/6 + (K-3)^2/24]$$

The conclusion can also be drawn on the basis of probability value. If the value of probability is more that 0.05 at 5% level of significance, we accept the null hypothesis for normality and can be concluded that the observed series follows normal distribution.

Kolmogorov-Smirnov (KS) Test is a well accepted goodness of fit test. It compares the observed cumulative distribution function for a variable with a specified theoretical distribution which may be normal, uniform, poisson or exponential. It determines that how well a random sample of data fits a particular distribution. It checks whether the observations have come from the specified distribution.

Run Test is used to test randomness of the time series. The null hypothesis of the test is that the observed series is random variable. When the Z value is more than $\pm$ 1.96 at 5 percent level of significance, the test rejects the null hypothesis. The test is non-parametric and is independent of the normality and constant variance of data.

Unit Root Test is used to test the stationarity of time series data and to find out whether a time series variable is non-stationary. The most popular unit root tests used to test the stationarity are the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. Both tests use the existence of a unit root as the null hypothesis. If the series is non-stationary and the first difference of the series is stationary, the series contains a unit root.

Autocorrelation Function (ACF) is used to determine the correlation of series with itself. It measures the amount of linear dependence between observations in a time series that are separated by lag. The ACF shows the pattern of autocorrelation present in time series as well as the extent to which current values of the series are related to various lags of the past data. ACF shows whether the serial correlation is significantly different from zero. In an efficient market, existence of zero autocorrelation forms the null hypothesis.

Return of the indexes are used to conduct the run test, normality test and autocorrelation for the time series, Daily return has been calculated as follows by taking the natural logarithm of the daily closing price relatives.

$$r = \ln\ (P_t/P_{t-1})$$

It may also be noted that the price of the indexes are used to test the stationarity.

6. Analysis and Findings

6.1 Descriptive Statistics

The descriptive statistics describes the characteristics of the data as the summary of descriptive statistic, which is provided in table 1 for both period-I and period-II. The sample means, median, maximum, standard deviation, skewness, kurtosis, Jarque-Bera statistics and probability value are given here under.

Table 1: Descriptive Statistics

	Period-I		Period-II	
	BSE	NSE	BSE	NSE
Mean	4554.935	1440.562	14309.74	4257.488
Median	3946.530	1248.950	14467.36	4291.100
Maximum	8799.960	2663.350	20873.33	6287.850
Minimum	2600.120	854.2000	7944.100	2386.750
Std. Dev.	1501.642	448.7140	3252.326	968.7726
Skewness	0.805417	0.737581	-0.105559	-0.008327
Kurtosis	2.551511	2.344944	2.021163	2.000515
Jarque-Bera	145.2718	135.3619	51.34619	51.16979
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1247	1247	1229	1229

From the data of period I, it is clearly seen that BSE has the higher value in terms of mean, median, maximum price, minimum price and standard deviation while these values are lower in case of NSE's S&P CNX NIFTY. The higher value of standard deviation explains that the BSE is considered to be more volatile market as compared to NSE. The values of skewness and kurtosis reveal that both markets do not follow normal distribution, which is further verified by the value of Jarque-Bera statistic and probability value.

Data for period-II also gives the same result as given in period-I, therefore, it can be concluded BSE is more volatile in period-II as well. However, the volatility, for both the markets, has increased simultaneously during the period of financial crisis. But, both the markets still not follow normal distribution as explained by the values of skewness, kurtosis and Jarque-Bera statistic.

6.2 One-Sample Kolmogorov-Smirnov Test

The KS one sample test compares the cumulative distribution function for variable with a uniform or normal distribution and tests whether the observation have come from the specified distribution. Table 2 shows the results of KS test for period-I and period-II respectively.

Table 2: One-Sample Kolmogorov-Smirnov Test (Period - I & II)

		Period-I		Period-II	
		BSE	NSE	BSE	NSE
N		1246	1246	1228	1228
Most Extreme Differences	Absolute	0.052	0.058	0.088	0.082
	Positive	0.052	0.058	0.088	0.082
	Negative	-0.048	-0.047	-0.067	-0.066
Kolmogorov-Smirnov Z		1.832	2.050	3.087	2.858
Asymp. Sig. (2-tailed)		0.002	0.000	0.000	0.000

Test distribution is Normal

As given in period-II, that in period-I, returns of both the markets, NSE and BSE do not follow normal distribution as the value of probability is less that 0.05 at 5 percent level of significance and null hypothesis of normal distribution for both the markets are therefore rejected. Data of period-II indicates that there is no change in status of both markets during the period of financial crisis. Further, the frequency distributions of both the markets do not fit normal distribution. Hence, the returns are not found to be normally distributed.

6.3 Run Test

The results of run test are given in the following tables. Table 3 gives the values of run test for period-I i.e. the period before crisis and the value for period-II i.e. the period of recent financial crisis.

Table 3: Run Test (Period - I & II)

	Period - I		Period - II	
	BSE	NSE	BSE	NSE
Test Value[a]	0.00	0.00	0.00	0.00
Cases < Test Value	623	623	614	614
Cases >= Test Value	623	623	614	614
Total Cases	1246	1246	1228	1228
Number of Runs	559	567	601	601
Z	-3.684	-3.231	-0.799	-0.799
Asymp. Sig. (2-tailed)	0.000	0.001	0.424	0.424

a. Median

From period-I, it can be make out that Z values are more than + 1.96, therefore, null hypothesis for the run test is rejected at 5 percent level of significance for the period before crisis. Hence, it can be concluded that both the series do not follow random walk over the time of study and for this reason both NSE and BSE are considered to be weak form inefficient.

The run test for period-II shows the sign of efficiency because the value of Z statistic are less than + 1.96 at 5 percent level of significance. Thus, the markets are expected to follow random walk. So, it can be easily make out from the results that the state of efficiency has changed as the impact of recent financial crisis in the Indian stock markets. The markets have become efficient during the time period of recent financial crisis. It is interesting to note that in period-II the values of run test for both the market are similar thus it can be perceived that both the markets have shown similar drift in period-II irrespective of their performance in period-I.

6.4 Unit Root Test

The unit root test is used to test the existence of non-staionarity in the time series data. If the series is non-stationary in level form and stationary in first difference form, then it is expected that the series contains unit root. The results of two tests are given in following part. The null hypothesis of unit root states that the series is does not contain unit root.

6.4.1 Augmented Dickey-Fuller (ADF) Test

The results of ADFAugmented Dickey-Fuller Test of unit root are given in table 4a for period before crisis (period-I) and in table 4b for the period during crisis (period-II).

Table 4a: Unit Root Test (Period - I)

Augmented Dickey-Fuller (ADF) Test

	Level			First difference		
Symbol	Lag length	ADF statistic	p-value	Lag length	ADF statistic	p-value
BSE	4	0.557775	0.9886	3	-15.81881	0.0000
NSE	4	0.165287	0.9703	3	-15.86687	0.0000

Exogenous: Constant

Lag Length: Automatic based on SIC, MAXLAG=4

*MacKinnon (1996) one-sided p-values.

Deterministic terms: Intercept

Values in table 4a exhibit that the null hypothesis of unit root cannot be rejected for both BSE and NSE as it can be seen from the table values that both series are non-stationary in level form but are stationary in first difference form, which implies that the series contains unit root. Therefore, the markets do not follow random walk and are considered to be weak form inefficient in before crisis period.

Table 4b: Unit Root Test (Period - II)

Augmented Dickey-Fuller (ADF) Test

	Level			First difference		
Symbol	Lag length	ADF statistic	p-value	Lag length	ADF statistic	p-value
BSE	0	-1.547277	0.5093	0	-32.50305	0.0000
NSE	0	-1.504393	0.5313	0	-33.15154	0.0000

Exogenous: Constant

Lag Length: Automatic based on SIC, MAXLAG=4

*MacKinnon (1996) one-sided p-values.

Deterministic terms: Intercept

The results do not vary in the period-II. It can be seen from the values given in table 4b that during recent financial crisis the condition of markets remained same, i.e. daily price series are non-stationary in level form but stationary in first difference form. Hence, in period-II also the markets do not follow random walk and considered to be weak form inefficient.

Phillips-Perron (PP) Test

PP test is another way of testing the stationarity in time series data. The results of PP test for period before crisis (period-I) and the period during crisis (period-II) are given in table 5a and table 5b respectively.

Table 5a: Unit Root Test (Period - I)

Phillips-Perron (PP) Test

	Level			First difference		
Symbol	Bandwidth	P-P test statistic	p-value	Bandwidth	P-P test statistic	p-value
BSE	1	0.708657	0.9923	3	-31.62680	0.0000
NSE	3	0.345972	0.9806	5	-30.96579	0.0000

Exogenous: Constant

Bandwidth: Newey-West using Bartlett kernel

MacKinnon (1996) one-sided p-values

Deterministic terms: Intercept

It can be clearly seen from table 5a that null hypothesis for PP test is also rejected because in before crisis period, both series are non-stationary in level form but are stationary in first difference form, which implies that both BSE and NSE contains unit root. Thus, it can be concluded that the markets do not follow random walk and are considered to be inefficient in weak form in before crisis period.

Table 5b: Unit Root Test (Period - II)

Phillips-Perron (PP) Test

	Level			First difference		
Symbol	Bandwidth	P-P test statistic	p-value	Bandwidth	P-P test statistic	p-value
BSE	16	-1.604642	0.4799	19	-32.46163	0.0000
NSE	15	-1.556062	0.5048	18	-33.15054	0.0000

Exogenous: Constant

Bandwidth: Newey-West using Bartlett kernel

MacKinnon (1996) one-sided p-values

Deterministic terms: Intercept

As in the case of ADF test for period-II, the results do not vary for PP test also. Table 5b shows that behavior of market remained same during recent financial crisis. The daily price series for both BSE and NSE are non-stationary in level form but stationary in first difference form. That's why in period-II also the markets do not follow random walk and are inefficient in weak form.

Auto Correlation Function (ACF)

The ACF is used to determine the independence of stock price changes. It measures the amount of linear dependence between observations in time series that are separated by lag. The Ljung-Box (Q) statistic is used to test whether a group of autocorrelations are different from zero. The ACF and Q statistic of BSE and NSE for period-I and period-II are presented in table 6.

Table 6: Autocorrelation Function (Period - I & II)

Lags	Period - I				Period - II			
	BSE		NSE		BSE		NSE	
	ACF	Ljung-Box	ACF	Ljung-Box	ACF	Ljung-Box	ACF	Ljung-Box
1	0.094*	11.091	0.119*	17.577	0.070*	5.974	0.051*	3.181
2	-0.090*	21.259	-0.125*	37.202	-0.042	8.123	-0.026	3.999
3	0.016	21.598	0.036	38.786	-0.017	8.470	-0.014	4.255
4	0.101*	34.306	0.101*	51.584	-0.031	9.627	-0.020	4.773
5	0.010	34.433	0.014	51.834	-0.034	11.029	-0.031	5.966
6	-0.068*	40.212	-0.065*	57.149	-0.040	12.997	-0.048	8.865
7	-0.013	40.417	-0.032	58.417	0.019	13.452	0.029	9.891
8	-0.007	40.476	-0.025	59.204	0.085*	22.356	0.083*	18.424
9	0.049	43.456	0.051*	62.475	0.029	23.367	0.026	19.237
10	0.023	44.111	0.050*	65.617	0.012	23.541	0.000	19.237
11	0.017	44.464	0.008	65.700	-0.019	23.981	-0.027	20.135
12	-0.030	45.591	-0.049	68.778	0.014	24.235	0.021	20.678
13	0.014	45.825	0.028	69.790	0.046	26.922	0.052*	24.042
14	0.052*	49.175	0.055*	73.613	0.047	29.671	0.051*	27.251
15	-0.030	50.325	-0.032	74.897	0.010	29.797	0.014	27.479
16	-0.009	50.421	-0.028	75.918	0.017	30.151	0.026	28.353

*Significant at two standard errors at 1 percent level of significance.

According to the values of ACF presented in table 6, the values for BSE are found to be significant at lags 1,2,4,6 and 14 during the period before financial crisis. Thus, Ljung-Box or Q statistic rejects the null hypothesis of zero autocorrelation at one percent level of significance. The behavior of NSE in this period is found to be worse as compared to BSE because ACFs are significant at lags 1,2,4,6,9,10 and 14 and the Q test also rejects the null hypothesis of zero autocorrelation at one percent level of significance. Therefore, the ACFs for BSE and NSE are highly autocorrelated and it can be concluded that both BSE and NSE, both are considered to inefficient markets during the pre crisis period.

Table 6 also exhibits the ACF values for period during financial crisis and this period seems better as compared to pre crisis period because the figures indicate that, at lag 1 and 8 the ACF is found to be significant in case of BSE and for NSE, ACF is significant at lag 1,8,13 and 14. The Ljung-Box or Q statistic also rejects the null hypothesis of zero autocorrelation at 1 percent level of significance, which ultimately shows that both the markets, NSE and BSE are still inefficient in period-II but the situation has improved as compared to pre crisis period. Therefore, markets are less inefficient as it were in pre-crisis period, but still there is possibility of earning extra income on the account of market inefficiency.

7. Discussion

Since this type of studies are longitudinal in nature so new set of findings may be worked out by taking the data for different time periods. With the passage of time, new and interesting things might have cropped up in the markets which are required to be captured and presented before the important stakeholders. The uniqueness of this paper is to study the impact of recent financial crisis on Indian stock

markets by taking the data for latest ten years on daily basis and dividing it into two equal time periods i.e. before and during the financial crisis. All important tests have been used to justify the rationale of the paper and the conclusions drawn are interesting while we go through the findings of the paper. The present paper has added worth to the past literature of market efficiency by studying the impact of recent financial crisis on stock market efficiency in emerging market like India.

8. Conclusion

The efficiency in stock markets explains the extent to which the stock prices reflects all available information in the market and therefore by relying upon this information one can take decision about buying or selling the stocks. Relevant investment strategies could be adopted after deciding whether the market is efficient or not.

On the basis of empirical results given by various tests in previous section, we can conclude that Indian stock markets does not exhibit weak form market efficiency and thus do not follow random walk in both period-I and period-II. The recent financial crisis did not impact the behavior of Indian stock markets to a great extent. There is no significant difference in market efficiency in both periods however the efficiency has improved marginally in period-II compared to period-I. Thus, there are possibilities of earning extra income in Indian markets because abnormal returns are possible only when the market is inefficient as the future prices can be predicted using the past information. Thus, observation and the use of the past behavior of stock price movement may help investors in generating excess profits.

The practical implication of inefficiency in stock markets is that, it may lead to the variation in the expected returns of the securities. This is because the changes in prices would be more than expectation on arrival of some new information in the market. In the state of inefficiency, the share prices may not reflect the fair value of the stocks because of which the companies with lower fair value of shares may find it difficult to raise capital, which may disturb the investment pattern in the country in long-run. The condition of weak form market inefficiency may have positive impact on the financial innovation because the opportunity of earning abnormal profit may hike the short-run investments in the country.

As far as the future implication of the present research work is considered, the research work on stock markets done in past may be functional for the researchers who wish to work on the same subject line in future because these type of studies are persistent in nature. The observations, which are drawn from such studies conducted in one time period, may be helpful in justifying the studies of future researchers. In addition, the results of the past studies are contradictory in nature which is an inspiring reason for future researches in the same area.

References

Abraham, A., Seyyed, F.J. and Alsakran, S.A. (2002). Testing the Random Walk Behavior and Efficiency of the Gulf Stock Markets. *The Financial Review,* 37, 469-480.

Ahmed, K.M., Ashraf S. and Ahmed, S. (2006). Testing Weak Form Efficiency of Indian Stock Markets. *Economic and Political Weekly,* XLI(1), 49-56.

Akinkugbe, O. (2005). Efficiency in Botswana Stock Exchange: An Empirical Analysis. *The Business Review,* 4(2), 223-230.

Al-Loughani, N. (1995). Random Walk in Thinly Traded Stock Markets: The Case of Kuwait. *Arab Journal of Administrative Sciences,* 3, 189-209.

Al-Loughani, N. and Chappell, D. (1997). On the Validity of the Weak-Form Efficient Markets Hypothesis Applied to the London Stock Exchange. *Applied Financial Economics,* 7, 173-176.

Annuar, M.N., Ariff, M. and Shamsher, M. (1991). Technical Analysis, Unit Root and Weak-Form Efficiency of the KLSE. *Banker's Journal Malaysia,* 64, 55-58.

Asiri, B.K. (2008). Testing Weak from Efficiency in the Bahrain Stock Market. *International Journal of Emerging Markets,* 3(1), 38-55.

Awad, I. and Daraghma, Z. (2009). Testing the Weak-Form Efficiency of the Palestinan Securities Market, *International Research Journal of Finance and Economics,* 32, 07-17.

Barnes, P. (1986). Thin Trading and Stock Market Efficiency: Case Study of the Kuala Lumpur Stock Exchange. *Journal of Business Finance & Accounting,* 13(4), 609-617.

Bhaumik, S.K. (1997). Stock Index Futures in India: Does the Market Justify Its Use?. *Economic and Political Weekly,* 32(41), 2608-2611.

Chigozie, O.G. (2009). Analysis of Weak-Form Efficiency on the Nigerian Stock Market: Further Evidence from GARCH Model. Retrieved May 21, 2010, from http://docsdrive.com/pdfs/ansinet/ijaef/0000/17124-17124.pdf.

Choudhari, S.K. (1991). Short Run Price Behaviour: New Evidence on Weak Form of Market Efficiency. *Vikalpa,* 16(4), 17-21.

Darrat, A.F. and Zhong, M. (2000). On Testing the Random-Walk Hypothesis: A Model-Comparison Approach. *The Financial Review,* 35(3), 105-124.

Fama, E.F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance,* 25(2), 383-417.

Filis, G. (2006). Testing for Market Efficiency in Emerging Market: Evidence from the Athens Stock Exchange. *Journal of Emerging Market Finance,* 5, 121-133.

Frennberg, P. and Hansson, B. (1993). Testing the Random Walk Hypothesis on Swedish Stock Prices: 1919-1990. *Journal of Banking and Finance,* 17, 175-191.

Gandhi, D.K., Saunders, A.S. and Woodward, R.S. (1980). Thin Capital Markets: A Case Study of the Kuwaiti Stock Market. *Applied Economics,* 12, 341-349.

Gupta, R. and Basu, P.K. (2007). Weak Form Efficiency in Indian Stock Markets. *International Business & Economics Research Journal,* 6(3), 57-64.

http://www.investopedia.com/terms/f/financial-crisis.asp, accessed on 3rd June 2011.

Karemera, D., Ojah, K. and Cole, J.A. (1999). Random Walk and Market Efficiency Tests: Evidence from Emerging Equity Markets. *Review of Quantitative Finance and Accounting,* 13(2), 171-188.

Laurence, M.M. (1986). Weak-Form Efficiency in the Kuala Lumpur and Singapore Stock Markets. *Journal of Banking and Finance,* 10(3), 431-445.

Lee, U. (1992). Do Stock Prices Follow Random Walk? Some International Evidence. *International Review of Economics and Finance,* 1(4), 315-327.

Lo, A.W. and Mackinlay, A.C. (1988). Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test. *Review of Financial Studies,* 1(1), 41-66.

Mahmood, F., Xinping, X., Shahid, H. and Usman, M. (2010), Global Financial Crisis: Chinese Stock Market Efficiency. *Asian Journal of Management Research,* 1(1), 90-101.

Mobarek, A. and Keasey, K. (2002). Weak-Form Market Efficiency of Emerging Market: Evidence from Dhaka Stock Market of Bangladesh. Retrieved May 21, 2010, from http://www.google.co.in/search?q=Weak-Form+ Market+Efficiency+of+Emerging+Market%3A+Evidence+from+Dhaka+Stock+Market+of+Bangladesh&hl=en&rlz=1T4ACAW_enIN382&sa=2.

Omran, M. and Farrar, S.V. (2006). Tests of Weak Form Efficiency in the Middle East Emerging Markets. *Studies in Economics and Finance,* 23(1), 13-26.

Pant, B. and Bishnoi, T.R. (2002). Testing Random Walk Hypothesis for Indian Stock Market Indices. Retrieved on May 19, 2010, from http://www.utiicm.com/Cmc/PDFs/2002/bhanu_pant.pdf.

Parkinson, J. M. (1987). The EMH and CAPM on Nairobi Stock Exchange. *East Africa Economy Review,* 3(2), 105-110.

Poshakwale, S. (1996). Evidence on the Weak Form Efficiency and the Day of the Week Effect in the Indian Stock Market. *Finance India,* 10(3), 605-616.

Rahman, M.Z., Salat, A. and Bhuiyan, M.M.H. (2004). Testing Weak Form of Efficiency of the Dhaka Stock Exchange. *Journal of Business Studies,* 25(2), 175-188.

Ramasastri, A.S. (1999). Market Efficiency in the Nineties: Testing Unit Roots. *Prajnan,* 28(2), 155-161.

Rao, D.N. and Shankaraiah, K. (2003). Stock Market Efficiency and Strategies for Developing GCC Financial Markets: A Case Study of the Bahrain Stock Market. *The Arab Bank Review,* 5(2), 16-21.

Samanta, G.P. (2004). Evolving Weak-Form Informational Efficiency of Indian Stock Market, *Journal of Quantitative Economics,* 2(1), 66-75.

Sharma, G.D. and Mahendru, M. (2009). Efficiency Hypothesis of the Stock Markets: A Case of Indian Securities. *International Journal of Business and Management,* 4(3), 136-144.

Sharma, J.L. and Kennedy, R.E. (1977). A Comparative Analysis of Stock Price Behaviour on the Bombay, London and New York Stock Exchanges. *Journal of Financial and Quantitative Analysis,* 12(3), 391-413.

Uddin, M. G. S. and Khoda, A. K. M. N. (2009). Testing Random Walk Hypothesis for Dhaka Stock Exchange: An Empirical Examination. *International Research Journal of Finance and Economics,* 33, 64-76.

Urrutia, J.L. (1995). Tests of Random Walk and Market Efficiency. Journal of Financial Research, 18, 299-309.

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