Weak Form Efficiency of the Chittagong Stock Exchange: An Empirical Analysis (2006-2016)

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ABSTRACT

We study the random walk behavior of Chittagong Stock Exchange (CSE) by using daily returns of three indices for the period of 2006 to 2016 employing both non-parametric test (run test) and parametric tests [autocorrelation coefficient test, Ljung– Box (LB) statistics]. The skewness and kurtosis properties of daily return series are non-normal, with a hint of positively skewed and leptokurtic distribution. The results of run test; autocorrelation and Ljung–Box (LB) statistics provide evidences against random walk behavior in the Chittagong Stock Exchange. Overall our result suggest that Chittagong Stock Exchange does not exhibit weak form of efficiency. Hence, there is opportunity of generating a superior return by the active investors.

1.0   INTRODUCTION

The growth of equity markets and the globalization of financial markets are often the subject of major research studies in developing countries. Additionally, testing different forms of the efficient market hypothesis seems to be the most popular theme of these empirical investigations. Market Efficiency is defined by Fama (1970 and 1991) as a market in which prices always fully reflect all available information. He argues that the allocation of the ownership of the economy's capital stock, which represents the primary role of the capital market, is ideally fulfilled if the market is efficient, because prices from such a market provide accurate signals for resource allocation. Actually, the Efficient Market Hypothesis (EMH) says that the changes in price occur in an efficient market randomly and independently.

Efficiency in stock market requires to satisfy certain essential pre-requisites like availability of relevant information, frequent trading activity, sophisticated and developed trading mechanism, large number

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of listed securities, high liquidity, presence of large number of rational risk averse investors, low brokerage and commission cost etc. When all these factors meet, they can reasonably guarantee that stock prices will react very quickly on the availability of any new information and the behavior of stock prices can be explained by the arrival of any new information not by their historical prices (Ali, 2012). There are three different levels of efficiency which are defined based on the level of information reflected in the prices: weak- form, semi-strong and strong form. Weak form of efficiency indicates that price of financial assets reflects all information contained in the past prices. Semi strong form of efficiency asserts that prices reflect all the publicly available information where as strong form says that prices of financial assets reflect in addition to information on past prices and publicly as well as privately available information. The random walk hypothesis is a financial theory stating that stock market prices evolve according to a random walk and thus the price changes in the stock market cannot be predicted. That is an investor can't make any superior return making any predictions using any co-relationship of future prices with past prices. The hypothesis states that stock price changes have the same distribution and are independent of each other, so the past movement or trend of a stock price or market cannot be used to predict its future movement. The EMH is also consistent with the random walk hypothesis.

In this paper, we have tried to analyze whether the Chittagong Stock Exchange is efficient in weak form or not. Here, the returns of CSE All Share Price Index, CSE Selective Index and CSE Selective Categories Index are tested using Autocorrelation, LB statistic and run test. In the first part of this article theoretical description has been given on these statistical tools. Then in the later part empirical analysis and results have been shown. In our findings, the descriptive statistic shows that none of the return series follow normal distribution. On the basis of the results of autocorrelation test, LB test and runs test carried out on the sample drawn from CSE, it can be concluded that the stock market returns do not follow random walk and they provide evidence against the weak form of efficiency of Chittagong Stock Exchange during our study period.

2.0   LITERATURE REVIEW

Pyemo Afego (2012) examined the weak-form efficient markets hypothesis for the Nigerian stock market by testing for random walks in the monthly index returns over the period 1984-2009. This paper showed the opportunity is existing to have superior earnings for market participants by using the non-parametric runs test. Finally, a range of policy strategies are suggested for improving the allocative capacity and quality of the information to ensure the environment of the NSE. Similar conclusion is drawn by Akram and Murad (2013) examining the weak-form efficiency of Palestine Exchange (PEX). They employ the serial correlation and the Augmented Dickey-Fuller test (ADF) as parametric tests and the runs test as a non-parametric test and concluded that results of both tests are consistent with the alternative hypothesis that the stock market is weak-form inefficient and the main index found to be moving non-randomly. Asma Mobarek and Keavin Keasey (2000) have found from their study that there is no existence of weak form efficiency of Dhaka Stock Exchange. The sample includes the daily price indices of all the listed securities on the DSE for the period of 1988 to 1997. The hypothesis of the study was whether the Dhaka Stock Market was weak form of efficient. The results of both non-parametric (Kolmogrov –Smirnov normality test and run test) test and parametric test (Auto-correlation test, Auto-regression, ARIMA model) provide evidence that the share return series do not follow random walk model and the significant autocorrelation co-efficient at different lags reject the null hypothesis of weak-form efficiency.

Haroon (2012) also conducted a similar research like ours on Karachi Stock Exchange. In their research, weak form efficiency has been tested of Karachi Stock Exchange—KSE covering the period of 2nd November 1991 to 2nd November 2011. He employed non-parametric tests were KS Goodness-of-Fit test, run test and autocorrelation test to find out serial independency of the data. Results prove that KSE is not weak-form-efficient. Thus, it can be said that technical analysis may be applied to gain abnormal returns. Sania and Rizwan (2014), Muhammad and Nawaz (2014) also put the same argument. On the other hand, Mayowa and Richard (2012) have found the Nigerian Capital Market is efficient in

the weak-form. Mohammad Bayezid Ali (2012) in his paper examines the comparative efficiency to identify any discrepancy in stock prices between Dhaka Stock Exchange (DSE) and Chittagong Stock Exchange (CSE) between February 2004 and August 2010. Daily, weekly as well as monthly stock price data from DSE and CSE have been used to test whether they exhibit price behavior that resemble to random walk hypothesis (RWH). Based on descriptive statistics, CSE stock prices are found to be more volatile than DSE stock prices. Estimates of Ljung-Box Q-statistics provide that autocorrelation exists in both DSE and CSE stock prices up to lag 10. Stationarity test provides that DSE and CSE stock price are non-stationary time series at level but becomes stationary at their first differenced form. Finally, multiple variance ratio tests reveal that, with few exception, DSE and CSE stock prices fails to exhibit random walk at daily and weekly data series. But for monthly data, both stock prices follow random walk.

Khairul Alom and Muhammad Raquib (2014) in their paper examine paradigm of non-parametric tests of market efficiency for an emerging stock market, the Dhaka Stock Exchange (DSE), consisting of non-parametric test which is autocorrelation function tests (ACF), to establish a more definitive conclusion about efficient market hypothesis in emerging financial markets. The result of their research demonstrated that a positive autocorrelation on DSE returns exists particularly in the period of 1998-2012 and DSE didn't hold weak form of efficiency and was not following the Random walk model. Syed Tauseef Raza Gilani, et al. (2014) in a similar study like ours they explored the weak form of efficiency of Islamabad Stock Exchange (ISE). Here, they have used run test and ADF test to check the weak form using data from January, 2013 to December, 2013.

Md. Zobaer Hasan, et al. (2011) measured the status of technical efficiency of companies in Dhaka stock exchange (DSE) for panel data using the stochastic frontier production function, incorporating technical inefficiency effect model. It was observed that the inefficiency increased over the reference period. Chu V. Nguyen and Muhammad Mahboob Ali (2011) investigated whether the Dhaka Stock Exchange in Bangladesh is weakly efficient by modifying and estimating Dockery and Kavussanos' multivariate model using a set of panel data. Their findings suggest that the Dhaka Stock Market is not informationally efficient.

3.0   DATA AND METHODOLOGY

To study whether random walk hypothesis is experimental in Chittagong Stock Exchange or not, we took three market indices of Chittagong Stock Exchange (CSE) into our analysis. All data was taken from the website of Chittagong Stock Exchange consisting of 2248 observations. The data was taken for the period of 1st July, 2006 to 31st October, 2016. The daily index data for different periods are converted into continuously compounded return because lognormal returns are more likely to be normally distributed (Strong, 1992). We calculate lognormal return by using following formula.

$R_t = \ln (P_t/P_{t-1}) \times 100$

Where,
R_t= logarithmic return in period t
P_t= stock index price at time t
P_{t-1} = stock index price at time t-1

The analysis is done by using SPSS16 software package. Different techniques are used to find out the random walk hypothesis for stock market. Our study mainly focuses on parametric autocorrelation test and non-parametric run test to test the random walk hypothesis of Chittagong Stock Exchange (CSE).

3.1   AUTOCORRELATION

Autocorrelation measures the similarity of changes in returns between two successive time intervals. It calculates the correlation between return in the current period and those in the previous period. A

significant positive autocorrelation means the series do not follow random walk. The serial correlation coefficient at lag k, denoted by p_k, is defined as

$$p_{k} = [\sum_{t=1}^{n-k}(R_t - \overline{R})(R_{t+k} - \overline{R})]/[\sum_{t=1}^{n}(R_t - \overline{R})^2]$$

Where,
R_t and R_{t-1} represent return in period t and t-1 respectively.

According to Bartlett (1946), the standard error of the autocorrelation coefficient, P_k, is equal to:

$$\sigma(p_k) = \sqrt{1/n}$$

Test statistics (Z) for the autocorrelation can be written as

$$Z = \frac{p_k}{\sigma(p_k)}$$

The following hypothesis is to be tested:
Ho: There is no autocorrelation between the returns of CSE.
H_1: There is autocorrelation between the returns of CSE.
The null hypothesis of the autocorrelation coefficient is equal to zero and rejected when calculated Z value of autocorrelation exceeds the critical Z value from normal distribution at chosen level of significance.

In addition, the null hypothesis that all coefficients are simultaneously equal to zero up to lag *k* tested by applying the Ljung-Box (LB) statistics. This statistic is defined as:

$$LB = n(n+2)\sum_{k=1}^{m}(\frac{p_K^2}{n-k}) \sim \chi^2 m$$

Where n = sample size and m = lag length. LB statistic follows the chi-square distribution with m degree of freedom.

The hypothesis for LB statistic can be written as follows:
Ho: All the autocorrelation coefficients of Returns of CSE up to a certain lag are simultaneously equal to zero.
H_1: Stock returns do not follow random walk.
The null hypothesis is rejected if the calculated LB value exceeds critical LB value from chi-square distribution at the chosen level of significance.

3.2   RUN TEST

Run test is a non-parametric test for testing the randomness of a financial time series. A non-parametric test does not require returns to be normally distributed. A run can be defined as an uninterrupted sequence of one symbol or attribute such as + or – and length of run is the number of elements in it. Under the assumption of random walk, actual number of runs (U) and expected number of runs are same. If there are too many runs, it indicates negative serial correlation. If there are too few runs, they may suggest positive serial correlation. Run test converts total number of run into z statistic. To perform this test on stock return of CSE, X is assigned to each return that equals or exceeds the median value and Y for the items that are below the median. Let n_X and n_Y be the sample sizes of items X and Y respectively and U is the observed number of runs. For large sample size, where, $n_X > 10$ and $n_Y > 10$, the following test statistic is used.

$$Z = \frac{U - \mu_U}{\sigma_U}$$

Where $\mu_U = \frac{2n_X n_Y}{n} + 1,$ $\sigma_U = \sqrt{\frac{2n_A n_B(2n_A n_B - n)}{n^2(n-1)}}$ and $n = n_X + n_Y$

Where μ_U indicates the expected number of runs and σ_U indicates the standard error.
The null hypothesis of run test can be written as follows:

Ho: Successive returns of CSE are independent.
H$_1$: Successive returns of CSE are not independent.

Null hypothesis of independence is rejected, if computed Z value exceeds the critical Z value at chosen level of significance.

4.0   EMPIRICAL ANALYSIS AND RESULT

4.1   DESCRIPTIVE STATISTICS

Table 1 presents a summary of descriptive statistics of the returns for three indices of CSE. Sample means, maximums, minimums, skewness, kurtosis and Jarque-Bera statistics are reported to analyze the normality of the returns. The summary statistics show positive mean daily return for all indices in the sample. The lowest returns (-8.65) and the highest returns (14.33) are in CSE30 index. The standard deviations of returns range from 1.4474 (CASPI Index) to 1.5513 (CSE 30 Index). The coefficients of skewness and kurtosis are asymptotically distributed as N (0, 6/n) and N (0, 24/n). The following ratios could be compared with the critical values from a standard normal distribution in order to test the hypothesis of normality. The ratios are:

$$V_1 = \frac{\text{Value of Skewness}}{\sqrt{6/n}}$$

$$V_2 = \frac{\text{Value of Kurtotis} - 3}{\sqrt{24/n}}$$

Table 1: Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	V1	Kurtosis	V2	Jarque Bera
CSE30	2248	-8.65	14.33	0.0658	1.5513	0.303	5.86	7.362	42.21	1816.60*
CSCX	2248	-7.8223	13.2844	0.0640	1.4679	0.157	3.03	6.128	30.27	925.71*
CASPI	2248	-7.7644	13.0707	0.0697	1.4474	0.136	2.63	6.273	31.67	1010.34*

Note: * indicates significance at 1% level.

The value of skewness and kurtosis indicate that the distribution is not normal. The coefficients of skewness are significantly positive and kurtosis represent a leptokurtic distribution. They provide evidence against the null hypothesis of normality of returns. Again, we used Jarque Bera test to find out the normality of returns. The following hypothesis is to be tested.
Ho: There is normal distribution of stock returns of CSE.
H$_1$: There is non-normal distribution of stock returns of CSE.

The normal distribution of stock return is found if the calculated results of JB statistics don't exceed the critical value at chosen level of significance

Here, we see that the calculated results of JB statistics reject the null hypothesis at 1% level of significance. This conclude that non-normal frequency distribution of stock returns is in Chittagong Stock Exchange.

4.2   RUN TEST

Table 2 presents the results of run test. The calculated z statistics of daily market return for every index is significantly negative. Thus, the negative z-values is a dictation that the actual number of runs is less than the expected number of runs under the null hypothesis of return independence at the 0.01 level or lower for all indices. Our results reject the null hypothesis showing that CSE doesn't follow the random walk and therefore, the market is not efficient in weak form.

Table 2:

	CSE 30 Index	CSCX Index	CASPI Index
Test Value	0.0658	0.0640	0.0698
Cases < Test Value	1154	1147	1141
Cases >= Test Value	1094	1101	1107
Total Cases	2248	2248	2248
Number of Runs	1016	1028	1022
Z	-4.568	-4.074	-4.336
Asymp. Sig. (2-tailed)	0.000	0.000	0.000

4.3   AUTOCORRELATION TEST:

Autocorrelation or serial correlation, a mathematical tool, measures serial independence or repeating pattern in the returns up to a certain lag period, It examines the presence of period signal at the different points in time of CSE Selective Index (CSE-30), CSE Selective Categories Index (CSCX) and CSE All Share Price Index (CASPI). The white noise of the series is explained hy Ljung-Box statistic. Table 3, 4 and 5 in appendix show the result of autocorrelation and Ljung-Box statistics of CSE-30, CSCX and CASPI. It is assumed that there are 25 lag periods in our test. There is significant positive autocorrelation at lag 1st and 3rd in each of the three indices. The presence of such autocorrelation coefficients in the returns is an indication of absence of random walk and CSE is not efficient in weak form. Again, the p value (0.000) at lag 25 means the LB statistics are jointly significant and indicates that the stock returns do not follow random walk for each three indices. Therefore, CSE is not efficient in weak form.

5.0   CONCLUSION

This paper analyzes the random walk movement and weak form of efficiency in the Chittagong Stock Exchange. Three important indices like CSE All Share Price Index, CSE Selective Index and CSE Selective Categories Index are verified by using both non-parametric test (run test) and parametric tests [autocorrelation coefficient test, Ljung– Box (LB) statistics]. Descriptive statistics reveals that the series of return is not normally distributed. There is existing a large spread between the minimum and maximum values. The coefficients of skewness are significantly positive and kurtosis represent a leptokurtic distribution Again the calculated results of JB statistics reject the null hypothesis at 1% level of significance and put argument in favor of non-normal frequency distribution of stock returns. Similarly autocorrelation test, LB test and runs test have rejected the null hypothesis and the independent movement of stock returns. Therefore, CSE do not follow random walk hypothesis and inefficient in weak form in our study period. Our findings have similarity with the study of Hasan (2015), Mudassar, Arshad, Maryam and Amir (2013), Chaity and Sharmin (2012), Khandoker, Siddik, and Azam (2011), Gupta and Basu (2007), Maghyereh (2003), Hassan, Islam, and Basher (2002). The trend of daily returns of CSE shows the opportunity of superior returns for market players. So there is a chance of predicting the future price movement by analyzing the past which could be contradicts with the goal of maximizing of shareholders wealth. This situation informs the authority of Bangladesh Securities and Exchange Commission (BSEC) to take immediate steps to safe the general investors in the stock market. However, our study is based on market index rather than individual securities. Above all this study undoubtedly requires further research based on individual securities listed in Chittagong Stock Exchange.

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APPENDIX: RESULT OF AUTOCORRELATION

Table 3: CSE 30 index

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	0.079*	0.021	13.914	1	0.000
2	-0.006	0.021	13.982	2	0.000
3	0.087*	0.021	31.161	3	0.000
4	0.040	0.021	34.788	4	0.000
5	0.043	0.021	38.962	5	0.000
6	0.045	0.021	43.500	6	0.000
7	0.011	0.021	43.759	7	0.000
8	0.025	0.021	45.156	8	0.000
9	0.000	0.021	45.158	9	0.000
10	-0.019	0.021	45.949	10	0.000
11	0.036	0.021	48.876	11	0.000
12	0.035	0.021	51.608	12	0.000
13	0.029	0.021	53.547	13	0.000
14	0.010	0.021	53.761	14	0.000
15	0.001	0.021	53.764	15	0.000
16	0.004	0.021	53.806	16	0.000
17	0.027	0.021	55.494	17	0.000
18	0.018	0.021	56.215	18	0.000
19	0.047	0.021	61.157	19	0.000
20	0.040	0.021	64.879	20	0.000
21	0.015	0.021	65.388	21	0.000
22	0.039	0.021	68.919	22	0.000
23	0.039	0.021	72.430	23	0.000
24	0.028	0.021	74.157	24	0.000
25	-0.012	0.021	74.482	25	0.000

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.
Note: * indicates significance at 5% level.

Table 4: CSCX index

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	0.051*	0.021	5.903	1	0.000
2	-0.015	0.021	6.419	2	0.000
3	0.085*	0.021	22.722	3	0.000
4	0.025	0.021	24.107	4	0.000
5	0.041	0.021	27.854	5	0.000
6	0.033	0.021	30.367	6	0.000
7	0.001	0.021	30.372	7	0.000
8	0.032	0.021	32.689	8	0.000
9	0.000	0.021	32.689	9	0.000
10	-0.039	0.021	36.046	10	0.000
11	0.044	0.021	40.477	11	0.000
12	0.042	0.021	44.549	12	0.000
13	0.028	0.021	46.374	13	0.000
14	0.014	0.021	46.798	14	0.000
15	-0.010	0.021	47.012	15	0.000
16	0.011	0.021	47.278	16	0.000

17	0.037	0.021	50.311	17	0.000
18	0.000	0.021	50.311	18	0.000
19	0.043	0.021	54.584	19	0.000
20	0.041	0.021	58.317	20	0.000
21	0.020	0.021	59.261	21	0.000
22	0.024	0.021	60.525	22	0.000
23	0.038	0.021	63.754	23	0.000
24	0.024	0.021	65.082	24	0.000
25	-0.015	0.021	65.609	25	0.000

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.
Note: * indicates significance at 5% level

Table 5: CASPI index

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	**0.050***	0.021	5.522	1	0.000
2	-0.017	0.021	6.207	2	0.000
3	**0.089***	0.021	23.868	3	0.000
4	0.024	0.021	25.118	4	0.000
5	0.045	0.021	29.656	5	0.000
6	0.038	0.021	32.975	6	0.000
7	0.005	0.021	33.041	7	0.000
8	0.032	0.021	35.296	8	0.000
9	-0.005	0.021	35.350	9	0.000
10	-0.039	0.021	38.797	10	0.000
11	0.046	0.021	43.575	11	0.000
12	0.044	0.021	47.905	12	0.000
13	0.034	0.021	50.458	13	0.000
14	0.012	0.021	50.811	14	0.000
15	-0.008	0.021	50.944	15	0.000
16	0.013	0.021	51.332	16	0.000
17	0.037	0.021	54.516	17	0.000
18	0.006	0.021	54.599	18	0.000
19	0.046	0.021	59.412	19	0.000
20	0.042	0.021	63.430	20	0.000
21	0.020	0.021	64.305	21	0.000
22	0.025	0.021	65.693	22	0.000
23	0.040	0.021	69.346	23	0.000
24	0.018	0.021	70.046	24	0.000
25	-0.014	0.021	70.505	25	0.000

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.
Note: * indicates significance at 5% level