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Abstract

This paper attempts to find out evidence for the weak form of market efficiency i.e. random walk using the daily data on returns for stock prices on the Dhaka Stock Exchange (DSE). The efficiency of the DSE is tested by using the all share price index, DSE general price index, and DSE broad index covering the period from January 1, 1993 to June 30, 2015 by employing the runs test, serial correlation test, and variance ratio test. These tests are also applied to the share price of fifty selected individual companies. The runs test results show that the share price of all the three indices does not follow a random walk. While returns on the DSE broad index show little evidence in favor of random walk by the autocorrelation test and the DSE general index shows some signs of efficiency by the variance ratio tests under homoskedastic and heteroskedastic assumptions. Therefore, the DSE is not weak-form efficient. This result implies that daily changes in stock prices reflect past prices, suggesting that investors can predict future stock prices to a great extent using past price patterns and can often earn abnormal profit. It also appears that the policy reforms after the bubble-burst in December 2010 to enhance transparency and efficiency did not make any significant contribution toward stock market efficiency.

Keywords: Capital market, efficient market hypothesis, runs test, autocorrelation test, variance ratio test

JEL Classification Codes: G3, G14, G12, G15.

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I. Introduction

The knowledge about the efficiency of the stock market is central to market participants dealing with the capital market. An efficient capital market ensures intense competition in the capital market which leads to fair pricing of stocks, debts, and securities. In the presence of an efficient capital market, the movements of stock price are erratic due to all new information is quickly understood by the market participants. As a result, the market participants can not outguess the market for abnormal profit.

The concept of stock market efficiency is divided into two major fields: operational efficiency and information efficiency. According to Baumol (1965) and Fama (1970), testing stock market efficiency from the operational perspective seeks to address the aspects of functionality that includes transaction cost, the liquidity of the market, and timeliness in the transaction. The second field of stock market efficiency is information efficiency. The information efficiency test seeks to evaluate how the investors in the stock market respond to available information. The information efficiency of the stock market, therefore, implies that, at all times, the market adjusts quickly to new information. That means the stocks prices reflect all available information.

The idea forms the theoretical basis of the Efficient Market Hypothesis (henceforth EMH) that relies on the efficient exploitation of information by the economic actors. Theoretically, it is common to distinguish between three levels of the EMH according to the level of information reflected in the prices, the weak, semi-strong and strong forms. These three levels differ by their concepts of what is meant by the term "all available information" (Bodie et al, 1999). The weak-form EMH holds that current stock prices fully reflect all historical market information that can be derived by examining market trading data, such as the history of past prices, trading volume or short interest. The semi-strong-form EMH asserts that prices fully reflect not merely all the historical information, but also all publicly available information regarding the prospect of a firm that includes fundamental data on the firm's product line, quality of management, balance sheet composition patents held, earning forecasts, and accounting practices. Finally, the strong-form EMH contends that stock prices reflect all information from historical, public, and private sources that includes information available solely to company insiders so that no single investor can realize the abnormal rate of return.

In view of the efficient capital market, the question is whether the capital market of Bangladesh is efficient or not. If the market is efficient, to what extent is it efficient? It is important because the ability of the capital market to perform its vital role and assure investors of fair returns is dependent on the extent to which it can be considered efficient.

This paper attempts to measure the extent of efficiency in the capital market of Bangladesh. The measurement of the efficiency of the stock market in Bangladesh is highly important on many accounts. Market efficiency has always been an important concept for the individual and institutional investors and market regulators. An investment strategy of an investor is greatly influenced by market efficiency. Information about the efficiency of the stock market also dictates the regulatory measures ensuring orderly development of the capital markets and planning long-term financial developments of a country.

The Dhaka Stock Exchange (henceforth DSE) has gone through several structural modifications as well as witnessed some policy reforms in the last few years. So, it is necessary to test the market efficiency of DSE to analyze the effect of these reforms. Besides, the DSE faced two big bubble bursts since its inception. The first one was in 1996 and the other was in 2010. The main reason for the burst was the inefficiency of the market. In the absence of market efficiency, some market players predict the future value of equity and manipulate the share price for exploiting abnormal profit. In an efficient market where all new information is quickly incorporated into market prices, market participants cannot make an

abnormal profit. To avoid such events in the future, knowledge of the market efficiency in the capital market is extremely significant for the market participants and market regulators.

After the independence of Bangladesh, the DSE had started operation from 1976 with 9 listed companies having a total issued capital of Tk. 0.14 billion. Over time, the market has gained popularity among small and medium investors. As a result, capital market's depth has increased tremendously which is reflected in the indicators of the capital market. At the end of 2010, the market capitalization reached as high as US\$ 43.2 billion, which was 37.6% of country's GDP. The value of stock traded stood at 50.3% of the GDP. At the end of June 2015, the market capitalization reached US\$ 34.7 billion, which was 17.8% of country's GDP.

Given the importance of an idea about the efficiency of the market, the study attempts to revisit the stock market to offer a more comprehensive study by considering very recent DSE data. This study is different from the earlier studies in a number of ways. First, we employ daily data for DSE share price indices using the longest possible sample sizes which may reduce the problem of infrequent trading and increase the power of the random walk test. Moreover, in cognition, no attempt has been made so far to test the market efficiency at individual company level in the the DSE. More importantly, this study covers two incidents of shocks in the DSE, which will provide important information regarding the efficiency of the market. This study appears to be the first to apply three kinds of indices, i.e. All Share Price Index (ASI), DSE General Index (DSEG), and DSE Broad Index (DSEX).

The remainder of the paper is as follows. Section 2 reviews some previous studies regarding the market efficiency with special reference to Bangladesh. Section 3 enumerates some stylized facts of the DSE. Section 4 discusses data and methodology. Section 5 lays out the empirical analysis of the estimated results. The conclusion of the paper is specified in section 6.

2. Review of Literature

Efficiency in the context of the capital market has been defined in a number of ways, but the most common way has been defined it in terms of what sort of information is available to market participants, and how they handle that information. The level of information being considered determines the theme of the EMH. A capital market is said to be efficient if the asset price in question fully reflects all available information. In an efficient capital market, past stock prices have no predictive content to forecast future stock prices. Such unpredictability of stock price is known as 'random walk'. The influential work of Fama (1965, 1970) provided some new insights in the EMH and laid down the basis of the random walk model (RWM)—a mathematical model for testing market efficiency. In fact, EMH is the application of the 'random walk' theory.

This randomness implies that successive changes in stock prices or returns have the same distribution and are independent of each other. As a result, the EMH and random walk behaviour are tied together because, in an efficient market, the prices fluctuate in response to genuinely new information and since information enters the market randomly, so the price fluctuations also become random. In the weak-form efficient, the price movements fluctuate and the changes of price are independent. In that case, investors cannot predict the insights of the future prices based on the past information and cannot earn abnormal returns.

The existing market efficiency literature is extremely extensive, that even a careful survey of it is undoubtedly beyond the scope of this paper. Consequently, the study only provides a short analysis of market efficiency literature regarding the random walk hypothesis or weak-form efficiency in developing countries. Most empirical studies found in the literature devoted to testing the random walk hypothesis in developing countries have focused on testing the weak form of efficiency. This is because it is the least

form of efficiency and it is widely believed that emerging markets experience this least form of efficiency. As a result, if the evidence fails to support that the market is efficient in weak form, there is no justification to examine the higher level of efficiencies. Therefore, the literature review is anchored solely on examining the random walk hypothesis or weak-form efficiency in developing countries with special reference to the DSE.

Depending upon the findings, research studies on market efficiency in the context of the DSE can be categorized into three distinct categories. The first category of research finds the DSE security returns follows a random walk, but the other finds that the returns do not follow a random walk. The third categories of research found a mixed result.

There have been very few studies, such as Alam and Kadapakkam (1999), Hassan and Chowdhury (2008), Uddin and Shakila (2008) support the existence of weak form efficiency of the DSE. In contrast, the studies such as, Chowdhury (1994), Basher, Hassan and Islam (2007), Hassan and Maroney (2004), Islam and Khaled (2005), Kader and Rahman (2005), Alam, Alam and Uddin (2007), Uddin and Alam (2007), Mobarek et al. (2008) and some others do not support the weak form of efficiency of the DSE. For example, Mobarek et al. (2008) investigate daily DSE price indices over the period of 1988 to 2000 conclude that indices don't follow a random walk. Raquib and Alom (2015) using the DSE returns in the period of 2001-2013 applying non-parametric test also finds an existence of a positive autocorrelation of the DSE returns and conclude that it doesn't hold a weak form of efficiency and not following the Random walk model.

Miah (2014) examines the weak-form efficiency of daily, weekly and monthly returns of the DSE for both observed data and for data which is corrected for thin or infrequent trading from 2001 to 2010. Parametric as well as non-parametric test (i.e. runs test) results show that none of the daily, weekly, and monthly returns follow a random walk. But variance ratio test under the assumption of both homoskedastic and heteroskedastic random walk show that daily and weekly observed returns do not follow a random walk. However, if returns are corrected for infrequent trading, then daily and weekly returns follow a random walk. Moreover, monthly observed and corrected series of returns confirm that the DSE is efficient in weak form. Maxim et al. (2013) find a mixed result as the data is divided among two time periods, the year 2009-2010 and 2011-2012 to compare the efficiency of the market before and after the market crash of December 2010. The result of their runs test is quite interesting as it shows that returns of the DSE were not random before the market crash, but surprisingly, a random walk is observed for the returns after the market crash. Islam and Khaled (2005) using heteroskedasticity-robust test also finds evidence in favour of short-run predictability of the share price in the DSE prior to the 1996 boom, but not during the post-crash period. This finding of weak form efficiency during the latter period, which they attribute to the reforms taken to promote transparency and efficiency in the DSE.

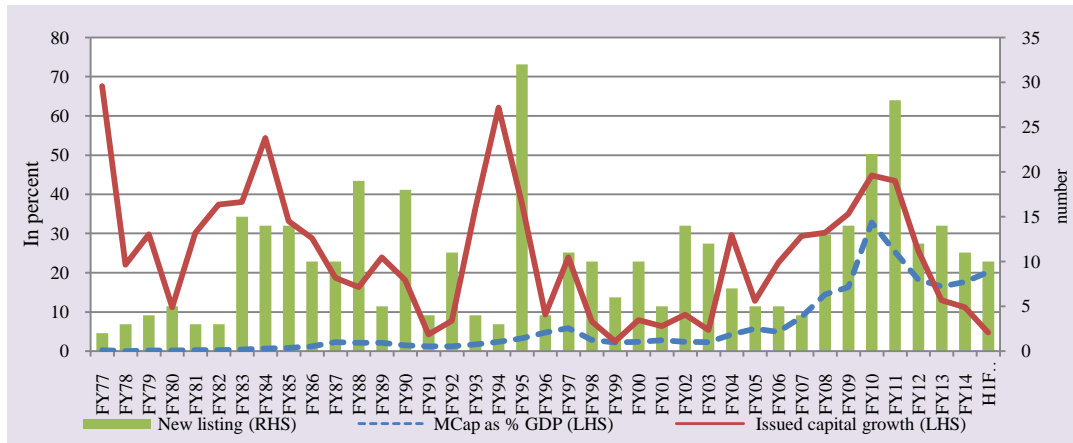
The findings of market efficiency tests (mostly weak-form efficiency tests) on emerging markets also confer mix outcomes. Some researchers find evidence in favour of weak-form of efficiency (e.g. see Cheung and Coutts 2001; Abrosimova et al. 2002, but others find evidence of predictability of stock prices e.g. see Mobarek and Keasey 2000, Lee et al. 2001; Smith et al. 2002; Nisar and Hanif 2012. All the studies used the data for overall stock returns. However, in this study we consider the data for the overall stock returns as well as returns of individual companies to test the recent efficiency level of the DSE.

3. Stylized Facts of the Capital Market in Bangladesh

After the independence of Bangladesh, the DSE had started operation from 1976 with 9 listed companies having a total issued capital of Tk. 0.14 billion, which was 0.14 percent of GDP. Since then the DSE has continued its journey of growth. At the end of 2010, the market capitalization reached as

high as US\$ 47 billion, which was 47 percent of country's GDP. The value of stocks traded at the same time stood at 15 percent of the country's GDP. Although, after November 2010, the capital market witnessed downward correction. At the end of June 2015, the market capitalization came down to US\$ 41.78 billion which was 24.04 percent of country's GDP. Accordingly, the value of stock traded at the same time stood at 7.42 percent of the GDP.

Figure 1: Developments of capital market in Bangladesh



Source: DSE Factbook 1994, DES Monthly Review, December 1995-December 2015.

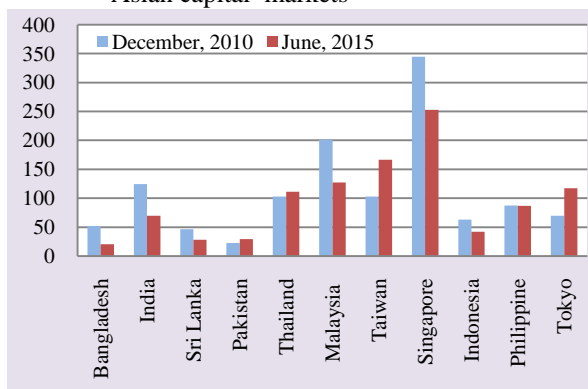
In its journey, the market witnessed two unprecedented crashes, one was in 1996 and the other was in 2011. In June 1996, there was a large surge in the DSE, all share price index stood at 959.0 points from 834.8 points in January 1995; after that the index started to rise sharply and stood at 3,065 points in November of the same year. The market observed a rise of about 220 percent, whereas, there was no remarkable improvement in the fundamentals of the listed companies. The market, however, crashed in December of 1996 and the index started to decline significantly since then. In April 1997, the index decreased to 957 points, stabilizing the market at about the same level as it has been just 10 months back.

The second wave of historical crash struck at the very end of 2010. In December 2010, the DSE general index reached the highest level in its history to 8,919 points. Within a few months, the market lost more than 5,000 points when it plummeted to 3,800 points in February 2011. Afterwards, investors' confidence was significantly damaged because of excessive speculation, allegedly aggregated by widespread irregular activities. This lack of confidence causes the market to suffer from the absence of investors.

3.1 Size of the DSE: Issued capital and market capitalization in the DSE had increased rapidly since 2005 (Figure 1). The outstanding total capital issued stood at Tk. 1.09 trillion at the end of FY15. Treasury Bonds constituted 50.24 percent or Tk. 0.55 trillion. The listed T-Bonds playing an insignificant role in the fluctuations of market price index or market capitalization. The stock market is yet to notice an efficient secondary trading of T-Bonds.

3.2 Market Capitalization to GDP Ratio: Size of the capital market is often measured by the market capitalization to GDP ratio. In recent years market capitalization to GDP ratio increased significantly in the DSE. The ratio increased to 20.33 percent at the end of June 2015 from 2.40 percent in FY02. The ratio was the highest 52.11 percent at the end of November 2010. In spite of the significant increase in recent years, the size of the Bangladesh's capital market is still narrow compared to other Asian capital markets (Figure 2).

Figure 2: Market capitalization to GDP ratio of some Asian capital markets



Source: DSE Monthly Review, December 2010-July 2015.

Table 1: Comparison among regional capital markets

| Country | Price Earnings Ratio | | Dividend Yield | |
|------------------------|----------------------|-----------|----------------|-----------|
| | Jun. 2015 | Dec. 2010 | Jun. 2015 | Dec. 2010 |
| Bangladesh (DSE) | 15.86 | 30.30 | 5.03 | 1.56 |
| India (BSE) | 20.74 | 22.99 | 1.37 | 1.09 |
| Sri Lanka (Colombo SE) | 17.84 | 25.16 | 2.26 | 1.16 |
| Thailand SE | 17.00 | 15.00 | 2.90 | 2.70 |
| Malaysia (KLSE) | 16.00 | 18.00 | 3.20 | 2.30 |
| Taiwan SE Corp. | 14.00 | 14.00 | 2.70 | 3.40 |
| Hong Kong Exchange | 12.00 | 22.00 | 2.50 | 2.50 |
| China | 12.00 | - | 2.50 | - |
| Singapore Exchange | 14.00 | 15.00 | 3.50 | 2.80 |

Source: DSE Monthly Review, December 2010-July 2015.

3.3 Price Earnings Ratio (P/E) and Dividend Yield: The price and earnings per share for a company reflect the market's stock valuation of the company and its shares relative to the income the company is actually generating. Stocks with higher expected earnings growth usually have a higher P/E, and those expected to have lower earnings growth usually have a lower P/E. On the other hand, the dividend yield is a financial ratio that shows how much a company pays out in dividends each year relative to its share price. In addition to capital gains (if any), the dividend yield is the return on investment for a stock. The higher the dividend yield the more attractive investment becomes in the capital market.

Cross-country data show that price-earnings ratio of June 2015 position of the Bangladesh's stock market is in the middle, while, dividend yield of it is the second highest in the South and East Asian countries (Table 1). It implies that currently the Bangladesh capital market is comparatively more attractive than other South and East Asian countries based on both price-earnings ratio and dividend yields.

4. Data and Methodology

There are two stock exchanges in Bangladesh namely, the Dhaka Stock Exchange (DSE) and the Chittagong Stock Exchange (CSE). Most of the companies listed on the DSE are also listed on the Chittagong stock exchange as a dual listing of companies is allowed in Bangladesh. DSE is the oldest stock exchange in the country. The size of the DSE, in terms of market capitalization and number of listed securities, is much bigger than the Chittagong stock exchange. So, for the purpose of this study, we will concentrate on the DSE.

To examine whether the DSE is efficient in its weak form, three tests namely, runs test, serial correlation test, and variance ratio test have been applied to the daily stock return of the DSE. Initially, the sample consisted with All Share Price Index (ASI), DSE General Index (DSEG), and DSE Broad Index (DSEX) from 1 January 1993 to 22 November 2001, 27 November 2001 to 31 July 2013 and 27 February 2013 to 30 June 2015 respectively. The sample includes 2381 daily observations of ASI, 2926 daily observations of DSEG and 516 observations of DSEX. The study also examines the market efficiency of individual company level. From the listed companies of the DSE, 50 companies are selected from different sectors on the basis of their paid up capital. Daily stock return data for 50 selected companies from January 2008 to June 2015 are analysed. As the sample period covered under study includes both bearish period and bullish period, it is expected that the results of the study would offer

more realistic measurement of the market efficiency of DSE which is the main component of the Bangladesh capital market.

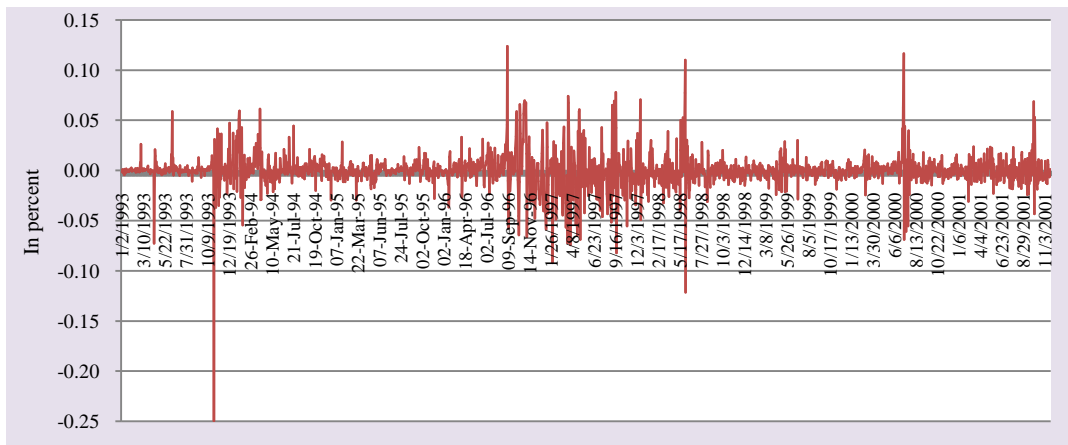
Descriptive statistics show that the daily return of the DSEX is less volatile compared to ASI and DSEG and it also tends to follow a normal distribution as the value of kurtosis is much smaller than that of other two indices (Table 2 and Figure 3 to 5).

Table 2: Descriptive statistics

| | All Share Price Index | DSE General Index | DSE Broad Index |
|--------------------|-----------------------|-------------------|-----------------|
| Mean | 0.0002131 | 0.0005738 | 0.0000438 |
| Maximum | 0.1240685 | 0.2038212 | 0.0367092 |
| Minimum | -0.2495818 | -0.0932997 | -0.0535836 |
| Standard Deviation | 0.0164028 | 0.0150659 | 0.010395 |
| Skewness | -1.110202 | 0.8234344 | -0.181743 |
| Kurtosis | 34.10928 | 21.60129 | 5.126596 |
| Jarque-Bera | 96501.70 | 42514.78 | 100.07 |
| N | 2381 | 2926 | 516 |

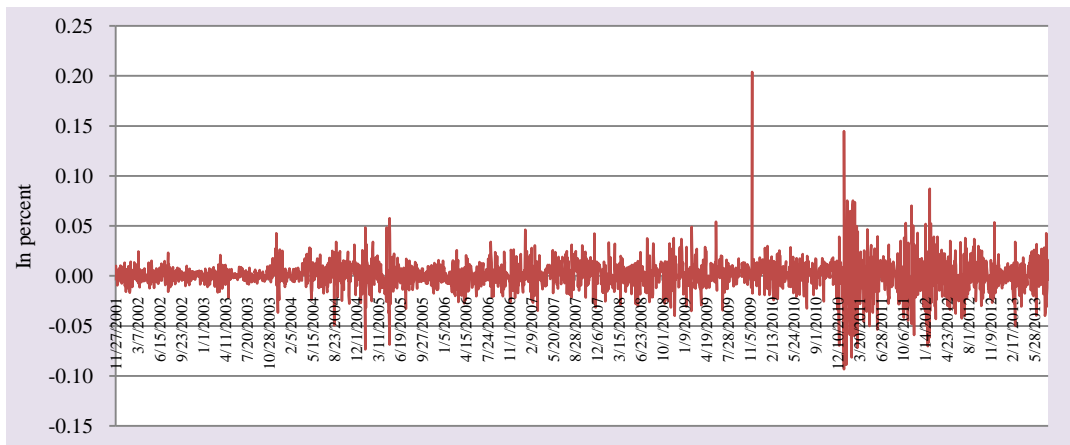
Source: Dhaka Stock Exchange.

Figure 3: Return on All Share Price Index (January 1993-November 2001)



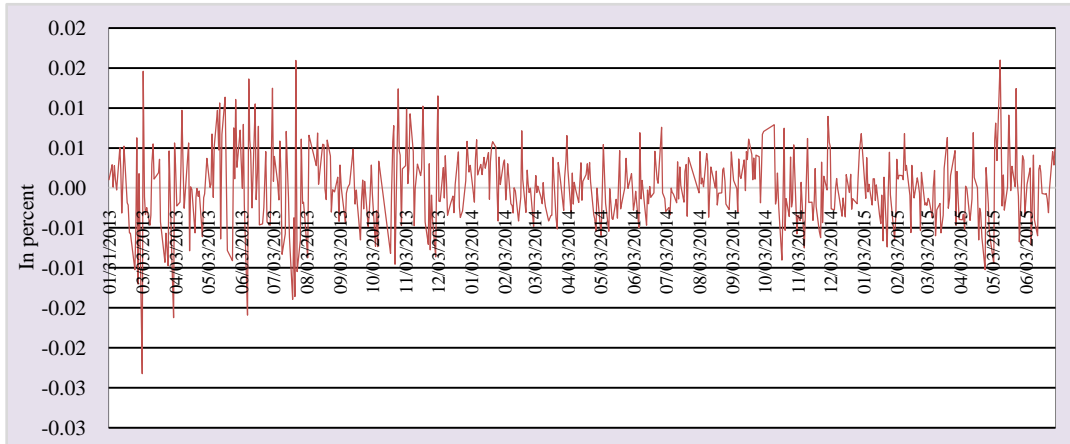
Source: Dhaka Stock Exchange.

Figure 4: Return on DSE General Index (November 2001-July 2013)



Source: Dhaka Stock Exchange.

Figure 5: Return on DSE Broad Index (February 2013-June 2015)



Source: Dhaka Stock Exchange.

Normality of data is checked using Jarque-Bera (JB) test and the results are presented in Table 2. The results of the J-B tests indicate that the returns are not normally distributed. In this situation, a non-parametric test is likely to be more appropriate in testing random walk hypothesis. So, the runs test is applied. However, following the empirical studies different non-probabilistic techniques like serial correlation test and variance ratio test are also used in this study to detect the random walk.

In order to test the null hypothesis that the share price follows random walk behaviour or that successive price changes are linearly independent, the log random walk (LRW) model has been applied in this study. This is a suitable data transformation procedure, which is used to make the original series stationary. Mathematically, the testable form of LRW model is:

$\ln(P_t/P_{t-1}) = e_t$, where, $E(e_t) = 0$, covariance $(e_t, e_{t-s}) = 0$ all $s \neq 0$; P_t, P_{t-1} are the stock prices at time t and $t-1$ respectively and e_t is the residual of the time t . On computing the daily stock returns based on this model, the weak form of the efficient market hypothesis have been tested with the help of 'runs test', 'serial correlation test' and 'variance ratio test'.

4.1 Runs Test: After computing the stock returns as per the LRW model, the runs test is applied. The runs test is a statistical technique used to detect if a time series is random or not. The computational procedure of runs test is that it ignores the absolute values in a time series and deals only with signs (positive or negative). The test is essentially concerned with the direction of changes in a given time series. Since it is a non-parametric test, there is no need to predefine the nature of probability distribution of the time series data.

In the runs test, the number of sequences of consecutive positive and negative returns is tabulated and compared against its sampling distribution under the random walk hypothesis. A run is defined as the repeated occurrence of the same value or category of a variable. It is indexed by two parameters, which are the types of the run and the length. Regarding the type, stock price runs can be positive, negative or have no change, while the length defines how often a run type occurs in succession. In other words, we compare the observed number with the expected number of runs. If the observed number of runs (R) is not significantly different from the expected number of runs (E), then it may be concluded that the successive price changes are independent and the series is characterized by mean reversion. On the other hand, if this difference is statistically significant, then the price series would be regarded as dependent, and the series is characterized by trends. In that case, we reject the null hypothesis that share price follows

a random walk. This conclusion will indicate that future share price may be predicted using historical information.

When each observation is assumed to be independent and identically distributed, and null hypothesis of randomness is true, the mean or expected number of runs can be calculated as:

$$E(R) = \frac{2(n_1n_2)}{n_1+n_2} + 1$$

The standard error of the number of runs SE(R) can be calculated as-

$$SE(R) = \frac{\sqrt{(2n_1n_2)(2n_1n_2-n)}}{n^2(n-1)}$$

To test whether the time series is random or not, we use the Z statistics:

$$Z = \frac{R-E(R)}{SE(R)} \sim N(0, 1)$$

Where, E(R) = Observed number of runs;

n = Number of observations;

n1 = Number of upward run (upward movement of price, + signs);

n2 = Number of downward run (downward movement of prices, - signs);

R = Number of actual runs;

Z = Standard normal variate;

SE(R) = Standard error of the number of runs.

In the study, the null and alternative hypotheses that were tested with the help of runs test are as follows:

H₀: The stock index series are random walk.

H₁: The stock index series are not random walk.

If the expected number of runs E (R) is significantly different from the observed number of runs R, we reject the null hypothesis that the return series follows a random walk. In that case, the DSE will satisfy a weak form of market efficiency.

4.2 Serial Correlation Test: Another way to test for randomness in stock index changes is to look at their serial correlations (also called auto- correlations). That is, whether the price changes in one period are correlated with the price changes in some other period. If such autocorrelation coefficient is negligible (statistically not significantly different from zero), the price changes are considered to be serially independent.

In the present study, the auto-correlation of return series has been examined for the sample period. Moreover, for testing the joint hypothesis that all the autocorrelation coefficients up to certain lags are simultaneously equal to zero, Box-Ljung (BL) statistic has been applied for 20 lags. BL statistic is defined as:

$$BL = n(n + 2) \sum_{k=1}^m \left(\frac{\hat{\rho}_k^2}{n-k} \right) \sim \chi^{2m}$$

Where, n= sample size, m=lag length and degree of freedom, ρ_k = serial correlation coefficient at lag k and BL= statistics follow the chi-square distribution with m degree of freedom.

4.3 Variance Ratio Test: Lo and MacKinlay (1988) have developed a sophisticated variance ratio test to check the EMH. The test implies that if the natural logarithm of a time series Y_t is a pure random walk,

the variance of its q-differences grow proportionally with the difference of q. In other words, if a series follows a random walk process, the variance of its q period should be q times the variance of the one period difference. The variance ratio test statistics are used to test the random walk under two different assumptions of homoskedastic and hetroskedastic by using asymptotic distribution.

5. Analysis of Results

The results of the runs test show that returns of all the Z values are negative, this indicates that the actual runs of all the series are significantly smaller than their corresponding expected runs (Table 3). In other words, as the negative Z values indicate a positive auto-correlation, the return series are autocorrelated.

Table 3: Results of runs test for three indices

| Indices | No of +ve return (N<=0) | No. of - ve return (N>0) | Total Run | Expected Run | Z value | P value |
|-----------------------------|-------------------------|--------------------------|-----------|--------------|---------|---------|
| All Share Price Index (ASI) | 1189 | 1192 | 903 | 1191 | -11.83 | 0.00 |
| DSE General Index (DSEG) | 1377 | 1549 | 1241 | 1459 | -8.09 | 0.00 |
| DSE Broad Index (DSEX) | 267 | 249 | 218 | 259 | -3.59 | 0.00 |

Source: Dhaka Stock Exchange.

From the table 3, it is also observed that p-values for the indices are zero. Thus, we may reject the null hypothesis. This implies that the succeeding price changes do not move in an independent manner. It implies that the returns of ASI, DSEG, and DSEX do not follow a random walk i.e., the DSE is not weak form of efficient.

Table 4: Results of autocorrelation test for three indices

| Lag | Daily Return of All Share Price Index (ASI) | | | Daily Return of DSE General Index (DSEG) | | | Daily Return of DSE Broad Index (DSEX) | | |
|-----|---------------------------------------------|--------|---------|------------------------------------------|--------|---------|----------------------------------------|--------|---------|
| | AC | Q-Stat | p-value | AC | Q-Stat | p-value | AC | Q-Stat | p-value |
| 1 | 0.2687 | 172.14 | 0.00 | 0.0386 | 4.3668 | 0.0366 | 0.057 | 1.7140 | 0.190 |
| 2 | -0.0179 | 172.91 | 0.00 | -0.0410 | 9.3014 | 0.0096 | 0.012 | 1.7882 | 0.409 |
| 3 | 0.0359 | 175.98 | 0.00 | 0.0008 | 9.3032 | 0.0255 | 0.085 | 5.5320 | 0.137 |
| 4 | 0.0781 | 190.55 | 0.00 | 0.0246 | 11.081 | 0.0257 | 0.097 | 10.490 | 0.033 |
| 5 | 0.0608 | 199.37 | 0.00 | 0.0211 | 12.388 | 0.0298 | 0.059 | 12.329 | 0.031 |
| 6 | -0.0152 | 199.92 | 0.00 | -0.0129 | 12.88 | 0.0450 | -0.029 | 12.776 | 0.047 |
| 7 | 0.0224 | 201.13 | 0.00 | -0.0009 | 12.882 | 0.0750 | -0.046 | 13.899 | 0.053 |
| 8 | 0.0391 | 204.79 | 0.00 | 0.0182 | 13.855 | 0.0856 | 0.015 | 14.022 | 0.081 |
| 9 | 0.0103 | 205.04 | 0.00 | 0.0601 | 24.449 | 0.0036 | 0.012 | 14.101 | 0.119 |
| 10 | 0.076 | 218.87 | 0.00 | 0.0115 | 24.839 | 0.0057 | 0.099 | 19.296 | 0.037 |
| 11 | 0.0627 | 228.27 | 0.00 | -0.0074 | 25.002 | 0.0091 | -0.021 | 19.540 | 0.052 |
| 12 | 0.0545 | 235.38 | 0.00 | 0.0142 | 25.597 | 0.0122 | 0.036 | 20.227 | 0.063 |
| 13 | 0.0264 | 237.04 | 0.00 | -0.0401 | 30.336 | 0.0042 | 0.028 | 20.658 | 0.080 |
| 14 | 0.006 | 237.13 | 0.00 | 0.0201 | 31.529 | 0.0047 | 0.003 | 20.662 | 0.111 |
| 15 | 0.0134 | 237.56 | 0.00 | 0.0335 | 34.84 | 0.0026 | 0.010 | 20.717 | 0.146 |
| 16 | -0.0131 | 237.97 | 0.00 | 0.0163 | 35.623 | 0.0033 | -0.003 | 20.722 | 0.189 |
| 17 | 0.0026 | 237.99 | 0.00 | -0.0155 | 36.329 | 0.0041 | -0.041 | 21.635 | 0.199 |
| 18 | 0.0036 | 238.02 | 0.00 | 0.0249 | 38.157 | 0.0037 | 0.020 | 21.841 | 0.239 |
| 19 | -0.022 | 239.18 | 0.00 | 0.0229 | 39.705 | 0.0036 | -0.015 | 21.969 | 0.286 |
| 20 | 0.016 | 239.80 | 0.00 | -0.0333 | 42.975 | 0.0021 | -0.005 | 21.984 | 0.341 |

To test the weak form of EMH for the DSE, the autocorrelation tests with 20 lags are performed for ASI, DSEG, and DSEX. The results of these tests are summarized in Table 4. It is found that the null hypothesis of a random walk is rejected for all lags at the 5% level of significance for ASI. In the case of DSEG, the null hypothesis is rejected for all lags at the 5% level of significance except for lag 7 and lag 8. While in the case of DSEX, the null is not rejected for almost all lags except a few, which indicate that there is some indication that the DSEX follows a random walk. The paper further tests the joint hypothesis of autocorrelation coefficients up to 20 lags applying Ljung-Box Q statistics. The result of Q statistics reveals that the autocorrelation coefficients up to 20 lags are jointly significant at the 1% level for ASI, DSEG but insignificant for DSEX index. This indicates that there is joint autocorrelation between the returns of ASI, DSE general index, but no joint autocorrelation in return for DSEX index.

This study further employs variance ratio (VR) tests for both null hypotheses, namely the homoskedastic and heteroskedastic increments random walk. In addition, the variance ratio is calculated for intervals (q) of 2, 4, 8 and 16 observations. If the variance ratio test is equal to one, then it means that stocks follow a random walk and the stock market would be considered as an efficient market. The results of overall market variance ratio test are reported in Table-5.

Table 5: Results of Variance Ratio (VR) test

| q | All Share Price Index (ASI) | | | | | DSE General Index (DSEG) | | | | | DSE Broad Index (DSEX) | | | | |
|----|-----------------------------|-------|---------|-------|---------|--------------------------|------|---------|-------|---------|------------------------|------|---------|-------|---------|
| | VR | Z(q) | p-value | Z*(q) | p-value | VR | Z(q) | p-value | Z*(q) | p-value | VR | Z(q) | p-value | Z*(q) | p-value |
| 2 | 1.27 | 13.15 | 0.00 | 5.65 | 0.00 | 1.04 | 2.14 | 0.03 | 0.93 | 0.35 | 1.06 | 1.36 | 0.17 | 0.92 | 0.19 |
| 4 | 1.40 | 10.62 | 0.00 | 4.80 | 0.00 | 1.02 | 0.59 | 0.55 | 0.26 | 0.79 | 1.14 | 1.68 | 0.09 | 1.21 | 0.13 |
| 8 | 1.62 | 10.26 | 0.00 | 5.01 | 0.00 | 1.05 | 0.88 | 0.38 | 0.44 | 0.65 | 1.33 | 2.58 | 0.01 | 1.98 | 0.02 |
| 16 | 1.95 | 10.51 | 0.00 | 5.64 | 0.00 | 1.14 | 1.67 | 0.10 | 0.91 | 0.36 | 1.53 | 2.75 | 0.01 | 2.25 | 0.01 |

Note: * Robust, Source: Dhaka Stock Exchange.

Results obtained from the variance ratio test for daily return based on ASI indicates that the random walk hypothesis under the assumption of both homoskedasticity and heteroskedasticity variances is rejected for all q's. In other words, the Z-statistic suggests that the variance ratios are significantly different from one for all values of q considering ASI. Therefore, the null hypothesis of a random walk is rejected for the daily return of ASI. While considering the returns of DSEG, the random walk hypothesis under the assumption of both homoskedasticity and heteroskedasticity variances is not significant at the 5% level of significance except for q=2 in homoskedastic assumption. So, we can not reject the null hypothesis of a random walk for the daily returns of DSEG index. In addition, for DSEX index, the results are mixed for different q's. Under the both homoskedastic and heteroskedastic assumptions, the return of DSEX index is insignificant for q=2 and q=4, it means that we cannot reject the null hypothesis of a random walk for these lags. On the other hand, the return of DSEX index is significant for q=8 and q=16 mean that we cannot accept the null hypothesis of a random walk for these lags.

5.1 Results at the company level: The summary of results obtained by applying different methods is reported in Table-6. It is evident from the table that Z statistics, which has been computed to test the significance of the difference between the number of actual runs and the expected runs are significant at the 5% level of significance in the case of 41 stocks out of 50 stocks (82% of the total). The table also shows that all signs of Z statistics is negative, which indicate that the actual number of runs have fallen short of the expected number of runs. Thus, runs test confirms that price changes are not random which implies that returns of 82% companies listed in the DSE do not follow the weak form of efficiency. It is also observed that BL statistic of an individual company is rejected for 40 companies out of 50 at the 5% level of significance which means that returns of 80% companies do not follow the weak form of efficiency. The value of variance ratio test for all companies are rejected under the null hypothesis

homoskedasticity variance at the 5% level of significance, but under the null hypothesis heteroskedasticity, the variance ratio test is significant for 47 companies. Test results in terms of the companies are presented table A1 in the Appendix.

Table 6: Summary results of different tests for 50 selected companies

| Name of Test | Ho: Not rejected | Ho: Rejected | % of rejection | Remarks |
|----------------------|------------------|--------------|----------------|----------------------------------------------|
| Runs test | 9 | 41 | 82 | 82 % companies do not follow a random walk |
| Autocorrelation test | 10 | 40 | 80 | 80 % companies do not follow a random walk |
| Variance ratio test | | | | |
| Homoskedastic | 0 | 50 | 100 | All 50 companies do not follow a random walk |
| Heteroskedastic | 3 | 47 | 94 | 94 % companies do not follow a random walk |

Source: Dhaka Stock Exchange.

5.2 Effects of policy changes: After the bubble burst in December 2010, the policy makers took various steps to reorganize the capital market aiming to regain the investors' confidence. The initiatives included: a uniform face value to Tk.10 and market lot of all companies converted one share; introduction of new index, namely DSE Broad Index (DSEX) and DSE-30 index since 28 January 2013; approval of the Exchanges Demutualization Act 2013 by the national parliament on 29 April 2013 (effective date of Demutualized Act 2013 since 2 May 2013). Moreover, the DSE transformed into demutualized from 21 November 2013. The Securities and Exchange Commission (SEC) installed surveillance software to monitor live trading on 11 February 2014. Finally, a new board of demutualized DSE formed on 14 February 2014.

Table 7: Results of runs test for DSE Broad Index* after different policy reforms

| Indices | No of +ve return (N<=0) | No. of - ve return (N>0) | Total Run | Expected Run | Z value | P value |
|---------------------------------------------|-------------------------|--------------------------|-----------|--------------|---------|---------|
| After bubble burst in December 2010 | 582 | 546 | 489 | 564 | -4.50 | 0.00 |
| After Exchanges Demutualization | 282 | 292 | 238 | 288 | -4.17 | 0.00 |
| After installation of Surveillance software | 197 | 186 | 161 | 192 | -3.21 | 0.00 |

* The DSEG index and DSEX index have been merged from 28 January 2013 to 01 January 2011. Source: Dhaka Stock Exchange.

Thus, it is important to verify if the above policy changes have any implication on the efficiency of the DSE. We tested for market efficiency after each of the policy changes by applying runs test on DSEX index for different starting date (01 January 2011, 29 April 2013¹ and 11 February 2014²). From table-7, it is evident that the runs test is significant in all cases. Which implies that DSEX index does not follow a random walk. We also employed serial correlation test and variance ratio test on DSEX index for the different starting dates corresponding to different policy changes. All the tests confirm that DSEX index does not follow a random walk except the serial correlation test on DSEX index starting from 01 January 2011. Consequently, the results indicate that policy reforms do not have a significant overall contribution towards the capital market efficiency. Table A2 and table A3 in the appendix shows the results of the serial correlation test and the variance ratio test on DSEX index related to different policy changes respectively.

¹ After the Exchanges Demutualization Act 2013 passed by national parliament.

² SEC installed surveillance software to watch live trading.

6. Conclusion

The main objectives of the study were to examine the weak form of market efficiency (random walk) of the DSE. The paper applies three tests namely runs test, serial correlation test and variance ratio test on the return of All Share Price Index (ASI), DSE General Index (DSEG), and DSE Broad Index (DSEX). These tests are also applied on the share price of 50 individual companies listed in the DSE.

Return on DSE broad index, which is associated with the latest data ranging from July 2013-June 2015, shows some evidence in favour of a random-walk by autocorrelation and also by variance ratio tests under homoskedastic and heteroskedastic assumptions with some specific lags. This implies that the level of inefficiency of the DSE is reduced in recent period and the market is heading towards the weak form of efficiency. Notwithstanding some sign of weak form of efficiency is found for DSEX index, results of the other tests do not support weak form of efficiency. The results of the various tests on the individual stock prices of the selected companies provide evidence that the DSE is not efficient in the weak form. We have also applied all the three tests to check the effectiveness of policy steps taken after the bubble burst in December 2010. The results indicate policy reforms do not have a significant contribution towards the capital market efficiency.

Consequently, it can be concluded that the market does not respond to new information instantaneously and absorbs publicly available information very slowly. This may be due to a delay in dissemination of new price sensitive information to market participants. Since the results indicate that the DSE is not efficient in the weak form, the study of historical prices is beneficial for the investors. So, there is a systematic way to exploit the trading opportunities in the DSE and the investors can earn abnormal profits by exploiting this opportunity. These results also suggest that there is a scope for technical analysis as a trading strategy. The findings also open up scope for the market regulators to initiate measures to ensure market efficiency.

To improve the operation of the DSE, the authority should emphasize a policy of timely disclosure and dissemination of financial and non-financial information to the stockholders and investors regarding the performance of listed companies. In addition to that, policy initiative should be aimed at attracting reputed Bangladeshi and multinational companies whose shares and bonds can be brought to the market. This initiative can attract institutional as well as foreign investors and raise the depth (liquidity) of the market by ensuring sustained demand with required supply of shares and bonds which can ultimately contribute to the overall improvement of the capital market efficiency status.

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Appendix:

Table A1: Comparison of different tests for 50 individual companies

| Sl. No. | Company Name | Run test | | Auto-correlation test | | Variance ratio test (16 Lag) | | | | |
|---------|-----------------------|----------|---------|-----------------------|---------|------------------------------|---------|---------|----------|---------|
| | | Z | p-value | BL | p-value | VR | Z | p-value | z-robust | p-value |
| 1 | Brac Bank | -2.57 | 0.01 | 114.45 | 0.0000 | 0.056 | -8.4946 | 0.00 | -3.6334 | 0.0003 |
| 2 | Islami Bank | -3.79 | 0.00 | 31.906 | 0.0443 | 0.061 | -8.4459 | 0.00 | -5.0119 | 0.0000 |
| 3 | Pubali Bank | -3.03 | 0.00 | 32.283 | 0.0404 | 0.062 | -8.4851 | 0.00 | -4.6612 | 0.0000 |
| 4 | AB Bank | -4.87 | 0.00 | 28.276 | 0.1030 | 0.065 | -8.4582 | 0.00 | -2.4049 | 0.0162 |
| 5 | Exim Bank | -2.12 | 0.03 | 101.92 | 0.0000 | 0.066 | -8.6700 | 0.00 | -5.4100 | 0.0000 |
| 6 | National Bank | -1.69 | 0.09 | 376.48 | 0.0000 | 0.052 | -8.7400 | 0.00 | -2.5700 | 0.0000 |
| 7 | Prime Bank | -1.13 | 0.08 | 354.63 | 0.0000 | 0.054 | -8.7200 | 0.00 | -2.4200 | 0.0000 |
| 8 | IDLC | -4.30 | 0.00 | 38.47 | 0.0078 | 0.060 | -8.4993 | 0.00 | -3.8258 | 0.0001 |
| 9 | ICB | -6.31 | 0.00 | 975.10 | 0.0000 | 0.045 | -8.5928 | 0.00 | -1.5738 | 0.1155 |
| 10 | Lanka Bangla Finance | -2.17 | 0.03 | 121.06 | 0.0000 | 0.054 | -8.5579 | 0.00 | -3.2673 | 0.0011 |
| 11 | Prime Finance | -4.80 | 0.00 | 68.599 | 0.0000 | 0.069 | -8.4194 | 0.00 | -3.6304 | 0.0003 |
| 12 | Uttara Finance | -5.08 | 0.00 | 38.576 | 0.0075 | 0.067 | -8.4379 | 0.00 | -4.9547 | 0.0000 |
| 13 | Aim M.F | -1.97 | 0.05 | 33.312 | 0.0312 | 0.066 | -8.2292 | 0.00 | -5.2524 | 0.0000 |
| 14 | Aftab Automobile | -3.62 | 0.00 | 139.36 | 0.0000 | 0.055 | -8.5023 | 0.00 | -3.5952 | 0.0003 |
| 15 | BD. Lamp | -5.19 | 0.00 | 41.981 | 0.0028 | 0.059 | -8.5054 | 0.00 | -4.8537 | 0.0000 |
| 16 | BSRM Steel | -3.25 | 0.00 | 62.972 | 0.0000 | 0.068 | -7.6728 | 0.00 | -4.2315 | 0.0000 |
| 17 | S.Alam | -2.96 | 0.00 | 101.88 | 0.0000 | 0.059 | -8.5058 | 0.00 | -4.3167 | 0.0000 |
| 18 | BATBC | -3.30 | 0.00 | 83.86 | 0.0000 | 0.060 | -8.4567 | 0.00 | -4.6159 | 0.0000 |
| 19 | Olympic | -3.17 | 0.00 | 143.10 | 0.0000 | 0.068 | -8.4245 | 0.00 | -4.0956 | 0.0000 |
| 20 | AMCL (Pran) | -2.57 | 0.01 | 849.9 | 0.0000 | 0.052 | -8.5743 | 0.00 | -1.9996 | 0.0455 |
| 21 | Apex Footwear | -2.90 | 0.00 | 419.52 | 0.0000 | 0.058 | -8.5200 | 0.00 | -2.5477 | 0.0108 |
| 22 | Apex Tannery | -4.08 | 0.00 | 262.92 | 0.0000 | 0.055 | -8.5420 | 0.00 | -2.5929 | 0.0095 |
| 23 | Bata Shoe | -5.12 | 0.00 | 79.652 | 0.0000 | 0.062 | -8.3916 | 0.00 | -4.4928 | 0.0000 |
| 24 | Linde Bangladesh | -3.12 | 0.00 | 87.59 | 0.0000 | 0.061 | -8.4033 | 0.00 | -4.9946 | 0.0000 |
| 25 | Titas | -3.70 | 0.00 | 10.41 | 0.9601 | 0.063 | -8.0761 | 0.00 | -5.0660 | 0.0000 |
| 26 | Powergrid | -1.13 | 0.26 | 120.05 | 0.0000 | 0.066 | -8.6100 | 0.00 | -5.6700 | 0.0000 |
| 27 | Padma Oil | -4.67 | 0.00 | 130.41 | 0.0000 | 0.054 | -7.7875 | 0.00 | -2.9223 | 0.0035 |
| 28 | Summit Power | -2.10 | 0.04 | 26.92 | 0.1374 | 0.064 | -8.4615 | 0.00 | -4.7691 | 0.0000 |
| 29 | Apex Spinning | -3.44 | 0.00 | 159.12 | 0.0000 | 0.060 | -8.2784 | 0.00 | -2.9695 | 0.0030 |
| 30 | Square textile | -3.57 | 0.00 | 63.19 | 0.0000 | 0.062 | -8.4830 | 0.00 | -4.7670 | 0.0000 |
| 31 | Delta Spinning | -2.60 | 0.01 | 172.41 | 0.0000 | 0.062 | -8.6000 | 0.00 | -3.6600 | 0.0000 |
| 32 | Beximco Pharma | -2.81 | 0.00 | 171.78 | 0.0000 | 0.051 | -8.5342 | 0.00 | -3.2547 | 0.0011 |
| 33 | ACI | -2.97 | 0.00 | 228.96 | 0.0000 | 0.056 | -8.4961 | 0.00 | -3.0780 | 0.0021 |
| 34 | Reckitt Benckiser | -1.80 | 0.07 | 16.50 | 0.6851 | 0.068 | -7.8561 | 0.00 | -5.8685 | 0.0000 |
| 35 | Square Pharma | -6.40 | 0.00 | 51.52 | 0.0001 | 0.058 | -8.5156 | 0.00 | -4.1393 | 0.0000 |
| 36 | Keya Cosmetic | -1.54 | 0.12 | 73.35 | 0.0000 | 0.055 | -8.7100 | 0.00 | -5.4200 | 0.0000 |
| 37 | Eastern Housing | -4.51 | 0.00 | 50.44 | 0.0002 | 0.064 | -8.4167 | 0.00 | -4.1599 | 0.0000 |
| 38 | Lafarge cement | -4.11 | 0.00 | 24.43 | 0.2239 | 0.061 | -8.4470 | 0.00 | -4.4590 | 0.0000 |
| 39 | Heidelberg Cement | -2.70 | 0.01 | 130.76 | 0.0000 | 0.050 | -8.5860 | 0.00 | -1.6578 | 0.0974 |
| 40 | Confidence Cement | -1.31 | 0.19 | 51.627 | 0.0000 | 0.064 | -8.5500 | 0.00 | -5.5100 | 0.0000 |
| 41 | RAK Ceramic | -2.71 | 0.01 | 26.32 | 0.1555 | 0.073 | -6.5790 | 0.00 | -4.5399 | 0.0000 |
| 42 | BGIC | -4.34 | 0.00 | 38.96 | 0.0067 | 0.070 | -8.1950 | 0.00 | -5.8161 | 0.0000 |
| 43 | Green Delta Insurance | -4.20 | 0.00 | 19.343 | 0.4997 | 0.092 | -8.2090 | 0.00 | -2.3507 | 0.0187 |
| 44 | Delta life | -8.94 | 0.00 | 21.371 | 0.3756 | 0.061 | -8.0956 | 0.00 | -1.2724 | 0.2032 |
| 45 | Eastland Insurance | -0.30 | 0.77 | 79.975 | 0.0000 | 0.070 | -4.9100 | 0.00 | -4.5700 | 0.0000 |
| 46 | Popular life | -1.52 | 0.13 | 175.18 | 0.0000 | 0.069 | -8.5700 | 0.00 | -3.9700 | 0.0000 |
| 47 | Grameen Phone | -3.01 | 0.00 | 17.114 | 0.6455 | 0.068 | -7.0360 | 0.00 | -4.9198 | 0.0000 |
| 48 | B.S.C | -4.32 | 0.00 | 72.174 | 0.0000 | 0.073 | -7.7180 | 0.00 | -5.7244 | 0.0000 |
| 49 | Beximco Limited | -3.28 | 0.00 | 66.451 | 0.0000 | 0.059 | -8.5120 | 0.00 | -3.7965 | 0.0001 |
| 50 | Berger Paints | -1.83 | 0.07 | 27.086 | 0.1329 | 0.062 | -8.3510 | 0.00 | -5.7394 | 0.0000 |

Source: Authors' own calculation based on DSE data.

Table A2: Results of Autocorrelation test for DSE Broad Index* after different policy reforms

| Lag | After bubble burst in December 2010 | | | After Exchanges Demutualization | | | After installation of Surveillance software | | |
|-----|-------------------------------------|--------|---------|---------------------------------|---------|---------|---------------------------------------------|--------|---------|
| | AC | Q-Stat | p-value | AC | Q-Stat | p-value | AC | Q-Stat | p-value |
| 1 | 0.004 | 0.0146 | 0.904 | 0.111 | 7.0778 | 0.008 | 0.197 | 15.021 | 0.000 |
| 2 | -0.013 | 0.2085 | 0.901 | 0.008 | 7.1185 | 0.028 | 0.051 | 16.021 | 0.000 |
| 3 | -0.024 | 0.8843 | 0.829 | 0.058 | 9.0366 | 0.029 | 0.059 | 17.364 | 0.001 |
| 4 | 0.010 | 1.0009 | 0.91 | 0.097 | 14.5080 | 0.006 | 0.089 | 20.426 | 0.000 |
| 5 | -0.004 | 1.0188 | 0.961 | 0.042 | 15.5500 | 0.008 | 0.022 | 20.617 | 0.001 |
| 6 | -0.032 | 2.1586 | 0.905 | -0.004 | 15.5610 | 0.016 | -0.012 | 20.677 | 0.002 |
| 7 | -0.030 | 3.2021 | 0.866 | -0.016 | 15.7190 | 0.028 | 0.022 | 20.859 | 0.004 |
| 8 | 0.033 | 4.4146 | 0.818 | 0.009 | 15.7610 | 0.046 | 0.006 | 20.872 | 0.007 |
| 9 | 0.067 | 9.578 | 0.386 | 0.024 | 16.1000 | 0.065 | -0.031 | 21.244 | 0.012 |
| 10 | 0.041 | 11.461 | 0.323 | 0.105 | 22.6010 | 0.012 | 0.048 | 22.147 | 0.014 |
| 11 | -0.067 | 16.62 | 0.120 | 0.002 | 22.6030 | 0.020 | 0.044 | 22.917 | 0.018 |
| 12 | 0.037 | 18.152 | 0.111 | 0.04 | 23.5330 | 0.024 | 0.024 | 23.139 | 0.027 |
| 13 | -0.082 | 25.831 | 0.018 | 0.002 | 23.5360 | 0.036 | 0.033 | 23.564 | 0.035 |
| 14 | 0.035 | 27.208 | 0.018 | -0.006 | 23.5550 | 0.052 | 0.033 | 23.986 | 0.046 |
| 15 | 0.025 | 27.916 | 0.022 | -0.039 | 24.4420 | 0.058 | -0.006 | 24.002 | 0.065 |
| 16 | -0.044 | 30.092 | 0.018 | -0.004 | 24.4510 | 0.080 | -0.081 | 26.627 | 0.046 |
| 17 | 0.001 | 30.094 | 0.026 | -0.091 | 29.3480 | 0.031 | -0.116 | 32.046 | 0.015 |
| 18 | 0.042 | 32.102 | 0.021 | -0.042 | 30.4190 | 0.034 | 0.005 | 32.057 | 0.022 |
| 19 | -0.011 | 32.253 | 0.029 | -0.018 | 30.6090 | 0.045 | -0.097 | 35.906 | 0.011 |
| 20 | -0.060 | 36.339 | 0.014 | -0.047 | 31.9120 | 0.044 | -0.069 | 37.867 | 0.009 |

* The DSEG index and DSEX index have been merged from 28 January 2013 to 01 January 2011.

Source: Authors' own calculation based on DSE data.

Table A3: Results of Variance Ratio test for DSE Broad Index* after different policy reforms

| q | After bubble burst in December 2010 | | After Exchanges Demutualization | | After installation of Surveillance software | |
|----|-------------------------------------|---------|---------------------------------|---------|---------------------------------------------|---------|
| | VR | p-value | VR | p-value | VR | p-value |
| 2 | 0.51 | 0.00 | 0.56 | 0.00 | 0.59 | 0.00 |
| 4 | 0.25 | 0.00 | 0.26 | 0.00 | 0.29 | 0.00 |
| 8 | 0.12 | 0.00 | 0.14 | 0.00 | 0.16 | 0.00 |
| 16 | 0.06 | 0.00 | 0.07 | 0.00 | 0.09 | 0.00 |

* The DSEG index and DSEX index have been merged from 28 January 2013 to 01 January 2011.

Source: Authors' own calculation based on DSE data.