Testing the weak form of stock market efficiency at Dhaka Stock Exchange of Bangladesh

UNITED INTERNATIONAL UNIVERSITY

Project Report

On

Testing the weak form of stock market efficiency at Dhaka Stock Exchange of Bangladesh

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Date of Submission: 28th August, 2019

CERTIFICATE

This is to certify that the work contained in the dissertation entitled "**Testing the weak form of stock market efficiency at Dhaka Stock Exchange of Bangladesh**", submitted by **Romana Afrose Pushpita**, ID: 111 161 214 partial fulfillment of the requirements for the award of the degree of **Bachelor of Business Administration** to the **United International University**, is a record of capita market research work carried out by her under my direct supervision and guidance.

I considered that the thesis has reached the standards and fulfilling the requirements of the rules and regulations relating to the nature of the degree. The contents embodied in the thesis have not been submitted for the award of any other degree or diploma in this or any other university.

Dr. Mohammad Musa
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Letter of transmittal

28th August, 2019
Dr. Mohammad Musa
Professor
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Subject: Request for the acceptance of the project report.

Dear Sir,

I am pleased and honored to submit you my dissertation entitled 'Testing the weak form of stock market efficiency at Dhaka Stock Exchange of Bangladesh'.

This paper is a vital part of my academic program in completion of my Bachelor of Business Administration (BBA) degree. It has been my absolute pleasure and honor to do a project under your supervision. I put my utmost effort to make a comprehensive thesis and conduct the research precisely.

Lastly, I really appreciate your thorough direction, support and guidance in formulating the report. Furthermore, I will respond to any queries if needed.

Respectfully,

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Declaration

I, Romana Afrose Pushpita, therefore, assert that this project report “Testing the weak form of stock market efficiency at Dhaka Stock Exchange of Bangladesh” has exclusively been constructed by me. The work contained in this dissertation is original and has been done by myself under the supervision and guidance of my supervisor. I certify that Whenever I have used materials (data and theoretical analysis) from other sources, I have given due credit to them by citing them in the text of the report and giving their details in the references. I approve that this paper has been developed only for the completion of my academic degree. It has not been made for fulfilling any other purpose. I can confirm that this paper has not been presented anywhere in Bangladesh beforehand. From the plagiarism test, it is found that the similarity index of whole paper is less than 10% as per the university guidelines.

Sincerely Yours,

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Abstract

This paper attempts to examine whether DSE, an emerging and less developed market, is efficient in weak-form or not. In order to do that, this paper employs daily share closing price index of DSEX (DSE Broad Index) for the period of 30th January, 2013 to 31st July 2019. The efficiency is verified by analyzing descriptive statistics, one parametric test (Auto Correlation test) and two non-parametric tests (Runs Test and Kolmogorov-Smirnov Goodness of Fit Test) using the software Statistical Package for Social Science (SPSS). All the tests are conducted on market return series that has been calculated from the daily closing price index of DSEX. The findings from descriptive statistics show that the data set is not normally distributed. Also, from Kolmogorov-Smirnov test, it has been found that daily price index of DSEX does not fit by normal or uniform distribution. The result of the runs test reveals that share price of the DSEX does not support random walk hypothesis (RWH). Again, autocorrelation test has been applied for 16 lag periods. The results show little indication in support of random walk hypothesis.

Therefore, this paper concludes that daily closing price index of DSEX does not follow a random walk and thus, rejects the RWH, meaning that, DSE Broad Index is not efficient in weak form. Hence, DSEX does not reflect the rational and appropriate prices of the stocks. Thus, it can be said that investors operating in DSEX can forecast subsequent prices by using historical price data or information and therefore; they can generate excessive return using investment strategies.

Table of Contents

CERTIFICATE iii

Letter of transmittal iv

Declaration v

Acknowledgement vi

Abstract vii

Table of Contents viii

List of tables x

List of Figures x

Chapter 1 1

1. Introduction 2

2. Brief Description about DSE 5

3. Objectives & Scope 8

3.1 Research objective 8

3.2 Scope of the research 8

3.3 Hypothesis of the study 8

4. Literature review 9

4.1 Review of Empirical Evidence in less developed countries 11

4.2 Review of empirical evidence in DSE 14

Chapter 2 16

5. Methodology 17

5.1 Sample selection 17

5.2 Sample Size 17

5.3 Sample Period 17

5.4 Statistical Methods 17

Chapter 3 20

6. Empirical evidence and Analysis 21

6.1 Descriptive statistics 21

6.2 Kolmogorov-Smirnov goodness of fit test 21

6.3 Runs test 23

6.4 Auto correlation 23
7. Summary of Findings 26
8. Conclusion 27
9. Bibliography xi

List of tables

Table 1: Review of DSE market, 2019 6
Table 2:review of empirical evidence of market efficiency test in less developed countries 13
Table 3: review of empirical results of market efficiency tests in DSE 15
Table 4: Descriptive statistics for the Daily Index Returns 21
Table 5: One Sample Kolmogorov Smirnov test for the daily market returns 22
Table 6: One sample Kolmogorov Smirnov test for the daily market returns 22
Table 7: Results of Runs test for the daily market returns 23
Table 8: Auto Correlation of daily stock market return 24

List of Figures

Figure 1: DSEX index performance 7
Figure 2: Graphical representation of Autocorrelation test 25

Chapter 1

- Introduction
- Objective of the report
- Brief review on DSE
- Literature Review
- Empirical review of previous studies

1. Introduction

Beginning with the most distinguishing concept of an efficient market developed by Eugene Fama **(1970)**, an efficient capital market is characterized as the one in which security prices fully and correctly reflect all the available relevant information. An efficient capital market is marked by intense competition, hence, all the securities in the market (stocks, debts, and others) are fairly priced. on the other hand, if a capital market is inefficient, then the new data or information is not reflected in security prices; as a result, price movements of shares are not random and may follow a trend.

In an efficient market, price movement is quickly understood by the market participants and thus, reflected in stock prices. As a consequence, investors operating in the market cannot possibly outsmart the capital market and gain excessive return. This can be well-understood from simple microeconomics that suggests that in the presence of sufficiently competitive market, investors cannot generate abnormal returns by using any speculation rules or strategies. But although this appears manifest today, it was far from conspicuous for the last century.

The philosophy of share market efficiency can be categorized into two key areas-

- operational efficiency
- Informational efficiency

As stated by Fama (**1970**) and Baumol **(1965)**, different approaches are followed to test the market efficiency under these two classifications. From the operational perspective, testing stock market efficiency means addressing the characteristics of functionality of a capital market. Some aspects of functionality may include issues like- liquidity of the market, transaction costs, and timeliness in the transaction. From the informational efficiency viewpoint, testing the market means estimating the manner in which the investors react to all publicly accessible information in the capital market. It infers that the market absorbs new information rapidly and this information is reflected in the stock prices.

The concept of market efficiency produces the theoretical foundation of one of the most controversial subjects, which is Efficient Market Hypothesis (EMH). This Efficient Market Hypothesis (EMH) says that all known information about investment securities-stocks, bonds, is already reflected into the prices of securities, thus, leads to the assumption that neither technical nor fundamental analysis can generate risk-adjusted excess returns or alpha, consistently and only inside information can result in outsized risk-adjusted returns. The levels of EMH can be distinguished between three levels depending on the degree of information that is represented by the stock prices. Three levels of EMH includes the weak, semi-strong and strong forms of market efficiency. The levels are different from each other based on the concept of what is meant by the term "all available information" **(ZVI BODIE, 1999)**.

In accordance with the weak-form of EMH, that present stock prices completely represent past data or historical information. Historical data includes all the information that can be found by scrutinizing stock exchange information, for example, the previous price records, data of past trading volume and short interest. No method of technical analysis can be used to assist investors in making such trading decisions that can generate abnormal profit. But some advocates for the weak form efficiency theory suggests that by using fundamental analysis, undervalued and

overvalued stocks can be determined, and thus investors can research companies' annual report and financial statements to increase their chances of generating profit that is higher than average market profits. This issue raises some major questions about weak form of market efficiency. These questions are discussed in this report to get the appropriate answer.

Another form of market efficiency is semi-strong form. According to semi-strong form of EMH, the prices absolutely reflect the previous data as well as all publicly available records related to a company. Publicly available information involves any fundamental facts about the company's production, quality of management, income statement and balance sheet information, earning forecasts, and accounting practices. So, theoretically, investors can utilize neither technical nor fundamental analysis to achieve higher profits in the market since share prices reflect the information already.

Lastly, the EMH in the strong form suggests that regardless of the type of information whether it is historical or public or private, it is reflected by the share price. Information that are private refers to the data that are accessible by the insiders only. Thus, the EMH proposes that individual investors cannot obtain abnormal return by means of insider trading. Analysts declare that if the market is strong form of efficient then, investors cannot possibly generate excessive returns on investments regardless of information retrieved or research conducted.

There have been numerous researches that strived to find out if the market is efficient, and if so, which form of market efficiency does it hold. These researches on stock price behavior show discrepancy regarding stock market efficiency suggesting that EMH is acceptable by some studies but not acceptable by some others. The possible reasons behind this is the critical role that is played in market efficiency in terms of its implications on capital formation, wealth distribution and investor rationality.

In many earlier studies [**(Poshakwale, 1996)**, **(Gupta & Basu, 2007)**, **(Branes, 1986), (Ansari & Chen, 2013)**] capital markets were shown as efficient at least in its weak form or semi-strong form. But, according to the recent studies, researchers are suggesting that the capital market of majority of developed and less developed countries are inefficient in strong and semi-strong form and some of them are not even holding weak form of market efficiency.

In consideration of the capital market efficiency, the primary query is whether the Dhaka stock market of Bangladesh (DSE) is efficient or not. Can the stock prices be forecasted using previous or public information or is there any information that is not fully represented in stock prices? Is it possible for the investors to gain abnormal return? If the market is efficient, what is the degree of efficiency? It is imperative to address these questions since the capacity of a stock market to carry out its operations efficaciously and ensure reasonable earnings for all the investors generally depend on the degree to which the market is competent and efficient. There have been several researches conducted around the world in last few decades. Nevertheless, different researches show varying empirical results.

This paper attempts to find out whether DSEX is efficient in weak form or not. To answer this question, some non-parametric and parametric tests are used to demonstrate empirical evidence.

This paper is constructed in the following way-

- Chapter 1 consists of basic introduction, objective of report, brief review on DSE, literature review, review of empirical evidence on weak form of efficiency tests in both less developed markets and DSE
- Chapter 2 includes data selection, methodology and description about statistical techniques that will be used
- Chapter 3 includes the empirical evidence, analysis and interpretation of the data
- Chapter 4 includes conclusion

2. Brief Description about DSE

At the very beginning, Dhaka stock exchange had been entitled as East Pakistan Stock exchange association on 28th April, 1954. In 1956, formal exchanging had been begun with 196 securities recorded on the DSE. The total paid up capital of the listed companies was about BDT 4 billion. On 23rd June, 1962, it was renamed as Dhaka Stock Exchange (DSE) Limited.

The Dhaka stock exchange has been registered as a public limited company. Its operations are controlled by AOA (Article of Association) and its own rules, laws and legislations and some by-laws along with the SEC (securities and exchange commission) Act, 1993, Securities and exchange ordinance, 1969 and the companies Act, 1994. DSE is an autonomous not-for-profit organization. At present, the number of members of DSE is 195, although it has provisions for total 500 members. Foreigners can also avail the Membership as well according to the regulations.

Due to the liberation war and the change in economic policy, the trading activities of the Dhaka Stock Exchange remained repressed from 1971 to 1976. After Bangladesh had achieved independence, the operations were resumed from 1976. At that time, there were only 9 listed companies in DSE and the total issued capital was BDT 0.14 billion. On 30th June, 1999, the number of listed securities in DSE was increased to 230 securities that had a market capitalization of around BDT 50,748 million. So, although the number of listed securities went up, the total issued capital and debentures of the listed companies went down from the period 1997-1998 to the period 1998-1999 as the amount decreased from BDT 30,211 million to 28,684 million.

Nevertheless, DSE gained more recognition and reputation among more small and medium investors gradually and as a result, DSE's depth had increased significantly. At the end of 2010, the total market capitalization rose to around US $ 43.2 billion. This turned out to be 37.6% of our country's GDP at that time. Also, the total value of stock traded went 50.3% of the GDP. By the end of June 2015, the stock market capitalization decreased significantly and went to US $ 34.7 billion which was 17.8% of country's GDP. As we can see, the market was extremely volatile and the amount of market capitalization fluctuated a lot throughout the years. By the end of 2016, total market capitalization of all listed securities in DSE increased again to US $ 1283.79 million. Compared to that, the amount declined to US $ 1046.36 million by the end of 2017. So, there was a decrease of 22% in total market capitalization from 2016 to 2017. The decline in market capitalization was caused by some issues, which are- listing of fewer number of new issued shares, lack of rights and bonus issues, impact of decline in all share price index during the bubble burst (2009-2010). During that period, all share price index of DSE decreased from 676.47 to 547.79.

As the time was moving forward, the number of listed companies had been growing. By the end of 2018, there were a total of 318 different financial instruments of several companies that was being traded. The trading in DSE is operated through an automated online system. Except Fridays, Saturdays and government holidays, trading can be done on any other days. In the capital market system, there are four distinct markets. Those are-

- Public market- trading of lot market share is operated here through automatic matching.
- Spot market- on spot transactions are done in this market with the help of automated matching. The trade must be settled within 24 hours.

- Block market- through pick and fill basis, bulk quantities of shares are traded here.
- Odd lot market- on the basis of pick and fill, odd lot scripts are traded here.

Any transactions in public market, after netting are settled and cleared through the DSE clearing house, are due on 3rd and 5th working day respectively which is counted from the date of trading. Members of DSE are permitted to perform transaction on behalf of foreign buyers and sellers. This kind of transactions may involve a custodian bank for the direct settlement within the 5th day following the trading day, T+5.

At present in 2019, the total number of listed securities is 579. Following table shows overall condition of DSE as of January, 2019.

Total number of listed		
Securities	579	
Companies	312	
Treasury bonds	221	
Commercial bonds	1	
Total Issued Capital:	**(Figure Tk. in mn.)**	**(Figure US$ in mn.)**
Securities	1,245,529	14,837
Companies Shares	637,966	7,599
Govt. T-Bonds	548,592	6,535
Corporate Bonds	3,000	36
Total Market Capitalization of all listed	**(Figure Tk. in mn.)**	**(Figure US$ in mn.)**
Securities	4,162,951	49,588
Companies Shares	3,573,340	42,565
Govt. T-Bonds	548,592	6,535
Corporate Bonds	2,799	33

Table 1: Review of DSE market, 2019

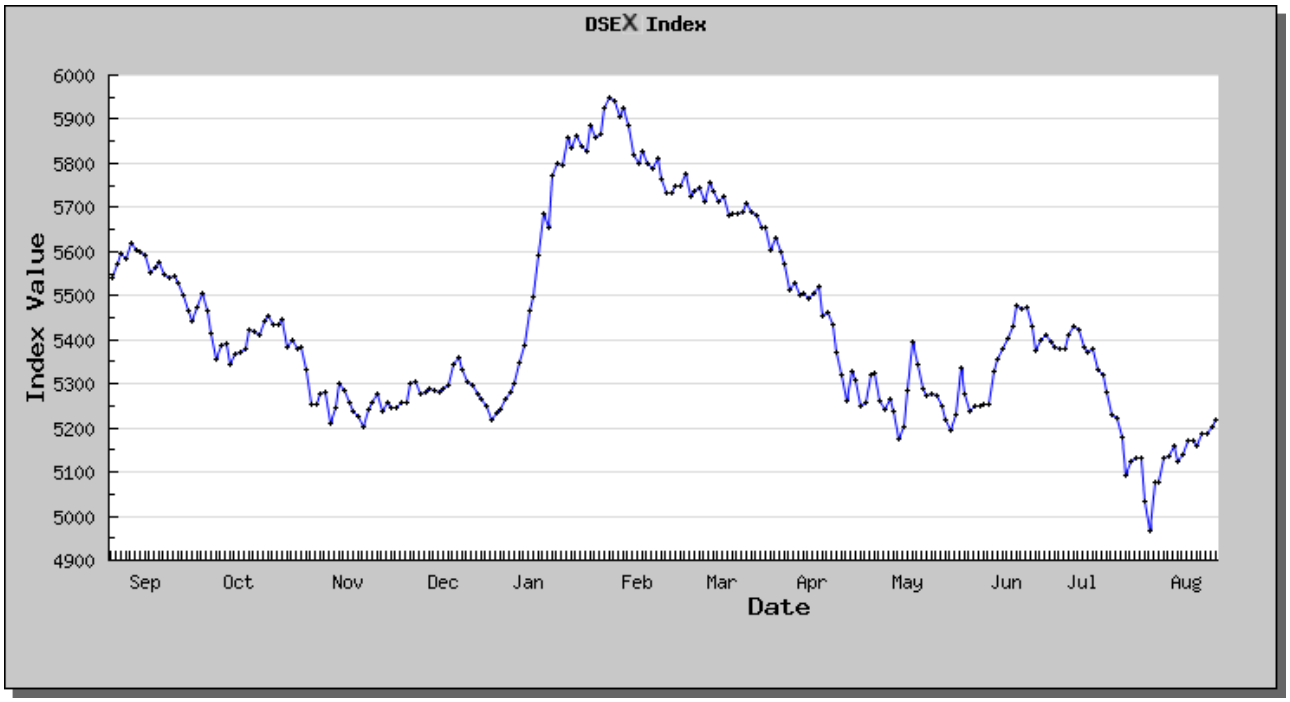
There had been many organizational modifications that DSE had gone through. Also, there had been some significant restructurings in its policies. These modifications were necessary since the stock market was volatile from the very beginning. Moreover, since its initiation, DSE confronted two big bubble bursts. The stock market crashed and many investors lost their capital during that period. The first bubble burst occurred in November, 1996 when the stock index had reached its peak in history. Another crash occurred in 2010. The reason behind the burst was inefficiency of the market. These incidents costed many investors who lost their valuable assets after the big bursts. To improve its efficiency, several alterations had been made but the effect of these reforms are controversial. Some researchers still found signs of inefficiency in DSE.

Due to all these reasons, it is imperative to test the market efficiency of DSE and analyze the outcome of those modifications.

This study employs the daily closing price of DSE Broad index. As per DSE Bangladesh Index Methodology, the Dhaka Stock Exchange limited presented DSEX and DSE 30 Index. These have been developed and designed by S&P Dow Jones Indices that came into effect from January 28, 2013. DSEX is the Broad Index of the exchange and it reflects 97% of the total equity market capitalization. DSEX includes stocks that have a float-adjusted market capitalization more than

BDT 100 million. To have a brief review about the performance of DSEX, index graph of last one year starting from 18th August, 2018 to 18th August, 2019 is given below-

Figure 1: DSEX index performance



There have been significant fluctuations in the stock market, the highest value that has been identified is 5950.01115.

And the lowest value is 4966.44063

3. Objectives & Scope

3.1 Research objective

The objective of this research is to evaluate the DSE market and analyze whether it is holding weak form of efficiency or not.

3.2 Scope of the research

After collecting all the relevant data from Dhaka stock exchange library, the empirical analysis is conducted. The study applies descriptive statistics, two non-parametric (Kolmogorov-Smirnov goodness of fit test and Runs test) and one parametric (Auto-correlation) for the purpose of testing market efficiency of DSEX (DSE broad index) for the time period of 30th January, 2013 to 31st July 2019.

3.3 Hypothesis of the study

1. For Runs Test,
   H_o= The succeeding price changes are not dependent and follow a random walk, therefore, market is weak form efficient.
   H_1= The succeeding price changes are dependent and do not follow a random walk, therefore, market is inefficient.

2. For Auto-correlation test,
   H_o=There is no autocorrelation, hence, market is efficient.
   H_1=There is autocorrelation, hence, market is inefficient.

4. Literature review

The literature review of this paper scrutinizes the philosophy of RWH (random walk hypothesis) and some empirical evidence of researches conducted previously on DSE. During the past century, many articles and papers were published regarding the weak form of market efficiency test. The results of the enormous studies are varying and thus arise an interesting empirical question: Does DSE, a less developed evolving market, hold weak form of efficiency?

After analyzing numerous results of several studies, it has been clear to researchers that the efficiency of DSE market is questionable. The initial researches began with testing efficiency of developed markets. The primary results were supporting the RWH model as majority of the developed markets turned out to be efficient at least in its weak form. The results showed a low degree of serial correlation, which means the markets were following the efficient market hypothesis **(Cootner, 1962)**, **(Kendall, 1943)**. As a result, it was concluded that price changes were arbitrary and past changes in price were not good indicator of future prices especially after transaction costs were taken into consideration. However, later, some studies found some correlation and certainty in stock price changes in some of the developed markets but those researches could not draw a conclusion on profitable trading rules or investment strategies [**(Fama & French, Permanent and temporary components of stock, 1988)**, **(Poterba & Summers, 1988)**]. A study conducted by Fama and French **(1988)** concluded that any degree of auto correlation may reflect market inefficiency and it may be possible for rational investors with investment rules to generate abnormal profit. According to Hudson, Dempsey and Keasey **(1935-1994)**, the technical trading strategies have strong power to predict future prices but it was not sufficient to generate excess return in U.K stock market. Likewise, **Nicolaas (1997)** drew conclusion that, in Australia, the historical data (i.e. past returns) have little to no predictive power and the degree of forecasting is not so strong for generating abnormal return. So, the findings of studies conducted on developed market supported EMH and RWH in general.

On the contrary, the empirical results of weak-form market efficiency test on developing and less developed countries are debatable. It has been viewed that majority of the less developed markets are facing the issue of thin trading. It is much simpler and easier for large traders to exploit the market specially when the market size is smaller. Generally, it is assumed that less developed or emerging markets are less efficient or inefficient. But the results of several empirical studies are varying. Two groups of findings are there- the first group found market efficiency in weak form in less developed and developed markets. For instance, **Branes** (1986) found efficiency in Kuala Lumpur stock exchange; **Chan, Gup and Pan** (1992) found efficiency in some major Asian markets; **Dickinson and Muragu** (1994) demonstrated evidence on efficiency in Nairobi stock exchange; and **Ojah and Karemera (1999)** found efficiency in four Latin American countries markets. On the contrary, another group established evidence that the majority of less developed or developing countries are not weak form efficient. For example- **Cheung, Wong & Ho** (1993) found inefficiency in Korean and Taiwan stock market; **Dasgupta and Glen** (1995) found similar results for majority of the emerging markets. **Nourrendine Khababa** (1998) examined behavior of stock price to analyze weak form efficiency of the Saudi financial market and concluded that market was not efficient in weak form. The delay in operations, thinness of trading, illiquidity in the market and the high

transaction costs associated with the trading are some reasons behind market inefficiency as he explained. **Poshakwale** (1996) found significant evidence of inefficiency or non-randomness in share price movement in both Johannesburg stock exchange and Indian share market. Thus, they declared that those two markets are inefficient in weak form.

There are some other researches that examined weak form efficiency. **Sharma & Kennedy** (1977) evaluated the share price indices of three stock markets- Bombay, London and NYSE for the period of 1963 to 1973. The research employed both runs test and spectral analysis. The findings of the tests indicated randomness of share price indices in all three stock exchange markets. Reyad and Hossain analyzed 15 Asian stock markets to test market efficiency. They employed daily share price indices in this regard and found inefficiency in all fifteen markets.

Omran studied five major middle eastern emerging markets to test RWH. His study employed runs test, autocorrelation test, box-pierce test and unit root test and analyzed Kruskal-Wallis test as well for investigating calendar effects. The results demonstrated that, unlike other markets, Israel-s TA-100 share market was supporting RWH (random walk hypothesis). Some anomalies related to day of week effects, were found. In another research, **Asiri** (2008) utilized cross sectional time series data to examine 40 listed companies in BSE (Bahrain stock exchange) for the period from 1st June 1990 to 31st December, 2000.

So, it can be said that significant amount of studies has been conducted to analyze market efficiency. A brief review of some other studies is demonstrated in the following tabular format.

4.1 Review of Empirical Evidence in less developed countries

Serial no	Study conducted	Selected markets	Time period	Statistical Technique	Findings
1	**S.K. Chaudhuri (1991)**	India	1988-1990	Runs test and Serial-correlation	Market is not efficient even in weak form.
2	**Sunil Poshakwale (1996)**	India	1987-1994	Runs test, Auto-correlation and KS test.	Results are supporting weak form of efficiency. Except Monday and Wednesday, Mean returns for other days are positive.
3	**(pant & Bishnoi)**	India	1996-2000	Unit Root test, Autocorrelation, Variance Ratio.	RWH is rejected for daily and weekly market indices returns.
4	**Ashutosh Verma (2005)**	India	1996-2001	Serial Correlation	Market is efficient in weak form.
5	**(Gupta & Basu, 2007)**	India	1991-2006	Augmented Dickey-Fuller (ADF), KPSS, Phillips-Perron test	Market is weak form inefficient.
6	**(Lawrence, Cai, & Quin, 1997)**	China	1993-1996	Co-integration, Serial Correlation, Unit Root, Granger causality test	Market is weak form efficient and it is becoming an international market.
7	**(Liu, 2003)**	China	1996-2002	Fama-MacBeth regressions, Autocorrelation	SSE Market is not weak form efficient.
8	**T.S.Syad Z.A, Kashif Hamid, Muhammad (2010)**	Sri Lanka, Pakistan, Korea, Malaysia, India, Hong Kong, China	2004-2009	Auto-correlation, Runs Test, Unit Root Test and Variance Ratio.	Neither of the markets is weak form efficient.
9	**(Cooray & Wickremasinghe)**	India, Sri Lanka, Bangladesh and Pakistan	1996-2005	Pair-wise Correlation, Autocorrelation, Cointegration test, Granger Causality test.	Except for Bangladesh, rest of the markets of south of Asia are weak form efficient.
10	**(Elango & Hussein, 2008)**	Abu dhabi, Dubai, Saudi	2001-2006	Run test, KS test. Auto-Correlation	Markets are not efficient even in the

		Arabia, Qatar, Oman, Bahrain, Kuwait			weak form. Larger variations in return have been observed.
11	**Barnes (1986)**	Kuala Lumpur, Malaysia	1975-1980	runs and autocorrelation test	the market is efficient in the weak-form
12	**Othman (1989)**	KLSE, Malaysia	1977-1988	serial correlation and run tests	He concluded that the Malaysian Stock Market was weak form inefficient.
13	**Lian and Leng (1994)**	KLSE, Malaysia		run tests, serial correlation test, modified Box-Pierce, Q test and Van Neumann's ratio test	The results of different statistical tests on the KLSE stock indices suggested that KLSE is weak form efficient.
14	**(Laurence, 1986)**	Kuala Lumpur Stock Exchange (KLSE) and the Stock Exchange of Singapore (SES).	1973-1978	runs and autocorrelation test	The results of both tests suggest that both markets are not weak form efficient
15	**(Ansari & Chen, 2013)**	Japan, Malaysia, Singapore, south korea, Taiwan, China, Australia, Hong Kong, Indonesia	2000-2006	Serial-correlation, Variance ratio, Unit root test, Random walk models, BDS test	Appropriate evidence was found in support of weak form of efficiency.
16	**Haque et al.**	Pakistani stock market	2000-2010	autocorrelation tests, a runs test, PP, ADF and KPSS unit root tests	The results Indicated the evidence of rejection of the random walk hypothesis
17	**(Moustafa, 2004)**	United Arab Emirates (UAE) stock market	2001-03	run tests	UAE is found to be weak-form efficient
18	**(Hamid, Suleman, Shah, & Akash , 2010)**	Pakistan, India, Korea,Hong Kong,Indonesia, Malaysia, Philippine,	2004 – 2009	normality in data distribution using Jarque-Bera statistics, serial correlation, using Ljung-Box Q-statistics test	Apart from Pakistan from 6 lag onwards, all the countries have failed to prove random, hence, declared market

		Singapore, Thailand, Japan,Australia			efficiency do not hold
19	**Shaheen, et al., 2015**	Hong Kong, Taiwan, Korea, Pakistan, and India	2000-2012	return and conducted descriptive statistics test using Jarque Bera test, ADF and serial correlation	found market do not follow random walk
20	**(Huang, 1995)**	Thailand, Taiwan, Indonesia, Malaysia, Korea, Singapore, Hong Kong, Japan, Philippines	Jan 1988-Jun 1992	single variance ratio test	RWH is rejected for all markets except for Taiwan, Indonesia and japan.
21	**(Chung, 2006)**	Shanghai and Shenzhen stock exchanges	Jan 2000–Dec 2000	runs test, Augmented Dickey-Fuller unit root tests, auto-correlation test, and variance ratio tests	Empirical evidence complies with the previous studies that these markets are not weak form efficient.
22	**Abeysekera (2001)**	Colombo stock market (Sri Lanka)		unit root tests, serial correlation, and runs	Market is not efficient in weak form.
23	**Mohammed Omran and Suzanne V. Farrar (2006)**	Morocco, Turkey, Israel, Egypt, Jordan	1996-2000	Variance Ratio, Auto-correlation.	These middle eastern markets are not weak form efficient.

Table 2:review of empirical evidence of market efficiency test in less developed countries

Numerous studies have been conducted for testing market efficiency of DSE as well. Depending on the results, research studies on market efficiency in the context of the DSE can be divided into three different 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.

Research of Alam and Kadapakkam (1999), Hassan and Chowdhury (2008), Uddin and Shakila (2008) supports the existence of weak form efficiency of the DSE. On the contrary, 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 do not follow a random walk.
Some other empirical findings are shown in the tabular format below-

4.2 Review of empirical evidence in DSE

Seral no	Study conducted	Period of study	Methodology of study	Findings
1	**(Asma & Keavin, Weak-form market efficiency of an emerging Market: Evidence from Dhaka Stock Market of Bangladesh, 2000)**	1988-1997	Auto-correlation test, Auto-regression, ARIMA model.	Market is not weak form efficient and thus, not following a random walk.
2	**(Asma, Mohllaha, & Bhuyan , 2008)**	1988-2000	Runs test, K-S test, Auto-correlation,	Market is inefficient and does not support RWH
3	**Miah (2014)**	2001-2010	variance ratio test, runs test	None of the monthly, weekly and daily returns suggest RWH
4	**(Islam, 2005)**	1990-2001	unit root test, autocorrelation test, and variance ratio test	Researchers found evidence of weak form efficiency before the 1996 stock market crash.
5	**(Bose, Uddin, & Islam , 2014)**	1993-2002	ARIMA, autocorrelation and run test	The result of study shows that DSE and CSE are not efficient in the weak-form and strong-form of EMH.
6	**(Raquib & Alom, 2015)**	2001-2013	Autocorrelation test	DSE doesn't hold a weak form of efficiency and not following the Random walk model.
7	**(Chaity & Sharmin, 2012)**	1993 –2011 and 2002 – 2011	daily return using logarithm, Kolmogrov-Smirnov Goodness of Fit test and Q-Q probability chart, ACF and PACF, Ljung–	found data not to be normally distributed. There was a significant positive auto correlation presence on first lag for both indices, which means data do not follow random walk.

			Box test in Auto Regressive Integrated Moving Average (ARIMA) modeling	Furthermore, ARIMA (time series) forecasting strengthens the non-random nature of DSE
8	**Khan & Huq, 2013**	2002– 2010 sub-segmented the timeline in 2002-2004, 2005-2007, 2008-2010	autocorrelation test, unit root test, and ARIMA model, runs test	Results say, stock market return series has dependence, data has no unit root (stationary), DSE data do not follow random walk, and returns can be predicted by using time series model like ARIMA. Therefore, they have concluded that DSE in not efficient in weak form
9	**Rahman et al. (2004), 2003**	31st Jan, 1990- 30th september	unit root tests (ADF and PP)	Market is weak form efficient.
10	**(Joarder, Ahmed, Haque, & Hasanuzzaman, 2014)**	1980-2008	ADF Unit root test	DSE is not weak form efficient.

Table 3: review of empirical results of market efficiency tests in DSE

Chapter 2

- **Methodology**
- **Statistical Techniques**

5. Methodology

5.1 Sample selection

The sample includes secondary data set of the daily closing price index of DSEX (DSE Broad Index) that has been collected from DSE library.

5.2 Sample Size

Total number of observations under study is 1568. The sample of this study includes daily price index of DSEX (DSE Broad Index). From daily all share price index, market return has been calculated for analyzing the market efficiency. For determining return series, following formula, which is known as LRW model, has been used-

$$\boldsymbol{Return} = \ln \frac{\boldsymbol{ASPI_t}}{\boldsymbol{ASPI_{t-1}}}$$

Here,

$ASPI_t$= All share price index at time 't'

$ASPI_{t-1}$ = All share price index at time 't-1'

5.3 Sample Period

The study considers daily closing price index of DSEX for the period from 30th January, 2013 till 31st July, 2019.

5.4 Statistical Methods

5.4.1 Descriptive Statistics

The calculated stock index return has been used for the purpose of determining the value of mean, median, standard deviation, variance, kurtosis and skewness. Descriptive statistics are useful for determining whether the data set is normally distributed or not.

5.4.2 Kolmogorov-Smirnov Goodness of Fit Test

Kolmogorov-Smirnov Goodness of fit test (K-S test) is a non-parametric test which is applied to determine how well a random sample of data fits a specific distribution. This test has been extensively used in many researches to compare the observed cumulative distribution function for a variable. The data set can follow any of these four distributions- normal, uniform, Poisson or exponential. This method of one sample goodness of fit test compares the cumulative distribution function for a specific variable with a uniform or normal or Poisson distributions. This test also identifies whether the distributions are homogenous.

5.4.3 Runs Test

Runs test is non-parametric statistical technique that is widely used to detect if a time series is random or not. Runs test has been used in this study to test the weak-form efficiency since it does not require returns to be normally distributed. This method of statistical technique involves some distinct characteristics-

- Absolute values in the time series are ignored
- The procedure deals only with signs, either positive or negative
- A run is considered when there is a recurring incidence of same value or sign or category of a variable.

In this report, run is defined as a price change sequence of the same sign. After identifying the runs, observed number of runs and expected number of runs are calculated. Then, the test compares the actual number of runs with the expected number of runs assuming prices change independently. The conclusion is drawn based on following criteria-

- If the difference between observed number of runs (R) and expected number of runs E(R) appears to be not significant, then it can be said that consecutive changes in prices are not dependent on each other. Therefore, the run is characterized by mean reversion. In that case, null hypothesis can be accepted.
- If the difference between (R) and E(R) is substantial, then it can be concluded that price series of securities is not independent and the series is characterized by trends. Therefore, null hypothesis can be rejected and alternative hypothesis can be accepted, meaning that, security prices can be forecasted using past or historical data.

Both too many runs and too few runs give a signal of non-randomness in the returns, which is not desirable. Too many runs suggest a negative autocorrelation whereas, too few runs indicate a positive autocorrelation.

So, primarily the comparison should be made between observed number of runs and expected number of runs. Here, mean is considered as the comparison base.

The expected number of runs or mean can be determined by using the following formula-

$$\mathrm{E(R)} = \frac{2(\mathrm{n1} * \mathrm{n2})}{\mathrm{n1} + \mathrm{n2}} + 1$$

The standard error of mean SE(R) can be determined by using the following formula-

$$SE(R) = \frac{\sqrt{(2n1 * n2)(2n1 * n2 - n)}}{n^2(n-1)}$$

For evaluating if the time series follows a random walk or not, Z statistics is applied here and it can be formulated in the following way-

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

Here,

- n = number of observations
- n1 = number of upward run (+ sign)
- n2 = number of downward run (- sign)
- E(R) = observed number of runs
- R = actual number of runs

- Z = standard normal variance
- SE(R) = standard error of mean

5.4.4 Auto Correlation

Auto correlation is another statistical technique that can be applied to test randomness in stock index changes. It is also known as serial correlations. This method of statistical technique tries to identify if the changes in prices within one period have any relationship with that of another period. If the correlation coefficient is not significant or noteworthy (not extensively different from zero), then the changes in price are considered to be independent of other price changes. On the other hand, if the correlation coefficient is significant, then the changes in price are not independent and therefore null hypothesis can be rejected. For the purpose of testing the joint hypothesis, Box-Ljung (BL) statistics has been applied for 10 lags. Here, the joint hypothesis is formulated as 'all the autocorrelation coefficients up to specific lags are instantaneously equal to zero'.
BL statistics can be calculated by using the following formula –

$$\boldsymbol{BL = n(n+2)\sum_{k=1}^{m}[\frac{\rho k^2}{n-k}]}$$

Here,

- BL = statistics following Chi-square distribution
- n= sample size
- k = lag
- m= degree of freedom and lag length
- ρk= serial correlation coefficient at lag k

Chapter 3

- **Empirical Evidence**
- **Analysis of data**
- **Interpretation**

6. Empirical evidence and Analysis

All the tests have been conducted using Statistical package for social science (SPSS) software. The results and interpretation are given below-

6.1 Descriptive statistics

According to the random walk hypothesis (RWH) model, the distribution of the return series should be normal. To test the distribution of the series, Descriptive statistics for daily share price return series of DSEX for the period of 30th January, 2013 to 31st July, 2019 have been calculated and summarized in the following table.

Table 4: Descriptive statistics for the Daily Index Returns

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Market return of Index series	1567	-0.054	.0368	.00013	.008	.000	-.052	.062	3.337	.124
Valid N (listwise)	1567									

From the table, we can see that mean returns of the DSEX index is positive, which is .00013. the minimum and maximum return have been identified -0.0535 and .0368, respectively. As can be seen, the value of skewness is negative and kurtosis value is positive. A data set is perfectly normally distributed if the value of skewness and kurtosis is zero and three respectively. On the other hand, negatively skewed or skewed to the left and higher kurtosis generally mean that a data series is not normally distributed. The returns of the DSEX index is negatively skewed and the kurtosis is also large, meaning that, daily return series is not normally distributed.

6.2 Kolmogorov-Smirnov goodness of fit test

Another non-parametric test has been conducted which is one sample Kolmogorov Smirnov Goodness of fitness test (K-S test) to determine whether the observed data set fits by normal, uniform or Poisson distribution. Here, both the normal and the uniform parameters have been used to test the distribution. The results are presented in the following table-

Table 5: One Sample Kolmogorov Smirnov test for the daily market returns

		Market return of Index series
N		1567
Normal Parameters[a]	Mean	.00013996646
	Std. Deviation	.008031997714
Most Extreme Differences	Absolute	.055
	Positive	.055
	Negative	-.051
Kolmogorov-Smirnov Z		2.174
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Normal.

The results show that the calculated value (sig.) is less than 0.05. it clearly indicates that distribution of daily price index of DSEX does not fit by normal distribution.

Table 6: One sample Kolmogorov Smirnov test for the daily market returns

		Market return of Index series
N		1567
Uniform Parameters[a]	Minimum	-.053583831
	Maximum	.036847408
Most Extreme Differences	Absolute	.408
	Positive	.215
	Negative	-.408
Kolmogorov-Smirnov Z		16.164
Asymp. Sig. (2-tailed)		.000

a. Test distribution is Uniform.

From the table above, it can be seen that the sig. value is less than level of significance. So, distribution does not fit by uniform distribution.

The findings undoubtedly indicate that the DSE Broad index (DSEX) fits by neither normal nor uniform distribution. Therefore, null hypothesis that the price index follows a random walk, is rejected. As a result, it can be said that, market is weak form inefficient.

6.3 Runs test

The results of runs test are presented in the following table.

Table 7: Results of Runs test for the daily market returns

	Market return of Index series
Test Value[a]	.00013996646
Cases < Test Value	791
Cases >= Test Value	776
Total Cases	1567
Number of Runs	669
Z	-5.834
Asymp. Sig. (2-tailed)	.000

a. Mean

From the table above, it is conspicuous that the p values are near to zero at 5% level of significance which indicates that the expected number of runs is greater than the actual number of runs. Consequently, null hypothesis that the data set follows a random walk is rejected.
So, DSEX is weak form inefficient.

6.4 Auto correlation

The following table presents the findings of Ljung -Box test for higher order correlations for DSEX daily stock price index. For the total sample, Box-Ljung statistics are significant at all the lags. This means that there is a serial correlation or dependence between the returns of the stock index. Thus, it can be concluded that the market under study is not following random walk model. Also, the sig. value is less than the level of significance, 0.05. therefore, null hypothesis is rejected, meaning that, DSEX is weak form inefficient. The graphical representation of serial correlation test has been demonstrated below as well-

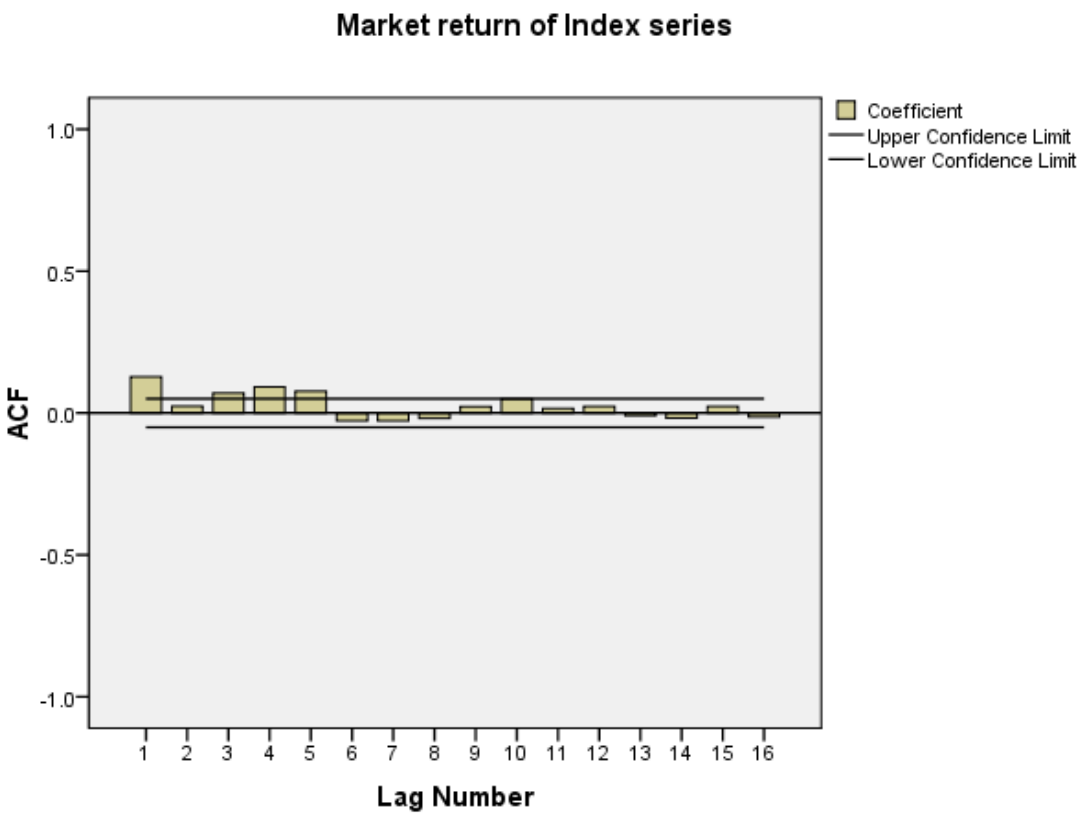
Table 8: Auto Correlation of daily stock market return

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	.127	.025	25.456	1	.000
2	.024	.025	26.378	2	.000
3	.070	.025	34.164	3	.000
4	.092	.025	47.493	4	.000
5	.076	.025	56.691	5	.000
6	-.028	.025	57.902	6	.000
7	-.028	.025	59.140	7	.000
8	-.019	.025	59.687	8	.000
9	.022	.025	60.471	9	.000
10	.050	.025	64.404	10	.000
11	.016	.025	64.817	11	.000
12	.024	.025	65.693	12	.000
13	-.009	.025	65.833	13	.000
14	-.018	.025	66.338	14	.000
15	.023	.025	67.175	15	.000
16	-.014	.025	67.489	16	.000

a. The underlying process assumed is independence (white noise).

b. Based on the asymptotic chi-square approximation.

Figure 2: Graphical representation of Autocorrelation test



7. Summary of Findings

The summary of all the test are compiled and demonstrated in the following table-

Selected market	Descriptive statistics	Kolmogorov-Smirnov test	Runs test	Auto Correlation test
DSEX Broad index	DSEX daily closing price index is not normally distribution. Market is weak form inefficient.	DSEX daily price index does not fit by normal or uniform distribution. Market is weak form inefficient.	Null Hypothesis is rejected. Market is weak form inefficient.	There is auto-correlation. Market is weak form inefficient.

8. Conclusion

This paper examines the weak form of market efficiency in DSE Broad Index. The samples were considered from 31st January, 2013 to 31st July, 2019 that included daily closing price of DSEX. For conducting the study, daily market return was calculated from the daily closing price index of DSE Broad Index. the empirical analysis was conducted using Statistical Package for Social Science (SPSS). Four different statistical technique have been applied to examine the random walk hypothesis (RWH). Those are- Descriptive statistics, Kolmogorov-Smirnov Goodness of Fit test, Runs test and Auto correlation. After analyzing all the findings, results were summarized in tabular format. Overall findings from the empirical analysis suggest that the Dhaka Stock Market of Bangladesh Broad Index is not efficient in weak-form. The results of this study demonstrate that the hypothesis of randomness of the stock returns are rejected for stock price index changes by using Runs test and at all lags using Auto-correlation test which means Dhaka Stock Exchange Broad Index is not efficient even in the weak form. This study concludes that DSEX is weak form inefficient.

Market inefficiency is caused by weak regulatory framework, poor corporate governance, absence of accountability and transparency in transactions, low level of institutional infrastructure and capacity of major market players. The process of publicizing new information in Bangladesh is very weak. It may be caused by large number of non-actively traded shares and inadequate role of mutual funds. In order to improve the capital market, in time disclosure and dissemination of information to the shareholder and investors of listed companies should be emphasized. The dealers and brokers generate their earning by analyzing historical returns of the stock. They try to generate abnormal return by predicting future prices using historical information.

So, the implication of the rejection of Randomness for the investors of DSE is that the market is weak-form inefficient and therefore; investors can generate abnormal return by analyzing historical past prices, trends and patterns.

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