Weak-form market efficiency of an emerging Market: Evidence from Dhaka Stock Market of Bangladesh.[1]

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ABSTRACT

The vast majority of efficient market research to date has focused on the major United States and European securities market. Far fewer have investigated the developing and less developed countries markets; and no study on this area has been performed on the Dhaka Stock Exchange (DSE). The study seeks evidence supporting the existence of at least weak-form efficiency of the market. The sample includes the daily price indices of all the listed securities on the DSE for the period of 1988 to 1997. The hypothesis of the study is whether the Dhaka Stock Market is weak-form efficient. The results of both non-parametric (Kolmogrov –Smirnov normality test and run test) test and parametric test (Auto-correlation test, Auto-regression, ARIMA model) provide evidence that the share return series do not follow random walk model and the significant auto-correlation co-efficient at different lags reject the null hypothesis of weak-form efficiency. The results are consistent in different sub-sample observations, without outlier and for individual securities. The issues are important to security analysts, investors and security exchange regulatory bodies in their policy making decisions to improve the market condition. This study deserves a continuous research on this area to reach an ultimate conclusion about the level of efficiency of less developed market.

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WEAK-FORM MARKET EFFICIENCY OF AN EMERGING MARKET:EVIDENCE FROM THE DHAKA STOCK EXCHANGE OF BANGLADESH.

1.0.INTRODUCTION :

It is usually believe that the markets in developing and less developed countries are not efficient in semi-strong form or strong form. The study seeks evidence of weak form efficient market hypothesis (WFEMH) in a less developed emerging market like DSE. It is very much convenient to test the weak form efficiency of the market rather than semi-strong form and strong-form efficiency. The test of semi strong form and strong form efficiency is very rare in less developed countries because of absence of sufficient data in a convenient form, structural profile, inadequate regulations, lack of supervision and administrative loose in the implication of existing rules. In addition, companies information are released and circulated before the annual report is officially available; the annual reports of some of the listed companies are mistrusted and is often result of rumors circulation in the market about the companies. The market moved dramatically over a period of time to become a speculation market and then a gamble market. That means there is a trend of market movement and most of the investors in the market become speculators. Moreover, share price indices data are available and reliable to test the weak form efficiency of the market.

The empirical research on market efficiency can be divided into two broad categories; one is technical analysis, which is mainly concerned with testing for availability of exploitable information in past security prices, is widely used in examining the weak form efficient market hypothesis. The other is fundamental analysis, which rests on the assumption that factors other than past security prices are relevant in the determination of the future prices. The first category of WFEMH testing can be divided into two sub approaches: one is to determine the existence of predictability using past return series or price information. The another is to use technical trading rules if they can be exploited as profit making strategy. The aim of the study is to test the former on the DSE. The study restrict attention exclusively for WFEMH or return predictability using time-series analysis of stock return behavior in an emerging market.

The remainder of the study is structured as follow: Section I, discusses the concepts and interactions between weak form market efficiency and emerging market; section II, reviews the previous empirical evidences on weak-form efficiency, section III, discusses about the data and the research method, section IV describes the variables used in the analysis, section V, lays out the empirical results of the hypotheses. Finally section VI, presents summary and conclusions .

I.THE INTERACTION BETWEEN WEAK FORM MARKET EFFICIENCY AND EMERGING MARKETS:

A few studies conducted on the test of efficient market hypothesis (EMH) in emerging markets compared to the volume of studies published on the developed market. It is generally assume that the emerging markets are less efficient than the developed market. The definition of emerging market highlighted on the growth potentiality as well as rapid growth of size of the market. However, it is not unlikely that the market participants are not well informed and behaving irrational compare to well organize markets. The causes of lack of financial development specially in capital markets are due to certain market imperfection such as transaction costs, lack of timely information, cost of acquiring new information, and possibly greater uncertainty about the future (Taylor, 1956; Goldsmith, 1971; Mason, 1972; Wai and Patrick, 1973).

The different researchers define the emerging market in different ways. According to Samuel's (1981), who asserts the nature of the emerging market in terms of information availability such as follows:

> *"Prices can not be assumed to fully reflect all available information. It can not be assumed that investors will correctly interpret the information that is released. The corporation has greater potential to influence its own stock market price and there is a greater possibility that its price will move about in a manner not justified by the information available [2]."*

Emerging markets are also defined in terms of policy-making decisions such as follows:

> *"A realization of inefficiencies inherent in command and control policies and the tighter lending policies of international creditors have led the developing countries*

to re-define the role of domestic equity markets in their economies. Most countries have adopted policies that make the allocation of equity capital more responsive to market forces. These policy changes have resulted in remarkable growth in the size of the equity markets in the developing world, commonly known as ' Emerging Stock Markets' (ESMs).[3]

And with this open market policy, in the emerging markets speculations are common; large investors can easily speculate the market. As a less organized market without market makers and timely available information, there is always remain a possibility to make profit by large investors and insiders. The ability to predict stock price changes based on a given set of information lies behind the notion of stock market efficiency. The lower the market efficiency, the greater the predictability of stock price changes.

The WFEMH tests measures whether past series of share prices or returns can be used to successfully predict future share prices or returns. The major empirical investigation of the above test measures the statistical dependence between price changes. If no dependence is found (i.e., price changes are random), then this provides evidence in support of the WFEMH, which implies that no profitable investment trading strategy can be derived based on past prices. On the other hand, if dependence is found, for example, price increases generally followed by price increases in the next period and vice versa; clearly indicates that this can be the basis of profitable investment rule and violates the assumption of the WFEMH. However, whether any trading rule is profitable depends largely on the operating cost (such as brokerage cost, interest cost, trading settlement procedure) and on whether transactions can be made at the exact prices quoted in the market.

In general, the results of previous research evidence that the market of developed economies are generally weak form efficient. That means the successive returns are independent and follow random walk (see, for example, Fama1, 1965,1970). On the other hand, the research findings on the market of developing and less developed countries are controversial. Some of the researcher find evidence of weak form efficiency and can not reject the random-walk hypothesis in emerging markets (For instance; Branes, 1986; Dickinson and Muragu, 1994; Urrutia, 1995;

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[2] Samuels,1981;P.129
[3] Hussain,1996, abstract

Ojah and Karemera, 1999). Whereas the others find the evidence of non-randomness stock price behavior and reject the weak-form efficiency in the developing and emerging markets (such as; Roux and Gilberson, 1978; Harvey, 1994; Claessens, Dasgupta and Glen, 1995; Poshakwale. S, 1996 and Nourredine Khaba, 1998).

The study is the detail case study on the Dhaka Stock market of Bangladesh where no study has yet done. So the test of WFEMH in an emerging market like DSE, is of interest in it's own right to reach an ultimate conclusion about the level of efficiency in developing and less developed emerging markets in general.

II. REVIEW OF EMPIRICAL EVIDENCE ON WEAK-FORM EFFICIENCY:

The early studies on testing weak form efficiency started on the developed market, generally agree with the support of weak-form efficiency of the market considering a low degree of serial correlation and transaction cost (Working, 1934; Kendall, 1943, 1953; Cootner, 1962; Osborne, 1962; Fama, 1965). All of the studies support the proposition that price changes are random and past changes were not useful in forecasting future price changes particularly after transaction costs were taken into account. However,there are some studies which found the predictability of share price changes (for example, Fama and French, 1988; Poterba and Summers, 1988) in developed markets but they did not reached to a conclusion about profitable trading rules. Poterba and Summers (1988) suggest that noise trading, trading by investors whose demand for shares is determined by factors other than their expected returns provides a plausible explanation for the transitory component in stock prices. And they suggest constructing and testing theories of noise trading as well as theories of changing risk factors could account for the characteristics of stock returns auto-correlogram they found. Fama and French (1988) conclude that auto-correlation's may reflect market inefficiency or time-varying equilibrium expected returns generated by rational investor behaviour and neither view suggests, however, the patterns of auto-correlation should be stable for a long sample period. Hudson, Dempsey and Keasey (1994) found that the technical trading rules have predictive power but not sufficient to enable excess return in U.K market. Similarly, Nicolaas, (1997) also conclude that past returns have predictive power in Australian market but the degree of predictability of return is not so high. Overall, the empirical studies on developed market shows no profitability from using past records of price series supports the weak-form efficiency of the EMH in general.

On the other hand, the research findings of weak-form efficiency on the market of developing and less developed markets are controversial. Most of the less developed market suffer with the problem of thin trading. In addition, in smaller markets, it is easier for large traders to manipulate the market. Though it is generally believe that the emerging markets are less efficient, the empirical evidence does not always support the thought. There are two groups of findings; the first group find weak-form efficiency in developing and less developed markets are Branes, 1986, (on the Kuala Lumpur Stock Exchange); Chan, Gup and Pan, 1992, (in major Asian markets) ; Dickinson and Muragu, 1994 (on the Nairobi Stock Exchange) and Ojah and Karemera 1999, (on the four Latin American countries market) despite the problems of thin trading. On the other hand, the latter group, who evidence that the market of developing and less developed markets are not efficient in weak-sense are Cheung, Wong and Ho, (1993), on the stock market of Korea and Taiwan; in a world bank study by Claessens, Dasgupta and Glen (1995), report significant serial correlation in equity returns from 19 emerging markets and suggest that stock prices in emerging markets violates weak form EMH; similar findings are reported by Harvey (1994) for most emerging markets. Nourrrendine Kababa (1998) has examined the behaviour of stock price in the Saudi Financial market seeking evidence that for weak-form efficiency and find that the market is not weak-form efficient. He explained that the inefficiency might be due to delay in operations and high transaction cost, thinness of trading and illuiquidity in the market. Roux and Gilberson (1978) and Poshakwale S. (1996) find the evidence of non-randomness stock price behaviour and the market inefficiency (not weak-form efficient) on the Johannesburg stock Exchange and on the Indian market.

In short, review of previous studies state that the developed markets are generally weak-form efficient. But the dynamics of emerging market equities requires clarification. Comparison and a needed additional information on equity price dynamics is an important segment of the world's emerging capital markets. So it is an interesting empirical question whether and to what extent, this is also the case with less developed market stock exchanges. And the review of previous empirical evidences addressed some research questions: Is the Dhaka Stock market as a less developed emerging market, weak form efficient or not? How far it deviates from idealized EMH? What return generating process drives emerging equity market series? Conflicting result is a function of the research methodology employed? Is it possible to build up a predictive model? What are the implications of the findings?

These issues are empirically examined in the following section.

III. SAMPLE AND EMPIRICAL METHOD:

The empirical analysis of the study uses daily market return of the Dhaka Stock Exchange for the period of 1st January 1988 to 31st December 1997. The data of daily price indices are collected from the Data Stream for the period of 1992-1997. The data, which are not available on the data stream for the sample period (1988-1991), are collected from the daily price quotations, officially published by the Dhaka Stock Exchange. The study use the general methodology followed by the Claessens et all, 1995 and Poshokwale, 1996 in emerging market.[4] There are some additional models such as auto-regression, Auto-regressive-Integrated-Moving Average (ARIMA); employed to confirm the results and to build up a predictive model.

Thin or infrequent trading can introduce serious bias in empirical work. In order to avoid the possible bias we use a longer time-period, which reduces the problem of non-trading bias (Lo and MacKinlay ,1988, cited in Dickinson and Muragu,1994) and increase the power of random walk test (Taylor, 1986; cited in, op. cit.). We use both non-parametric test and parametric-tests to compare the results considering that non-normal distribution can bias the findings.

In choosing the methodology of weak form efficiency test, we have considered the following issues:

(i) The research need triangulation between developed and less developed market (supporting the view of Dickinsons and Muragu, 1994). Triangulation in research may be both theoretical or implemental through the use of different research methods, different settings, different data and improved decision making techniques and so on.

(ii) The study considers both traditional (such as descriptive statistics, run test, auto-correlation test) and dynamic time series model (such as Auto-regression model, ARIMA model) which perhaps claims better findings.

(iii) Regression analyses are also used by some researchers such as, cross-sectional regression model (Jagadeesh, 1990) and time-series regression model (Poterba and summers, 1988). The study employs the time series regression analysis such as Auto-

[4] Claessens et all.,1995 use two different additional test such as variance ratio test and cross-sectional regression test and Poshokwale, S. 1996 included the weak-end effect .

regression analysis considering the lag of returns and current returns in Auto-regression analysis, which helps to determine if the returns are predictable from the past returns and the extent of dependency.

(iv) Recent approaches to the study of the predictability of stock market returns in developed market include variance ratio test (Lo and Mackinlay, 1988). Research in emerging markets such as, Claessens, Dasgupta and Glen, (1995) and Urrutia, (1995) also used single variance ratio technique, as one of their statistical tools, which has been found to have an important flaw (e.g., Chow and Denning, 1993; Eckbo and Liu, 1993), an issue addresses extensively in the methodology section cited by Ojah and Karemera, (1999). The study does not use the technique.

(v) Moreover, the robustness of the results is assessed in various ways.

Firstly: similar tests are conducted for various sub-samples of the original sample and by trimming outlying observations.

Secondly: the study considers individual actively traded shares return to get results free of thin trading bias.

Thirdly: the study includes some alternative variables (such as daily market return and daily individual share return) to confirm the results.

And finally, the use of different testing procedures helps to reach a conclusion of consistency in the findings (e.g., Urrutia, 1995 finds different findings from run test and variance ratio test).

3.1. SAMPLE PERIOD:

The sample included total 2638 daily observations for the total sample period 1988 to 1997. To confirm the results of the empirical analysis, we also compute the first sub-sample (1988-1992, first 5 years), the second sub-sample (1993-1997, last 5 years) and with observations excluding the outliers.

3.2. SAMPLE SIZE:

The sample included total 2638 daily observations of daily price indices for 10 years. In addition, the study also considers the 30 randomly selected companies; which are actively traded.

3.3.MODELS:

The study uses both non-parametric tests [(Kolmogrov – Smirnov goodness of fit test), run test] and parametric-tests [Auto-correlation coefficient test, Auto-regression test and Auto-regressive Integrated Moving average model (ARIMA)]. Basically the analyses are univariate time –series analysis.

IV.VARIABLES:

The daily market returns are used as an individual time –series variable [5]. The non-availability of computerized databases has had a significantly limiting effect on market studies in developing countries, and consequently on the volume of published evidence (Dickinson and Muragu, 1994). One probable solution to this problem is to use the indices of the index, which are published and readily available at low cost (Sharma and Kennedy, 1977; Ghandi, Saunders and woodward, 1980). Market returns are calculated from the daily price indices without adjustment of dividend, bonus and right issues. The daily share price indices include all the listed companies stock. Many researchers confirm that their conclusions remain unchanged whether they adjusted their data for dividend or not (for example, Lakonishok and Smidt, 1988; Fishe, Gosnell and Lasser, 1993).

TABLE 1.1. DESCRIPTION OF VARIABLES:

NAME OF THE VARIABLES	PROXY	DESCRIPTIONS
Daily Market Returns	(Rmt)	Natural log of market returns

[5] "The EMH gives no indication of the horizon over which the returns should be calculated. The tests therefore be done for alternative holding period of a day , week , month or even years ."K.Cuthbertson,1996, p.117

		$(R_{mt}) = Ln(PI_t / PI_{t-1})$, Where, R_{mt} = market return, in period t; PI_t = price index at day t; PI_{t-1}= the price index at period t-1 and ln = natural log.
Daily individual share return	Ln (Shrit)	Natural log of individual share return = Ln [(Pt-1 +Dt) / Pt-1] Where, LnSHRjt- is the natural logarithm of returns on individual security (j), Pjt daily price per share at time t, Pjt-1-is the daily price per share at time t -1, Djt is the dividend per share of an individual security (j).

The study mainly considers the daily market returns as individual variable in time series analysis. To avoid the thin trading bias only in the run test, individual companies daily share returns are also considered.

DSE prepares daily price index from daily weighted-average price of daily transaction of each stock. Daily market returns (R_{mt}) are calculated from the daily price indices such as follows:

$$R_{mt} = Ln(PI_t / PI_{t-1}),$$

Where,

R_{mt} = market return, in period t;

PI_t = price index at day t;

PI_{t-1}= the price index at period t-1 and

ln = natural log.

The reasons to take logarithm returns are justified by both theoretically and empirically. Theoretically, logarithmic returns are analytically more tractable when linking together sub-period returns to form returns over longer intervals[6]. Empirically logarithmic returns are more likely to be normally distributed which is prior condition of standard statistical techniques (Strong, 1992).

For individual companies, the daily return
Ln [(Pt-1 +Dt) / Pt-1]

Where, LnSHRjt- is the natural logarithm of returns on individual security (j), Pjt daily price per share at time t, Pjt-1-is the daily price per share at time t -1, Djt is the dividend per share of an individual security (j).R_{it} = [(Pt – Pt-1+Dt) / Pt-1)]

The study considers daily returns of 30 individual companies as an additional variable to confirm the results avoiding thin trading bias.

V. HYPOTHESES AND EMPIRICAL RESULTS:

The hypotheses of the study and the empirical results of individual tests on weak form efficiency are described in two subsections.

5.1. HYPOTHESES: -

The study seeks evidence whether the Dhaka Stock market follows random walk model or the market is weak form efficient.
H01: The Dhaka stock market follows random –walk model.
H02: The Dhaka stock market is efficient in weak form.

5.2.EMPIRICAL RESULTS & DISCUSSIONS: -

The empirical results are classified in accordance with the different statistical techniques used. The findings of individual statistical techniques are discussed in each subsection below.

5. 2. A. DESCRIPTIVE STATISTICS: -

[6] Poshokwale, S.1996, described about this clearly.

One of the basic assumptions of random walk model is that the distribution of the return series should be normal. In order to test the distribution of the return series, the descriptive statistics of the log of the market returns are calculated and presented on the table 1.2.

TABLE: - 1.2

DESCRIPTIVE STATISTICS OF DAILY MARKET RETURN (LOG OF THE MARKET RETURNS):

N= 2638 observations.

Variable	**Mean**	**Median**	**Std. deviation**	**Minimum**	**Maximum**	**Skewness**	**Kurtosis**
LnRmt	1.5E-04 (.0004)	.00	1.988	-.35	.33	1.203 (.048)	114.816 (.095)

From the table 1.2, it can be seen that the frequency distribution of the return series is not normal. The skewness coefficient in excess of unity, generally taken to be fairly extreme (Chou, 1969, p.109). The evidence of positive skewness (1.203) is similar to the findings of Poshokwale, S., (1996) in Indian market but their positive skewness coefficient (0.98) is much lesser. In a Guassian distribution, one would expect these data to have a kurtosis coefficient of 2.902.[7] Kurtosis generally either much higher or lower indicates extreme leptokurtic or extreme platykurtic (Parkinson, 1987). Our evidence of the value of (114.816) falls under the extreme leptokutic distribution. Generally, values for skewness zero and kurtosis value 3 represents that the observed distribution is perfectly normally distributed. So skewness and leptokurtic frequency distribution of stock return series on the DSE indicates that the distribution is not normal. In other words, the non-normal frequency distributions of the stock return series deviate from the prior condition of random walk model.

To confirm the distribution pattern of the stock return series, Kolmogrov Smirnov Goodness of Fitness test is used, which provides further evidence whether the distribution confirms to a normal distribution or not.

[7] Kendall (1943) calculated the expected normal kurtosis equal to
3(n-1/n+1) = 2.902, where, n= sample size.

5.2. B. NON- PARAMETRIC TESTS: -

The study uses two different non-parametric tests; one (kolmogrov Smirnov Goodness of fit test) is to examine if the distribution is normal and the another (run test) is to prove if the daily return series follows random walk model.

(i) KOLMOGROV SMIRNOV GOODNESS OF FIT TEST : -

Kolmogrov Smirnov Goodness of fit test (K-S test) is a non-parametric test and is used to determine how well a random sample of data fits a particular distribution (uniform, normal and Poisson). The one sample K-S test compares the cumulative distribution function for a variable with a uniform or normal distribution and test whether the distribution are homogeneous. We use both normal and uniform parameters to test the distribution.

Results from the table 1.3, (K-S test) shows a 0.0000 probability for the Z, clearly indicates that the frequency distribution of the daily price indices of Dhaka Stock Exchange does not fit by normal distribution.

TABLE: -1. 3.

KOLMOGROV SMIRNOV GOODNESS OF FIT TEST:

DAILY MARKET RETURN: (2638 observations)

	Absolute	Positive	Negative	K-S Z	Z- Tailed P
Normal	.282	.275	-.282	14.468	0.00

On the whole, the empirical distributions of the share return series on the DSE resembles as found in other markets such as Australia and New Zealand (Nicolaas, 1997), India (Poshokwale. S, 1996), Japan, the U.S. and the Asian NICs (Ko and Lee, 1991) and Kuala Lumpur and Singapore (Laurence, 1986) stock markets.

(ii) RUN TEST: -

The run test is another approach to test and detect statistical dependencies (randomness) which may not be detected by the auto-correlation test. We prefer the well-known run test to prove the random-walk model because the test ignores the properties of distribution. The null hypothesis of the test is that the observed series is a random series. A run is defined by Siegel (1956), as

> *" a succession of identical symbols which are followed or preceded by different symbols or no symbol at all" p.52*

The number of runs is computed as a sequence of the price changes of the same sign (such as; ++, _ _, 0 0). When the expected number of run is significantly different from the observed number of runs, the test reject the null hypothesis that the daily returns are random. As defined by Poshokwale, (1996);

> *"a lower than expected number of runs indicates market's overreaction to information, subsequently reversed, while higher number of runs reflect a lagged response to information. Either situation would suggest an opportunity to make excess returns." P.89*

The run test converts the total number of runs into a Z statistic. For large samples the Z statistics gives the probability of difference between the actual and expected number of runs. The Z value is greater than or equal to ± 1.96, reject the null hypothesis at 5% level of significance (Sharma and Kennedy, 1977). As can be seen from the table 1.4, the Z statistics of daily market return is greater than ± 1.96 and negative, which means that the observed number of runs is fewer than the expected number of runs with observed significance level[8]. In addition to that, the observed numbers of run also indicates to reject or accept the random walk model.

> *" If in an application it is found that the number of runs is equal to or less than 9 or equal to or greater than 20, one can reject (At the 5% level of significance) the hypothesis that the observed sequence is random."[9]*

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[8] As the table value does not represent the expected number of runs, we calculate the values following the formula (Urrutia, 1995); 2(n+1) / 3; where, n= number of observations; and the results shows that there is a significant difference between the observed number of runs and expected number of runs.

[9] Damodar N. Gujarati, "Basic Econometrics", second edition,1988, Mcgraw –Hill Book company, P.691.

The number of run is greater than 20 in all the cases states that the series return are not following the assumption independent relationship of random walk model. Therefore, we can reject the null hypothesis that the return series on the DSE follows random walk. Moreover, the results of run test to individual company's daily share return shows that among the 30 individual companies, 28 companies Z value is negative and grater than ± 1.96, which is consistent with the previous findings that the return series are not following random walk model. The significant two-tailed with negative Z values greater than ±1.96 suggest non-randomness because of too few observed numbers of runs than expected.

The results are similar to the findings of Poshokwale (1996), who also finds that the actual number of runs significantly lower than expected number of runs for daily returns in India, Philippines, Malaysia, and Thailand. Overall, the results of run test analysis on the Dhaka Stock Exchange of Bangladesh indicates that the daily share return of Dhaka Stock Exchange are not random as the probabilities associated with expected number of runs are all greater than the observed number of runs.

TABLE: 1.4.THE RESULTS OF RUN TEST ON THE DSE FOR THE PERIOD OF 1988 TO 1997 :

Particulars of the variables	Total Number of Runs(M)	Z	Asymp sig (2-tailed)
Daily market return	882	-15.39*	.000
Individual company's daily return serial. No.			
1	749	-8.42*	0.00
2	597	-10.21*	0.00

3	475	-11.55*	0.00
4	429	-14.40*	0.00
5	1011	-5.698*	0.00
6	650	-4.344*	0.00
7	363	-16.71*	0.00
8	965	-4.934*	0.00
9	1117	-3.671*	0.00
10	433	-8.770*	0.00
11	277	-1.261	0.00
12	979	-4.065*	0.00
13	773	-6.356*	0.00
14	984	-3.090*	0.00
15	277	-11.37*	0.00
16	413	-12.91*	0.00
17	93	-5.895*	0.00
18	462	-3.910*	0.00
19	669	-2.780*	0.00
20	195	-0.70	0.00
21	770	-6.897*	0.00
22	197	-2.771*	0.00
23	301	-2.370*	0.00
24	887	-5.086*	0.00
25	719	-7.385*	0.00
26	851	-4.809*	0.00
27	839	-7.423*	0.00
28	480	-3.530*	0.00
29	309	-5.247*	0.00
30	915	-4.632*	0.00

NOTE: Statistics are computed according to SPSS program specifications.

5.2.C. PARAMETRIC TESTS: -

Moreover, the study investigates the parametric tests to examine if the findings of non-parametric test confirmed by the findings of parametric tests. The extent of dependency is also measured with the parameters estimated under different statistical techniques.

(i) AUTO-CORRELATION TEST : -

Auto-correlation test is a reliable measure for testing of either dependence or independence of random variables in a series. Kendall (1948, p. 412) compute the price changes at different lagged 1,2,3,4, time periods. Later the test is used very popularly (e.g., Laurence, 1986; Claessens, Dasgupta and Glen, 1995; Poshokwale, S. 1996; Nicolaas, 1997; Nourredine Khaba, 1998). The serial correlation coefficient measures the relationship between the values of a random variable at time t and its value in the previous period. Auto correlation test evidence whether the correlation coefficients are significantly different from zero. For a large sample the Ljung—Box statistic follows the chi-square distribution with m degrees of freedom:

$$LB = n(n+2) \sum^{m}_{K=1} (P^{\wedge 2}_{K} / n - k) \sim \chi 2$$

Where, $P^{\wedge}_{k}$ = Auto-correlation coefficients at lag k;
n = sample size.

The auto-correlation coefficients have been computed for the log of the market return series, shows significant auto-correlation at different lags for the whole sample period, sub sample period and without outlier. In table 1.4, the results of auto-correlation analysis are presented. It is evident that there are significant (positive sign) auto-correlation coefficient at 5^{th}, 8^{th}, 14^{th}, and 19^{th} lag and significant (negative sign) auto-correlation coefficient at 2^{nd}, and 17^{th} lag. The presence of non-zero auto-correlation coefficients in the log of the market returns series clearly suggests that there is a serial dependence between the values. To confirm the results, the auto-correlation co-efficient of the return series without outlier and for two different sub-sample periods are also calculated. The results from the table 1.4 confirm that there is significant auto-correlation of daily market returns for the whole sample period, sub-sample period and without outlier. The first order auto-correlation in first sub-sample is higher than the second sub-sample period. On the other hand, second order auto-correlation and auto-correlation at higher lags is significant in second sub-sample than the first sub-sample period.

The nonzero auto-correlation of the series associated with Ljung -Box Q statistics, which are jointly significant at 1% level at 22 degrees of freedom (lags), suggest that return series doesnot follow random walk model.

The results of auto-correlation tests are consistent with the findings of Harvey, (1994); Claessens, Dasgupta and Glen, (1995); and Poshokwale, (1996) in emerging market returns behavior. They find significant predictability of returns. Comparing with the developed markets, Harvey, (1994) states that,

> *" in the MCSI (Morgan Stanley Capital Information) sample, there are only five out of 21 developed markets with first-order auto-correlation that exceeds 10%. In the*

emerging countries, there are eight countries with Auto-correlation greater than 10%. Indeed, there are eight countries with auto-correlation above 20% (Colombia, Indonesia, Mexico, Pakistan, Philippines, Portugal, Turkey, and Venezuela). This suggests that the returns in these countries are predictable based on past information."[10]

Similarly, Claessens et al. (1995), finds that most industrial economies, first-order auto-correlation are not generally higher than 0.2; whereas in eight economies in emerging market (such as Chile, Colombia, Mexico, Pakistan, the Philippines, Portugal, Turkey, and Venezuela) have significant first order auto-correlation greater than .20. The highest first order auto-correlation is in Colombia (.489). Poshokwale (1996) finds significant auto-correlation at various lags of the return series in India, Philippines, Malaysia and Thailand suggests interdependence in returns. The results find in the study on the Dhaka Stock Exchange is consistent with the findings in emerging market.

[10] Harvey,1994.p.9

TABLE : -1. 5. RESULTS OF AUTO-CORRELATION(LOG OF THE DAILY MARKET RETURN) : -

lag	Auto-correlation (1988-1997)	Ljung-Box Statistics(22 df)	Auto-correlation (1988-1992)	Ljung-Box Statistics (22 df)	Auto-correlation (1993-1997)	Ljung-Box Statistics (22 df)	Auto-correlation (without outlier)	Ljung-Box Statistics (22 df)
1	.035	3.276	-.205*	56.035**	.072*	6.764**	.042*	4.577
2	-.124*	43.623**	.054*	60.001**	-.152*	36.843**	-.018	5.460
3	.034	46.747**	.085*	69.625**	.026	37.737**	.080*	22.366**
4	.005	46.802**	.032	70.990**	.000	37.737**	.045*	27.614**
5	.068*	59.168**	.012	71.171**	.077*	45.451**	.017	28.344**
6	-.001	59.171**	.020	71.689**	-.005	45.482**	-.010	28.619**
7	.010	59.430**	.009	71.792**	.010	45.603**	.016	29.262**
8	.115*	94.145**	.034	73.335**	.127*	66.642**	.082*	46.881**
9	.039	98.104**	.028	74.379**	.040	68.731**	.054*	54.645**
10	-.045	103.382**	.015	74.676**	-.054	72.618**	.060*	64.303**
11	.046	109.023**	.013	74.920**	.051	76.006**	.034	67.336**
12	-.061	119.040**	.006	74.966**	-.072*	82.910**	.007	67.462**
13	.015	119.626**	.010	75.109**	.015	83.209**	.016	68.162**
14	.115*	154.912**	-.001	75.110**	.133*	106.530**	.026	69.999**
15	.034	157.948**	-.069*	81.560**	.049	109.738**	.049*	76.238**
16	.013	158.366**	.029	82.701**	.010	109.857**	-.002	76.248**
17	-.110*	190.488**	.007	82.770**	-.129*	131.721**	-.037*	79.914**
18	-.005	190.547**	-.041	85.012**	.000	131.721**	.027	81.852**
19	.113*	224.262**	.029	86.130**	.125*	152.521**	.045*	87.197**
20	.037	227.928**	-.002	86.135**	.043	154.945**	.054*	94.886**
21	.002	227.938**	-.031	87.443**	.007	155.003**	.046*	100.523**
22	.013	228.375**	.019	87.915**	.011	155.178**	-.019	101.498**

*significant auto-correlation at two standard error limits;** LB statistics significant at 1% level of significance

(ii) **REGRESSION RESULTS:**

AUTO-REGRESSION TEST:

The study use exact maximum likelihood auto-regression techniques in time series analysis to examine if there is non-zero significant relationship exist between current return series with the first and second lag values of itself. The co-efficient significantly different from zero indicates the predictability of share return from the past information. The results presented on the table 1.5, shows a significant auto-regression coefficient AR_1 (.249) different from zero during the sample period 1988 to 1997. The auto-regression coefficient at first and second lags are significant at 1% level of significance prove that the series are not independent and the market is not weak form efficient. The result does not differ significantly when we exclude the outlier and divide the sample into two sub-samples. The results are consistent with the auto-correlation tests that the auto-regression coefficient is significant in only first lag at first sub-sample period but the co-efficient on both first and second lag are significant during second-sub-sample period, overall sample period and without outlier observations. The null hypothesis that the return series are independent is rejected in all cases.

TABLE 1.5: RESULTS OF AUTO-REGRESSION TEST (DAILY RETURN SERIES): -

Variables in the model(overall 10 YRS)	*coefficients*	*SEB*	*T-Ratio*	*Approx. Prob.*
AR1	.2488*	.0691	3.598	.0003
LnRmt-1	-.2036*	.0192	-10.614	.000
LnRmt-2	-.1775*	.0192	-9.250	.000
CONSTANT	.0204	.05113	.3979	.6907
Variables in the model(Ist sub-sample)				
AR1	-.1529	.2663	-.5744	.5658
LnRmt-1	-.0485**	.0274	-1.7661	.0776
LnRmt-2	.0365	.0274	1.3300	.1837
CONSTANT	-.02495	.02389	-1.0445	.29644
Variables in the model(2nd subsample)				
AR1	.25195*	.09224	2.7313	.0064
Lnrmt-1	-.1607*	.02716	-5.9153	.000
LnRmt-2	-.203*	.02716	-7.4572	.000
CONSTANT	.0746	.0959	.7777	.43691
Variables in the model(without outlier)				
AR1	.4299*	.0392	10.979	.000

LnRmt-1	-.3858*	.01916	-20.141	.000
Lnrmt-2	-.1896*	.01916	-9.8953	.000
CONSTANT	.0176	.05379	.3281	.74289

Note: * denotes significant at 1% level and ** denotes significant at 10% level.

(iii) ARIMA (AUTO-REGRESSIVE-INTEGRATED-MOVING AVERAGE) MODEL:

In addition to the above statistical techniques, the study employs ARIMA, the dynamic time series model to examine if the stock return series depends not only on it's past values of the return series but also past and current disturbance terms. Theoretically the weak-form efficiency of the market persist when we can not predict the share prices from its historical price information. When the share return can be predicted on the basis of data on past returns and on forecasted errors together this gives rise to ARMA [11] model (Cuthbertson , 1996). That is to mean if stock price is a function of it's past values of stock prices itself or the current and past values of the disturbance term. We use ARIMA model instead of ARMA because it included the integration process. Moreover, the random walk model needs to fit the model ARIMA (0,1,0), where the future value of share prices can not be determined on the basis of past information. Specifically, future share prices will not depend on past (lag) values of share prices or on the disturbance terms. The significant coefficients different from zero suggest dependency of the series, which violates the assumption of random walk model and weak-form efficiency.

TABLE: -1.6
RESULTS OF ARIMA (0,1,0) FOR THE DAILY PRICE INDEX SERIES; ARIMA (2,0,1) AND ARIMA (1,0,0) MODELS FOR THE DAILY RETURN SERIES: 1-2638 OBSERVATIONS.

ARIMA (0,1,0)	Coefficient	SE	T-ratio	Prob.
CONSTANT	.096	.75467	.122756	.9023
ARIMA (2,0,1)				
AR1	-.5278*	.09367	-5.635	0.000
AR2	-.0948*	.0293	-4.135	0.000
MA1	-.5784*	.09315	-6.209	0.000
CONSTANT	.0147	.0373	.3952	.6927

[11] " If the weak-form efficiency does not hold then actual return (Rt+1) might not only depend upon past returns but could also depend on past forecast errors." K.Cuthbertson, 1996, p.126.

ARIMA (1,0,0)				
AR1	.035**	.0195	1.809	.0706
CONSTANT	.00015	.0004	.3684	.7126

Note: *denotes significant at 1% level and ** denotes significant at 10% level.

Results of the ARIMA analysis presented on the table 1.6 suggest that the price index series and return series are not following random walk model. As we know that, ARIMA (0,1,0) supports the random walk model. We at first, calculate ARIMA (0,1,0) of the daily price indices where the coefficient is .0926 (.755) with a t-ratio (.123) and probability of .9023, and in diagnostic checking, the significant residual auto-correlation at 2,4,5,8,10,12 and 14 lag; reject the assumption of random-walk model. During the whole sample period ARIMA (2,0,1) is found as the best fitted model with AR_1 coefficient (-. 528); AR_2 (-. 095); and MA_1 (-. 578) significant at 1% level of significance. The diagnostic checking shows that there is no significant residual auto-correlation in the return series. Moreover, ARIMA (1,0,0) for the whole period is calculated to examine if the auto-regression coefficient is equal to one. But the results presented on the table shows that coefficient is only .035, means that the change in the return series are not due to the current disturbance terms (random-walk model). All the evidence is against the weak-form efficiency of the market and proves that the past price series can be used to predict the future.

Then we try to build up a predictive model if the model fitted a part of the observations can forecast the future values of the series in the rest of the observations.

<u>TO BUILD UP A PREDICTIVE MODEL: -</u>

To build up a predictive model, the total observation period is divided into two periods; 1-1335 is considered as historical period and 1336-2638 as the validation period. At first we calculate the best fitted model during the historical period and then fitted the predictive model to the validation period. The ARIMA (2,0,1), that is also the best-fitted model (table 1.7) for the historical period. The diagnostic checking shows that there is no significant residual auto-correlation in the return series. The (ARIMA, 2,0,1) model, which is the best model during the historical period used to predict the rest of the observations (1336-2638).

TABLE: -1.7
RESULTS OF ARIMA (2,0,1) FOR THE DAILY RETURN SERIES:

HISTORICAL PERIOD (1-1335 OBSERVATIONS).

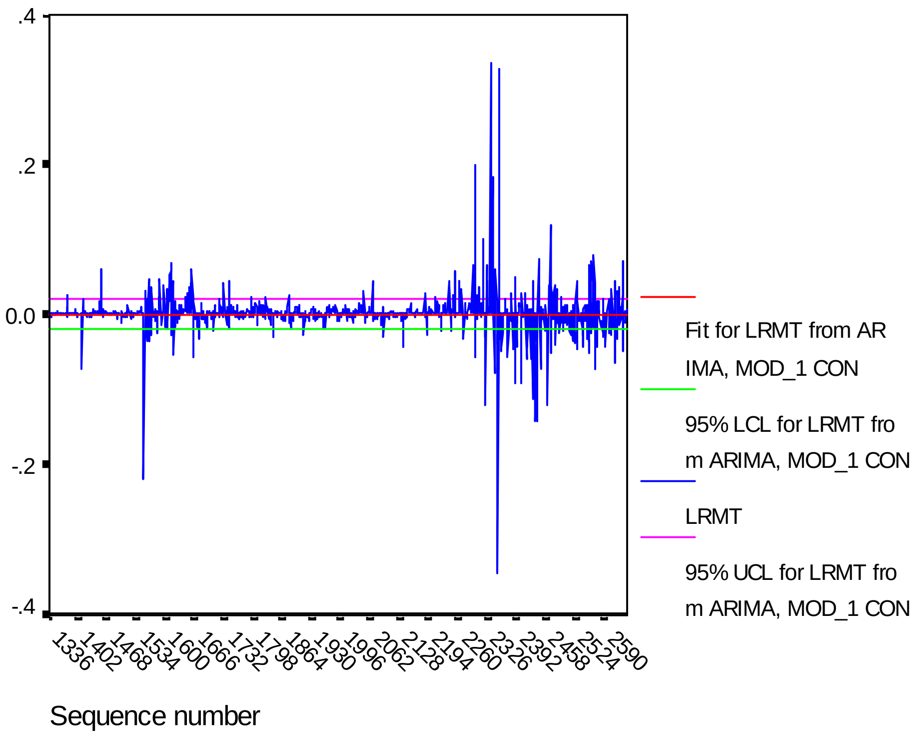
Variables	Coefficient	SE	T-ratio	Prob.
AR1	.604*	.09221	6.555	.000
AR2	.227*	.0273	8.293	.000
MA1	.805*	.092	8.753	.000
CONSTANT	-.0002	.0003	-.787	.432

We predict the model during the validation period to examine how far the fitted value deviate from the actual value. From the figure 1.1 it can be seen that the fitted value and actual value is nearly well fitted. The deviations are only seen in the peak volatile period.

FIGURE 1.1.

BUILDING UP PREDICTIVE MODEL (ARIMA, 2,0,1) FOR THE HISTORICAL PERIOD

(1-1335) AND FORECASTING THE VALIDATION PERIOD (1336-2638).



5.2.D. OVER

The assumption that stock returns series are random is basic to the Efficient Market Hypothesis and Capital Asset Pricing Models. The results of the analysis differ from the findings of idealized efficient market. The frequency distribution of the stock price series in DSE does not follow a normal or uniform distribution, which is confirmed by the non-parametric K-S test. The results of run test and auto-correlation coefficient tests indicate the non-random nature of the series and violate the assumption of null hypothesis that the market is efficient in weak form. Further test on the predictability of past values in the series using dynamic time series statistical techniques such as exact maximum Likelihood Auto regression model and ARIMA model confirms the previous findings and the results are consistent all over the sampling period, sub-sample period and without outliers.

Our results are similar with the findings of Nourredine Khaba (1998), Roux and Gilberson (1978) and Poshakwale S. (1996) who find the evidence of non-randomness stock price behaviour and the market inefficiency (not weak-form efficient) on the Saudi Arabian Financial market, Johannesburg stock Exchange and the Indian market respectively. While at the same time contradicts findings with Ojah and Karemera (1999), Branes (1986), and Dickinson and Muragu (1994), who document the evidence of weak form efficiency and can not reject the random walk hypothesis on the four Latin American countries market, Kuala Lumpur stock Exchange and the Nairobi Stock Exchange respectively.

VI. SUMMARY AND CONCLUSIONS:

The overall results from the empirical analysis suggest that the Dhaka Stock market of Bangladesh is not weak form efficient. However, the results presented in the study are not above limitations such the aspects of profit making strategy was not investigated in detail using any technical trading rules or adjusting transaction cost (such as bid-ask spread, brokerage fee, time lag of settlement procedures) and as a result we can reach no conclusion in this regard. At the same time, because of unavailability of value weighted index considering non-synchronous trading may bias the results. The problems of non-trading are however try to overcome by considering the individual company's daily share return series and run test. And the results of individual share returns also evidence that they are not following random walk model. The results found in the study should be interpreted cautiously because the presence of auto-correlation violates the assumption of random walk model not necessarily mean inefficiency. As noted by Ko and Lee, *"If the random walk hypothesis holds, the weak-form of the efficient market hypothesis must hold, but not vice versa. Thus, evidence supporting the random walk model is the evidence of market efficiency. But violation of the random walk model need not be evidence of market inefficiency in the weak form (1991, p.224)."*

The possible auto-correlation find in the return series not necessarily means that the returns are predictable (Cuthberston, 1996). It might be due to the presence of noise traders in the market (Uruttia, 1995) trading by investors whose demand for stocks is determined by factors other than their expected returns may provide an explanation for this. However, a lower degree of efficiency on less developed countries markets might be due to common characteristics of loose disclosure requirements, thinness and discontinuity in trading (Errunza and Losq, 1985). It might be due to the institutional factors such as illiquidity, market fragmentation, trading and reporting delays and absence of official market makers (Butler and Malaikah, 1992) or due to the delay in operations and high transaction cost, thinness of trading and illiquidity in the market (Nourrendine Khaba,1998).

Nevertheless, measures of return behavior may be useful in research on the determinants and behaviors of flows into the stock market (e.g., Claessens, Dasgupta and Glen, 1995). The major implication of the study can be pointed out as follows.

Firstly, the predictive ability is interesting for investors to beat the market using trading rules.

Secondly, if the auto-correlation present in the analyses not necessarily means the rejection of weak-form efficiency is still helpful to implement the regulatory change to prevent the bias mentioned above and to improve the overall market conditions and encourage savings and investments. The need to change the appropriate index calculation method considering the infrequent trading should be a suggestion to the responsible authorities.

Thirdly, the study provides the time series behaviour of a less developed market. It is also a matter that,

"despite the well-documented potential benefits of investing in the ESMs, a lack of adequate information appears to be a major factor hindering the foreign investment in these markets (Hussain, 1996)."

And finally, it is interesting to academic researchers and explores avenues for future research. Predicting model for forecasting the future based on the past and whether the deviation are large enough to exploit profitably considering transaction cost remains open question or should be an issue for further research. The study does not include the calendar anomalies and if any trading rules can make profitable investment strategy for the test of WFEMH may be a suggestion for future research.

The rejection of null hypothesis that the market is not weak form efficient can be interpreted as that price forming information in the particular market may not be disseminated rapidly because of sophisticated communication technology, a few number of business journals and lack of intensive market regulations. On the whole, this is a first attempt to judge the efficiency of the Dhaka Stock market, which shows the stock price behavior in one of a less developed market. The necessity to stock market for the development of a country might be quarry as according to Samuels and Yacout (1981) can be stated in this respect:

> " *. . . there are a priori reasons to believe that stock markets in developing countries are neither efficient nor perfect. If a stock market is not efficient, this does not necessarily mean that per se it is a bad thing. The crucial question is whether an inefficient stock market is better than no market at all.*"

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The study seeks evidence of weak form efficient market hypothesis (WFEMH) in a less developed emerging market like DSE. It is very much convenient to test the weak form efficiency of the market rather than semi-strong form and strong-form efficiency.Â The study is the detail case study on the Dhaka Stock market of Bangladesh where no study has yet done. So the test of WFEMH in an emerging market like DSE, is of interest in itâ€™s own right to reach an ultimate conclusion about the level of efficiency in developing and less developed emerging markets in general. II. Review of empirical evidence on weak-form efficiency Azizul Baten, 2012. Estimating Stock Market Technical Efficiency for Truncated Normal Distribution: Evidence from Dhaka Stock Exchange. Trends in Applied Sciences Research, 7: 532-540. DOI: 10.3923/tasr.2012.532.540.Â Year-wise mean efficiency of companies in Dhaka stock exchange. Table 3: Group-wise mean efficiency of companies with time-variant and time-invariant in Dhaka stock exchange.Â Analysis of weak-form efficiency on the nigerian stock market: Further evidence from GARCH model. Int. J. Applied Econ. This study aims to examine the weak form efficiency of Dhaka Stock Exchange (DSE) using random walk model of EMH based on daily return series. The study applies both non-parametric [Kolmogorov-Smirnov test with Lilliefors coefficient, run test] and parametric test [autocorrelation test, unit root test and variance ratio test] on DSE general index, DSE broad index and DSE30 index ranging from June 1, 2004, to March 18, 2018. The results of the tests reject the null hypothesis of randomness.Â "Random Walks and Market Efficiency Tests: Evidence from Emerging Equity Markets," Review of Quantitative Finance and Accounting, Springer, vol. 13(2), pages 171-188, September. Ojah, Kalu & Karemera, David, 1999. This paper examines the weak-form efficiency in Dhaka Stock Exchange (DSE) of Bangladesh adjusting for thin trading problem. Both non-parametric tests and parametric tests are used. The data sets consist of daily DSE General Index (DSE-GEN) and DSE 20 Index for the period ranging from January 1, 2002 to December 31, 2007.Â The results help to explain what impact taxes have on the ex-day stock prices behavior in an emerging market. To examine the tax effect on the ex-day stock prices behaviour, this study considers after-tax dividends and computes the raw price ratio, market-adjusted price ratio, raw price drop, market-adjusted price drop.