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Efficiency in Bangladesh Stock Market Behavior: Empirical Evidence

Dr. M. Farid Ahmed*
Mohammad Bayezid Ali**

Anyone familiar with the literature on Efficient Market Hypothesis (EMH) must agree that it is a controversial subject. It is also true that over the last few decades the body of literature is also growing significantly but still controversy exists. The researches on stock price behavior demonstrate conflicting result suggesting EMH is on the one hand acceptable by some studies and on the other not acceptable by others. This is possibly because of its critical role in market efficiency in terms of its implications on capital formation, wealth distribution and investor rationality. Besides, Keynes (1936) noted that "Even apart from the instability due to speculation, there is the instability due to the human nature that a large proportion of our positive activities depend on spontaneous optimism rather than mathematical expectations, whether moral or hedonistic or economic." In many earlier studies capital markets are shown as efficient at least in its weak form. Fama (1970) has indicated that the vast majority of the studies were unable to reject the Efficient Market Hypothesis (EHM) for common stocks. Many financial economists would agree with Jensen (1978) that 'there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis.' In an informationally efficient market, which is different from allocationally or Pareto-efficient market, price changes must be unforecastable if they fully incorporate the expectations and information of all market participants. The more efficient the market, the more random the sequence of price changes generated by such a market, and the most efficient of all is one in which the price changes are completely random and unpredictable (Lo, 1997). Grossman and Stiglitz (1980) argue that 'perfectly informationally efficient markets are an impossibility, for if markets are efficient, the return to gathering information is nil, in which case there would be little reason to trade and markets would eventually collapse. Alternatively, the degree of market inefficiency determines the effort investors are willing to expand to gather and trade on information, hence a non-degenerate market equilibrium will arise only when there are sufficient profit opportunities, i.e., inefficiencies, to compensate investors for the cost of trading and information gathering.'

*Professor, Department of Finance, University of Dhaka
** Assistant Professor, Dept. of Finance, Jagannath University

Although most of these studies are based on the developed markets, studies on emerging or frontier markets is a recent phenomenon. Now-a-days investment in these markets have got phenomenal rise in order to take the advantages of diversification. In order to face this situation, emergence of more research on these markets is very much visible. Recent studies provide evidence, particularly in emerging markets, that the traditional tests of random walks are susceptible to errors because of spurious autocorrelation induced by non-synchronous trading (Pope, 1989). It is also shown in Leroy (1973) and Lucas (1978) that rational expectations equilibrium prices need not even form a martingale sequence, wherein the random walk is a special case. A common explanation for departure from EMH is that investors don't always react in proper proportion to new information or misinformation. In an inefficient market misallocations of scarce resources may occur due to lack of accurate signals through price formation. If rejection of random walk is observed its implications are very significant and implies that price generating process needs to be visualized by a more explicit economic model.

Efficiency of Bangladesh market like other frontier markets has not been exposed to much research. Here is an attempt to investigate the behavior of stock price traded on the Dhaka Stock Exchange (DSE), the largest exchange in Bangladesh applying Ljung-Box (L-B) tests and multiple variance ratio tests within the general framework of the random walk hypothesis and to see the comparative position of these econometric models.

Equity Market Structure in Bangladesh

Bangladesh stock market of is gradually growing in terms of depth and breadth, turnover, and market capitalization that resulted in optimism among the stakeholders. Secondary stock markets in Bangladesh are represented by two stock exchanges, viz., Dhaka Stock Exchange (DSE) and Chittagong Stock Exchange (CSE). Both DSE and CSE are corporate bodies under Companies Act 1994. Although DSE was first established in 1954 its activities were suspended for a brief period from 1971 to 1976 due to introduction of socialistic approach of development during this period. DSE resumed its activities in the middle of 1976 with the change of government policy. DSE started functioning with 9 listed companies in1976, which has reached to 240 listed companies, 41 mutual funds, 8 debentures, 221 treasury bonds, and 3 corporate bonds totaling 513 listed securities in October 2012 (DSE Monthly Review, October 2012). CSE started its activities only in 1995. It is observed that CSE follows the tone and temperament of DSE. We have selected DSE for our investigation considering its size and dominance in the securities markets of Bangladesh.

Trading is conducted by the Broker-members of the stock exchanges in Bangladesh conduct exchange trading through call market. In order to execute an order to buy or sell securities on behalf of his client, a broker is supposed to provide services at the time of executing a sell order as well as provide services and funds for a buy order for commission. Thus, the stock markets in Bangladesh predominantly operate through the brokers. There is lack of effective market making roles like specialists.

Lock-in system and circuit breaker exist in the trading system. Lock-in system implies restrictions on trading in secondary market for certain period of time. Besides, all securities traded on the stock exchange are subject to daily price limitations in an attempt to discourage speculative investors known as circuit breaker. The exchanges set maximum upper and lower limits on daily price movements and transactions by shareholders. Sometimes, Bangladesh Securities and Exchange Commission (BSEC) also interferes in this process through regulating DSE activities. This practice can cause truncated returns and thus delay the effect of new information on stock prices that is likely to result in nonrandom behavior.

Margin trading is limited to securities listed on the stock exchange and strictly guided. Margin requirements are subject to change from time to time as a tool for regulating the demand for stocks. The government also uses tax policy to regulate trading activities in the market. Within the provision of tax law, dividend and interest paid to investors are subject to withholding tax. Capital gains are exempted from tax for individuals if it is reinvested within certain period.

Table-1: Market capitalization and turnover

(In million Taka, $1=Taka 81.58)

Year	Market capitalization (year end)	Turnover	Turnover: market capitalization (%)
1984-85	2,256		
1985-86	3,493	34.3	0.98
1986-87	5,731	152.4	2.66
1987-88	12,671	120.8	0.95
1988-89	13,557	154.3	1.14
1989-90	12,018	187.7	1.56
1990-91	10,775	100.4	0.93
1991-92	12,879	261	2.03
1992-93	15,391	403.6	2.62
1993-94	31,992	2,442.90	7.64
1994-95	47,890	4,660.80	9.73
1995-96	65,026	8,199.10	12.61
1996-97	105,018	35,413.50	33.72
1997-98	60,527	12,616.90	20.85
1998-99	49,065	51,893.80	105.75
1999-00	54,004	27,696.00	51.29
2000-01	72,168	49,094.00	68.03
2001-02	63,135	34755.858	55.05
2002-03	69,201	30317.471	43.81
2003-04	136,641	24372.124	17.84
2004-05	222,046	75296.325	33.91
2005-06	215,422	45788.647	21.26
2006-07	475,855	163328.987	34.32
2007-08	931,025	539976.385	58.00
2008-09	1,241,339	884367.263	71.24
2009-10	2,700,745	2546332.133	94.28
2010-11	2,816,757	3252295.506	115.46

Source: Compiled from DSE monthly Review- various issues.

Now-a-days, use of computer in trading system and a central depository system (CDS) have been introduced in order to bring efficiency in the market. In view of the frequent allegations about the market manipulation resulting market upsurges followed by sharp downswings, credibility of the system as a whole has been brought into question. It was expected that use of computer in the trading system and introduction of a CDS would bring improvement of the situation but found little tangible result. However, since physical delivery of share certificates is not permitted under CDS, kerb market has been eliminated and thereby the dominance of this market does not exist now. Demutualization of ownership and management of DSE which is believed to be a deterrent to market manipulation is being under active consideration for its introduction. Order flows are generated, although at least partially, by subtle interactions of human activities on the floor, including behavior of the rivals, floor atmosphere, floor gossips and so on. All these can hardly be held by computer implying 'overshooting' or 'undershooting' in prices if traders are just reacting to price moves on the screen without well understanding the reasons behind such moves. The system, therefore, needs to combine the advantages of the technology - efficiency, accuracy and speed - with those of human interaction, visibility and information exchangeability on the trading floor in association with improved legal framework and their execution so that better market coordination with less price volatility can be ensured.

The widespread view is that most of the equities are tightly held by the families, relatives and friends. The shares of Multinational Companies (MNCs) are owned by foreign parents and government who usually tend to decline to sell their shares in the local markets. Different informal estimates suggest that between 50-70 percent of equity is tightly held by families, relatives and friends. Institutions appear to be less dominant in stock exchange trading, although no reliable figures are available (Ahmed, 2000). Anyway, all these estimates should be treated with caution.

Market activities can be visualized from the Table-1. Market capitalization also includes corporate bonds and mutual funds which are limited in number and preference shares are issued by one or two companies. It appears that the ratio between market capitalization and turnover has been below 3 till 1992-93 since then rapid growth of turnover ratio is observed which reached more than 100% in 2010-11. The Table gives the impression that the Bangladesh markets maintain a low ratio of market capitalization and turnover in general compared with other emerging markets. Besides, total equity market capitalization of DSE was \$28.8 billion while it was \$1,092.6 billion for Bombay Stock Exchange, India, \$14.3 billion for Colombo Stock Exchange, \$317.8 billion for Thailand Stock Exchange, \$2,408.1 billion for Hong Kong Exchanges and \$445.9 billion for Bursa, Malaysia during July 2012 (DSE Monthly Review, August 2012). These low figures suggest a small share of equity markets and a low level of market activity in DSE.

Figure-1 presents monthly DSE General Index from November 2001 to May 2010. Overall movement of the monthly DSE General Index curve shows that it has an increasing trend for the period under study. But if we analyze the trend for different sub-periods, it appears to be different. For instance, the period from November 2001 to end of 2003, monthly general index shows no significant upward trend but it tends to rise between April 2004 and March 2005. Then it began to decline and this fall continues up to April 2007. Thereafter, a steady rise continues from May 2007 to June 2008. Then a downward movement is found between July 2008 and August 2009. Finally a very sharp rise in the form of bubble takes place from September 2009 to the end of 2010 and this bubble bursts at the end of December 2010 and January 2011. Accordingly this abnormality has been excluded from our study.

Figure 1: Stock price Trend

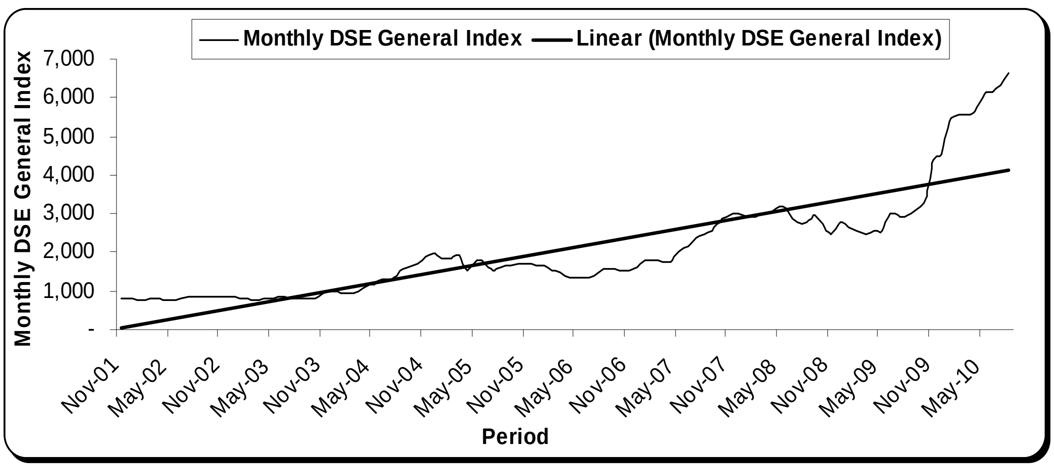

Table-2 shows description of data used in this study which are daily, weekly and monthly beginning from November 2001 to August 2010. The start of the period was determined by the availability of relevant information of the DSE General Index (DGEN) and ended in August 2010 considered appropriate because of the abnormality found since then. This data set consists of the share prices of all listed companies and has market value weights. Descriptive statistics. of the market indicates mean trading value and standard deviations for daily, weekly and monthly data divided into two sub-periods, viz., the first one covers from November 2001 to December 2005 and the second one covers from January 2006 to August 2010. This presents the variations at different points of time. It is clear that for the second period average trading values and standard deviations are abruptly high which is difficult to explain in terms of economic rationality. For first and second sub periods the numbers of observations for daily data are 1142 and 1112, for weekly data 105 and 217 and monthly data 50 and 56 respectively.

Table-2: Market Characteristics in terms of Trade Value for Different Time Periods

Descriptive Statistics	Daily Trading Value (Tk. In Crore)		Weekly Trading Value (Tk. In Crore)		Monthly Trading Value (Tk. In Crore)	
	1st Sub Period (Nov 2001- Dec 2005)	2nd Sub-Period (Jan 2006 – Aug 2010)	1st Sub Period (Nov 2001- Dec 2005)	2nd Sub-Period (Jan 2006 – Aug 2010)	1st Sub Period (Nov 2001- Dec 2005)	2nd Sub-Period (Jan 2006 – Aug 2010)
Mean	**15.46584**	**441.0371**	**88.30997**	**2189.434**	**353.2399**	**8757.737**
Median	12.59581	249.1258	79.08012	1115.034	316.3205	4460.136
Maximum	62.65008	2486.044	279.2221	9885.207	1116.888	39540.83
Minimum	1.691234	7.706751	18.17557	66.61354	72.70227	266.4542
Std. Dev.	**10.93203**	**511.5916**	**55.41601**	**2585.404**	**221.6641**	**10341.62**
Skewness	1.303287	1.713719	1.231662	1.672873	1.231662	1.672873
Kurtosis	4.872638	5.394390	4.793988	5.033952	4.793988	5.033952
Observations	1142	1112	105	217	50	56

Literature Review

Among many works on stock market efficiency some seminal studies like Fama and French (1988), Lo and MacKinlay (1988), Fuller and King (1990), Hearney (1990), and Jagadeesh (1990) are mention worthy in this context. In general, the results are not unambiguous. The EMH has received some attention in studies of emerging stock markets (Sharma and Kennedy, 1977; Gandhi, Saunders and Woodward, 1980; Cooper, 1982; Parkinson, 1987and so on). The conclusions of these studies have been mixed. Evidence on emerging markets, however, remains small.

Ayadi O.F. and Pyun C. S.(1994) have applied Lo and Mackinlay (1988) variance ratio test methodology to investigate the random walk characteristics in Korean Securities Market between 1984 and 1988. Daily, weekly and monthly data series have been used under homoskedastic and heteroskedastic increments test assumptions to estimate variance ratio test statistics. They have concluded that random walk hypothesis is rejected when daily data are used. But when longer horizons such as weekly, monthly and 60-day data are used, the random walk hypothesis is not rejected in general.

Chang and Ting (2000) have examined the variance ratio (VR) test in Taiwan's Stock Market from 1971 to 1996. They have found that weekly value-weighted market index doesn't follow random walk characteristics. They also found that random walk hypothesis (RWH) can't be rejected with monthly, quarterly and yearly value-weighted market index.

Darrat and Zhong (2000) have tested RWH in stock indexes of two Chinese Stock Exchanges: Shanghai and Shenzhen. They have used class A share index from both stock exchanges and collect daily data from Dec 20, 1990 to Oct 19, 1998 for Shanghai Exchange and April 4, 1991 to Oct. 19, 1998 for Shenzhen Exchange. They have found that weekly VR test estimate is statistically significant for lag 2, 4, 8 but not for lag 16 and 32 for Shanghai Stock Market. On the other hand, for Shenzhen Stock Market weekly VR test estimates are statistically significant for lag 2, 4, 8, 16 but not for lag 32.

Smith G. et al. (2002) have used Chow-Denning multiple variance ratio test to examine the RWH of 8 different African stock market index. They found that except South Africa, other countries, i.e., Egypt, Kenya, Morocco, Nigeria, Zimbabwe, Botswana and Mauritius stock market don't follow random walk.

Smith S and Ryoo H. J. (2003) have tested the hypothesis of random walk in the stock market price indices for five European Emerging Markets, using multiple variance ratio test. Weekly data has been employed from the 3rd week of April 1991 through the last week of August 1998 in four of the markets: Greece, Hungary, Poland, and Portugal, the null hypothesis of random walk is rejected because returns have auto correlated errors. In Turkey, however, the Istambul Stock Market follows random walk. They have explained it in terms of the large size and the most liquidity condition prevailing in the market.

Weak form market efficiency of the stock market returns of Pakistan, India, Sri Lanka, China, Korea, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand, Taiwan, Japan and Australia has been studied by Hamid, K. et.al. (2010). Monthly data have been used for the period of January 2004 to December 2009. Autocorrelation, L-B statistics, Run test, Unit Root test, and Variance Ratio test have been employed to test the hypothesis that stock prices follow random walk. They have concluded that monthly prices do not follow random walks in all the countries of the Asia- Pacific region.

Al-Jafari and Kadim (2012) have applied variance ratio test to examine the RWH in Bahrain Bourse. They have used daily data from February 2003 to November 2010 and under homoskedastic and heteroskedastic test assumption for lag 2, 4, 8, 10, 16, and 32. They have found that daily stock index doesn't conform to RWH.

Al-Ahmed (2012) examines the weak form efficiency of the Damascus Securities Exchange. Daily returns of the DWX Index from 31st December 2009 to 30th November

2011 have been used and unit root test and variance ratio test have been employed to test the hypothesis that stock prices follow random walk. All the test estimates reveal that stock prices on Damascus Securities Exchange do not follow random walk.

Statistical Methods and Data Source

This study is an attempt to test the random walk hypothesis for Dhaka Stock Exchange (DSE) in Bangladesh using three approaches of tests viz., run test, L-B statistic tests and multiple variance ratio tests. Thus, this will investigate the extent to which the series of successive index returns occur independently of one another. Data used in this study are the first difference of the logarithms of the weekly DSE General Index (DGEN). In this study natural logarithms rather than the absolute levels of the index are used as suggested by Fama (1965), Cochran and DeFina (1995) and Lo and MacKinlay (1988). It follows that the return series calculated is Rt = lnPt – lnPt-1 where lnPt and lnPt-1 are the natural logarithms on the indices levels at the end of periods 't' and 't-1' respectively. Weekly observation was chosen for several reasons. Sampling theory is based wholly on asymptotic approximations, a large number of observations is appropriate. While daily sampling yields many observations, the biases associated with non trading, the bid-ask spread, asynchronous prices etc. are troublesome. Weekly sampling is the ideal compromise, yielding a large number of observations while minimizing the biases inherent in daily data (Lo and MacKinlay, 1988). DSE trading hour starts at 10:30 a.m. and continues up to 2:30 p.m. for five days in a week from Sunday to Thursday. Thursday closing prices for the period from November 27, 2001 (which is the starting date of the available DSE general index data) through December 31, 2010 has been collected from *Research and Publication Divisions* of Dhaka Stock Exchange. This data has been trimmed for the period from September 2010 to December 2010 due to abnormal stock price behavior during this period. That yields 402 weekly return observations used for this study.

The Run Test

The run test is used in order to test the weak-form efficiency since it does not require returns to be normally distributed. This gives a better alternative to parametric serial correlation tests where distributions are assumed to be normally distributed. A run is defined as a price change sequence of the same sign. It compares the actual number of runs to the expected number assuming price change independence. Too many runs and too few runs give an indication of non randomness in the returns where too many runs indicate negative autocorrelation and too few runs indicate positive autocorrelation. To perform this test, let n_a and n_b represent observations above and below the sample mean or median respectively and r represents the observed number of runs, with $n = n_a + n_b$.

$$Z(r) = \frac{\text{r -E(r)}}{\sigma(r)} \qquad \text{………….. (i)}$$

The expected number of runs can therefore be calculated by the following formula:

$$E(r) = \frac{\text{n}-\text{2na nb}}{\text{n}} \qquad \text{………….. (ii)}$$

The standard error is represented by:

$$\sigma\text{E(r)} = [\frac{\text{2na nb(2na nb}-\text{n)}}{n^2(n-1)}]^{\frac{1}{2}} \qquad \text{………… (iii)}$$

The test for serial dependence is carried out by testing the hypothesis of no significance differences between the actual number of runs in the return series and the expected one in a random series.

Ljung-Box (LB) Tests

L-B test was developed in 1978. This test is an improvement over the Box-Pierce Q Statistic of 1970. The LB test statistic sets out to investigate whether a set of correlation coefficients calculated at various lags for a return time series may be deemed to be equal to zero (Gujrati, 1995). The LB statistic is based on autocorrelation coefficients. The k-th order autocorrelation function (ACF) is

$$\rho_k = \frac{\text{covariance at lag k}}{\text{variance}} = \frac{\partial k}{\partial o} \qquad \text{……………… (iv)}$$

Since both covariance and variance are measured in the same units of measurement ρ_k is unit less or pure number. It lies between – 1 and + 1, as any correlation coefficient does. The covariance at lag k and the variance can be computed as follows:

$$\partial_k = \frac{\sum_{t=1}^{n}(R_t-\bar{R})(R_{t+k}-\bar{R})}{n-1} \qquad \text{………………… (v)}$$

and

$$\partial_o = \frac{\sum_{t=1}^{n}(Rt-\bar{R})^2}{n-1} \qquad \text{…………………….. (vi)}$$

where R_t = return over period ‘t.’

$\bar{R}$ = mean return of the period over which the L-B statistic is being calculated.

R_{t+k}= the return for the period that comes k-holding periods after period ‘t’.

The ACFs thus computed at each lag will then be compared to be critical values for the 5% level of significance. This is to establish whether the individually computed ACFs are statistically significant. The critical values for a 95% confidence interval computed are as follows:

$$CL = \frac{1}{\sqrt{n}} \pm 1.96 \qquad \text{……..……… (vii)}$$

Where n is the total number of observations used in computing the ACFs and $\frac{1}{\sqrt{n}}$ is the standard error.

Accordingly if the ACF for the lag length falls outside the interval, then value is deemed to be statistically significant. It indicates that the successive returns in the series are not independent of one another.

The model used for computing the L-B test statistic is given below:

$$LB = n(n+2)\sum_{k-1}^{m}\left[\frac{\rho_k^2}{n-k}\right] \qquad \text{……............. (viii)}$$

Where n = total number of return observations used.

k = lag length for which ACF is computed.

ρ_k = kth order ACF of return series.

m = maximum lag length employed in the computation of statistic.

The L-B statistic follows a chi-squire distribution with m degrees of freedom. If the computed L-B statistic exceeds the critical value from the chi-squire table at the chosen level of significance, one can reject the null hypothesis that all ρ_k are zero; at least some of them are non-zero.

Since this test is easy to understand and used in other studies, it is more acceptable. Besides, it is non-parametric (L-B, 1978). Added to these, the data from such relatively small markets has been usually found not to conform to a normal distribution (Roux and Gibertson, 1978). All these reasoning have motivated us to choose it.

Multiple Variance Ratio Tests

For the purpose of variance ratio test uses, the principle that the variance of random walk increment is linear in the return interval. Accordingly, the variance of annual returns should be 12 times that of the monthly returns. The test is developed by assigning a base observation period to the data set, which could be a day, week or month. All statistics that are calculated in connection with this test will be based on base observation period.

Longer horizon returns which are multiples of base observation periods can also be estimated. For example, if we consider base observation period be one week and a return series "q" is taken to be the number of base observation period which constitute the return horizon of q = 3 will be made of returns with a three-week return horizon.

The unbiased variance of the base observation period return ratio may be calculated as:

$$\sigma_i^2 = \frac{\sum_{t=1}^{T}(Rt-\bar{R})^2}{T-1} \quad \text{........ (ix)}$$

where Rt = return over period 't.'

$\bar{R}$ = mean return of the period over which variance is calculated.

T = total number of return observations.

T is sometimes referred to as 'nq' in the variance ratio test literature. The other estimator calculated is:

$$\sigma_{(q)}^2 = \frac{1}{P}\sum_{t=1}^{T}(R_{tq} - \bar{R}_q)^2 \quad \text{..... (x)}$$

where δ_q^2 =unbiased estimator of $\frac{1}{q}$ of the variance of returns series with a holding period of 'q'.

R_{tq}= return with a holding period equivalent to 'q' times base observation period.

$\bar{R}_q$ = mean return in the series.

Let us see the calculation of 'p' below:

$$p = q\,(T- q + 1)(1 - \frac{q}{T}) \quad \text{........ (xi)}$$

Thus, 'bias adjusted variance ratio' is $VR_{(q)} = \frac{\sigma_{(q)}^2}{\sigma_i^2} - 1$ .... (xii)

If the series being investigated is a random walk, then Eq. (xii) should be equal to 0. Thus, test statistic to see whether the return series investigated to be a random walk is calculated. Of the two test statistics that are calculated one is assuming homoskedastic errors and the other is heteroskedastic errors. The homoskedasticity is calculated as:

$$Z(q) = \frac{\sqrt{T} * VR_q}{\sqrt{\frac{2(2q-1)(q-1)}{3q}}} \quad \text{......... (xiii)}$$

Next the other test statistic needs to be calculated because the data series from small emerging market like DSE are believed to suffer a lot from heteroskedasticity and non-normality as indicated in Ayoadi & Pyun (1994). That is calculated as:

$$Z^*(q) = \frac{\sqrt{T*}VR_q}{\sqrt{\theta\varepsilon\,(q)}} \qquad \ldots\ldots\ldots\ldots \quad \text{(xiv)}$$

where $\varepsilon(q)$ is the heteroskedasticity-consistent estimator of the variance of VR(q). It is in turn calculated as

$$\varepsilon(q) = \sum_{j=1}^{q-1} \left(\frac{2(q-j)}{q}\right)^2 X\,\gamma(j) \qquad \ldots\ldots\ldots\ldots\text{(xv)}$$

where $\gamma(j)$ is the heteroskedasticity-consistent estimator of the 'jth order' autocorrelation coefficient.

The variance of the autocorrelation coefficient is

$$\gamma(j) = \frac{\mathrm{T}\sum_{t=1}^{T} (Rt-\bar{R})^2\,(\mathrm{Rt{-}j}-\bar{R})^2}{\sum_{t=1}^{T}[(Rt-\bar{R})^2]^2} \qquad \ldots\ldots\ldots\ldots\ldots \text{(xvi)}$$

In this connection it is needless to say that Eq. (vii) is based on the following assumption. That is, the "bias adjusted variance ratio" VR (q) is approximately equal to the sum of linear combination of the initial 'q-1' auto-correction coefficients measured over q intervals.

It follows from the above that:

$$VR(q) = \sum_{j=1}^{q-1} \left(\frac{2(\mathrm{q}-\mathrm{j})}{\mathrm{q}}\right) X\,\rho(j) \qquad \ldots\ldots\ldots \quad \text{(xvii)}$$

where $\rho(j)$ is the jth-order autocorrelation coefficient of the return series and 'j' is the lag length over which the autocorrelation coefficient is calculated.

Here it is assumed "q" aggregation values of 2, 4, 8 and a maximum of 16. The statistical significance of the variance ratio test statistic is tested at the 5% significance level. It follows that the confidence limits for these 'statistics' are 1.96. If the absolute values of the calculated 'test statistics' are greater than the confidence limits, then the series is deemed not to be a random walk. The variance ratio tests have been applied in this study primarily for its superiority over popular unit root tests as indicated by Lo and MacKinlay (1988, 1989), Kim and Schmidt (1993) and Matome (1998).

The procedures suggested by Lo and McKinlay (1988) provide two test statistics $Z_{(q)}$ and $Z^*_{(q)}$, under the null hypothesis of homoscedastic and heteroscedastic increments random walk respectively. While using this method for testing random walk hypothesis there must have $VR_{(q)} = 1$ for all q. Lo and McKinlay consider testing individual variance ratios for a specific aggregation interval, q. But the multiple variance ratio (MVR) test developed by Chow and Denning (1993) show how controlling test size facilitates the MVR. This has derived a technique for the multiple comparison of the set of variance ratio test under the null hypothesis, $VR_{(q)} = 1$ and hence $Mr_{(q)} = VR_{(q)} - 1 = 0$. If we consider a set of m variance ratio tests $\{\mathrm{Mr(q)} | i = 1, 2, .., m\}$ associated with the set of aggregation intervals$\{q_i | i = 1, 2, ... m\}$. It is implied, therefore, that there are multiple sub-hypothesis under random walk hypothesis, viz.,

$H_{oi} : Mr_{(qi)} = 0$ for i = 1, 2, …… …. , m

$H_{1i} : Mr_{(qi)} \neq 0$ for any i = 1, 2, ……, m ……………(xviii)

Accordingly, for a given set of test statistics, the random walk hypothesis is not accepted if any one of the $VR_{(qi)}$ is considerably different than 1 and only maximum absolute value in the given set of test statistics is taken. Chow and Denning (1993) MRV test is based on the result

$$\mathrm{MN}\left\{\max\left(\left|z_{(q1)}\right|, \dots \dots \dots, \left|z_{(qm)}\right|\right) \leq SM(\lambda; n; T)\right\} \geq 1 - \lambda \quad \text{…….. (xix)}$$

$SM(\lambda; n; T)$ = is the higher λ position of the Studentize Maximum Modulus (SM) distribution with constraints 'n' and T sample size degrees of freedom.

When T is infinite then asymptotically,

$SM(\lambda; n; T) = Z_{\lambda/2}$ where $Z_{\lambda/2}$ is standard normal with

$$\lambda^* = 1 - (1 - \lambda)^{\frac{1}{m}} \quad \text{……. (xx)}$$

The size of the MVR test is controlled by Chow and Denning (1993) by comparing the computed values of the standardized test statistics, either $Z_{(qi)}$ or $Z^*_{(qi)}$ with the SM critical values. If the maximum absolute value of $Z_{(qi)}$ is greater than the SM critical value at a prearranged level then the random walk hypothesis is not accepted.

Results of Run Test

Run test results have been presented in Table-3. In this study, run test has been carried out in two different section: the first section deals with the result of run test for the entire sample of daily weekly and monthly data and the second section involves with the test result of two different sub-periods for daily weekly and monthly data. In case of the entire sample period, the test result reports the number of runs are less than one half of the entire sample size for daily, weekly and monthly data and in every cases *Z*-values are negative and their associated *p- values* are less than 0.05. All the test statistics reveals that daily, weekly and monthly DSE Gen index doesn't exhibit randomness. In the same way, the two sub-periods for daily, weekly and monthly data also found to be consistent with the total sample data. In every case *Z*-values are found to be negative and their associated p- *values* are less than 0.05. Finally, it can be said that the result of run test leads to a very precise decision that DSE Gen index is not a random variable.

Table-3: Output of Runs Test

Lag	Daily Log DSE Gen Index			Weekly Log DSE Gen Index			Monthly Log DSE Gen Index		
	Total	1st Sub	2nd Sub	Total	1st Sub	2nd Sub	Total	1st Sub	2nd Sub
K=Mean	7.43	6.98	7.88	7.46	6.98	7.87	7.46	6.99	7.88
Cases <K	1179	675	524	219	111	100	57	29	27
Cases ≥K	1054	446	588	183	74	117	49	21	29
Total cases	2233	1121	1112	402	185	217	106	50	56
Number of Runs	24	2	22	10	2	8	8	2	6
Z-value	-46.28	-33.43	-33.09	-19.16	-13.48	-13.80	-8.97	-6.85	-6.20
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Results of L-B Q Statistics

Table-4 displays the estimates of autocorrelation coefficients, L-B *Q*-statistics and their associated *p*-values of 16 different lags for daily, weekly and monthly DSE Gen index. This table also provides the same computation for the 1st sub-period and 2nd sub-period. In case of daily total data, all the autocorrelation coefficients are found to be positive except in lag 2 data and the *p*- values associated with each of the L-B *Q*-statistics are less than 0.05. This result implies that null hypothesis of no autocorrelation cannot be accepted at 5 percent significance level. This result of autocorrelation for the total period is also supported by the other two sub-periods. The autocorrelation coefficient and L-B

Q-statistics in the two sub-period also reveals that autocorrelation exist in the daily DSE Gen index.

In case of weekly data, the total period generate autocorrelation coefficients and L-B *Q*-statistics which lead to the conclusion that null hypothesis of no autocorrelation cannot be accepted at 5 percent significance level. But the two sub-period data produces a mixed result. In the 1st sub-period, autocorrelation coefficients and L-B *Q*-statistics for all the lag data except for lag 2, 3, 12, 13, and 14 reports that null hypothesis of no autocorrelation cannot be rejected at 5 percent significance level. On the other hand, for the 2nd sub-period, autocorrelation coefficients and L-B *Q*-statistics for all lags except 2, 3, 13, 14, 15, and 16 supports the presence of autocorrelation. But other lags accept the null hypothesis that there is no autocorrelation at 5 percent level. In such a situation, it can be concluded that, total weekly data doesn't produce consistent result with its two sub-period data.

Finally, in the case of total monthly data set, the departure from autocorrelation is clearly reported through the estimates of autocorrelation coefficient and L-B *Q*-statistics with *p*-values more than 0.05. This result is perfectly backed by the result of other two sub-period results. In a nutshell, it can be said that monthly DSE gen index is free from autocorrelation and it appears not to be a good functional variable that could be used to predict future values of the same.

Table-4: Estimates of Ljung-Box *Q*-Statistics for Log DSE Gen Index

Lag	Order of Estimates	Daily Log DSE Gen Index			Weekly Log DSE Gen Index			Monthly Log DSE Gen Index		
		Total	1st Sub	2nd Sub	Total	1st Sub	2nd Sub	Total	1st Sub	2nd Sub
1	AC	0.091	0.147	0.060	0.145	0.131	0.153	0.050	-0.103	0.155
	Q-Stat	18.655	24.206	4.0444	8.4994	3.2058	5.0972	0.2729	0.5509	1.3918
	Prob.	(0.000)	(0.000)	(0.044)	(0.004)	(0.073)	(0.024)	(0.601)	(0.458)	(0.238)
2	AC	-0.053	-0.024	-0.070	0.099	0.164	0.051	0.104	0.034	0.128
	Q-Stat	24.874	24.839	9.5613	12.438	8.2570	5.6589	1.4529	0.6534	2.3617
	Prob.	(0.000)	(0.000)	(0.008)	(0.002)	(0.016)	(0.059)	(0.484)	(0.721)	(0.307)
3	AC	0.033	0.047	0.023	-0.003	0.016	-0.019	0.137	0.255	0.002
	Q-Stat	27.309	27.346	10.172	12.442	8.3047	5.7347	3.5105	3.8887	2.36
	Prob.	(0.000)	(0.000)	(0.017)	(0.006)	(0.040)	(0.125)	(0.319)	(0.274)	(0.501)
4	AC	0.032	0.019	0.040	0.084	-0.017	0.153	0.083	0.037	0.139
	Q-Stat	29.638	27.733	11.923	15.282	8.3566	10.948	4.2779	3.9032	3.5429
	Prob.	(0.000)	(0.000)	(0.018)	(0.004)	(0.079)	(0.027)	(0.370)	(0.419)	(0.471)
5	AC	0.054	0.007	0.080	0.084	-0.025	0.156	0.146	0.061	0.189
	Q-Stat	36.104	27.781	19.033	18.138	8.4746	16.345	6.6812	4.2637	5.7756
	Prob.	(0.000)	(0.000)	(0.002)	(0.003)	(0.132)	(0.006)	(0.245)	(0.512)	(0.329)
6	AC	0.016	-0.001	0.024	-0.006	-0.139	0.080	0.103	0.068	0.081
	Q-Stat	36.702	27.782	19.676	18.152	12.170	17.796	7.8890	4.9649	6.1983

	Prob.	(0.000)	(0.000)	(0.003)	(0.006)	(0.058)	(0.007)	(0.246)	(0.548)	(0.401)
	AC	0.019	0.016	0.018	0.036	0.048	0.018	0.015	-0.017	0.013
7	Q-Stat	37.485	28.077	20.052	18.679	12.622	17.870	7.9142	4.9985	6.2089
	Prob.	(0.000)	(0.000)	(0.005)	(0.009)	(0.082)	(0.013)	(0.340)	(0.660)	(0.516)
	AC	0.005	0.000	0.006	0.062	0.047	0.069	-0.205	-0.316	-0.186
8	Q-Stat	37.530	28.077	20.094	20.262	13.045	18.959	12.804	8.5593	8.5084
	Prob.	(0.000)	(0.000)	(0.010)	(0.009)	(0.110)	(0.015)	(0.119)	(0.381)	(0.385)
	AC	0.038	0.040	0.037	0.068	0.130	0.024	0.120	0.040	0.039
9	Q-Stat	40.849	29.860	21.613	22.164	16.345	19.093	14.482	9.8287	8.6104
	Prob.	(0.000)	(0.000)	(0.010)	(0.008)	(0.060)	(0.024)	(0.106)	(0.365)	(0.474)
	AC	0.003	0.021	-0.008	0.070	0.065	0.062	-0.050	-0.125	-0.058
10	Q-Stat	40.871	30.381	21.681	24.200	17.168	19.975	14.776	11.396	8.8441
	Prob.	(0.000)	(0.001)	(0.017)	(0.007)	(0.071)	(0.029)	(0.140)	(0.327)	(0.547)
	AC	0.039	0.065	0.023	-0.005	0.078	-0.070	-0.006	0.097	-0.028
11	Q-Stat	44.270	35.210	22.276	24.211	18.382	21.096	14.780	11.396	8.9019
	Prob.	(0.000)	(0.000)	(0.022)	(0.012)	(0.073)	(0.032)	(0.193)	(0.411)	(0.631)
	AC	-0.017	0.031	-0.046	0.032	0.132	-0.035	-0.093	-0.002	-0.281
12	Q-Stat	44.932	36.334	24.623	24.624	21.873	21.383	15.832	11.413	14.647
	Prob.	(0.000)	(0.000)	(0.017)	(0.017)	(0.039)	(0.045)	(0.199)	(0.494)	(0.261)
	AC	0.020	0.022	0.017	0.054	0.104	0.017	-0.164	0.004	-0.143
13	Q-Stat	45.793	36.904	24.960	25.826	24.033	21.447	19.128	12.500	16.178
	Prob.	(0.000)	(0.000)	(0.023)	(0.018)	(0.031)	(0.065)	(0.119)	(0.487)	(0.240)
	AC	0.005	0.023	-0.007	0.067	0.023	0.086	-0.035	-0.089	-0.036
14	Q-Stat	45.850	37.488	25.013	27.691	24.136	23.172	19.277	12.837	16.275
	Prob.	(0.000)	(0.001)	(0.034)	(0.016)	(0.044)	(0.058)	(0.155)	(0.539)	(0.297)
	AC	0.019	0.005	0.027	0.018	0.005	0.020	-0.156	-0.216	-0.202
15	Q-Stat	46.680	37.512	25.865	27.828	24.141	23.262	22.310	14.833	19.485
	Prob.	(0.000)	(0.001)	(0.039)	(0.023)	(0.063)	(0.079)	(0.100)	(0.464)	(0.193)
	AC	0.025	0.054	0.010	-0.013	-0.078	0.021	-0.141	-0.025	-0.182
16	Q-Stat	48.087	40.831	25.968	27.898	25.378	23.366	24.824	14.957	22.147
	Prob.	(0.000)	(0.001)	(0.054)	(0.033)	(0.063)	(0.104)	(0.073)	(0.528)	(0.139)

Note: The value within parentheses represents *p*- value for Q-statistics.

Results of Multiple Variance Ratio Test

This study is intended to identify whether DSE General Index data series exhibit random walk characteristics or not. For this reason DSE data has been collected from November 2001 to August 2010 and organized the data based on daily, weekly and monthly data series. These classified data series has been used to estimate both the joint as well as individual variance ratio test statistics for different lags (i.e. 2, 4, 8 and 16) under homoskedasticity increments random walk and heteroskedasticity increments random walk assumptions. Under homoskedasticity assumption, when we consider daily data for the total sample period, the Chow-Denning Max $|Z|$ joint test statistics is found to be 4.308242 with a p-value of 0.0001 which implies that we can not accept the null hypothesis of random walk. Under heteroskedasticity test assumption, the Chow-Denning

Max $|Z|$ joint test statistics is 3.042146 with p-value equal to 0.0094 also reveals that the null hypothesis of random walk can't be accepted at 5 percent significance level in the daily data series. Under homoskedastic test assumption, the individual test statistics for lag 2, 4, 8, and 16 with their associated *p*-values also reveals that daily DSE Gen Index doesn't exhibit random walk characteristics. This identical evidence has also been found for individual test statistics for lag 2, 4, 8, and 16 under heteroskedastic test assumption.

Table- 5: Variance Ratio Test for Total Period (November 2001-September 2010)

Test Category		**Daily** |*(2233 observations)*		**Weekly** *(402 observations)*		**Monthly** *(106 observations)*	
		Under Homoskedastic Assumption	Under Heteroskedastic Assumption	Under Homoskedastic Assumption	Under Heteroskedastic Assumption	Under Homoskedastic Assumption	Under Heteroskedasti c Assumption
Joint Test of Chow-Denning Max $\lvert Z \rvert$ Statistics @ 5 percent level		4.308242 (0.0001)	3.042146 (0.0094)	4.149049 (0.0001)	3.889733 (0.0004)	4.465103 (0.1181)	2.088001 (0.1393)
Individual test for Different Lag	2	1.091191* 4.308242** (0.0000)	1.091191* 2.872625** (0.0041)	1.144372* 2.891057** (0.0038)	1.144372* 2.219511** (0.0265)	1.049447* 0.506684** (0.6124)	1.049447* 0.501383** (0.6161)
	4	1.100615* 2.540837** (0.0111)	1.100615* 1.720991** (0.0853)	1.314073* 3.361780** (0.0008)	1.314073* 2.796188** (0.0052)	1.231454* 1.267726** (0.2049)	1.231454* 1.210897** (0.2259)
	8	1.206625* 3.300084** (0.0010)	1.206625* 2.366132** (0.0180)	1.546467* 3.699406** (0.0002)	1.546467* 3.335795** (0.0009)	1.622920* 2.157857** (0.0309)	1.622920* 2.088001** (0.0368)
	16	1.362740* 3.893339** (0.0001)	1.362740* 3.042146** (0.0023)	1.912005* 4.149049** (0.0000)	1.912005* 3.889733** (0.0001)	1.384410* 0.894888** (0.3708)	1.384410* 0.892799** (0.3720)

Notes:

* indicates variance-ratio estimates

** indicates z-statistics

The value within the parentheses represents p-value for the test statistics

For weekly data set, under homoskedastic and heteroskedastic test assumption, the joint test statistics with their *p*-values explains that fact that weekly DSE Gen index doesn't comply with the norms of random walk. In the case of individual test statistics for lag 2, 4, 8 and 16 report that we cannot accept the null hypothesis of random walk. So it can be concluded that variance ratio test statistics for weekly DSE Gen Index are not statistically significant at 5 percent level. On the other hand, joint variance ratio test on monthly DSE Gen Index reports the evidence of random walk at 5 percent significance level under both homoskedasticity and heteroskedasticity test assumption. In both homoskedasticity and heteroskedasticity test assumptions, the individual variance ratio test statistics for lag 2, 4, 16 with their *p*-values reveals that we can't reject null hypothesis of random walk at 5 percent significance level. Surprisingly variance ratio test for lag 8 under both of these two assumptions doesn't exhibit random walk characteristics.

Table-6: Variance Ratio Test for 1st Sub-Period (November 2001- December 2005)

Test Category		Daily *(1121 observations)*		Weekly *(185 observations)*		Monthly *(50 observations)*	
		Under Homoskedastic Assumption	Under Heteroskedastic Assumption	Under Homoskedastic Assumption	Under Heteroskedastic Assumption	Under Homoskedastic Assumption	Under Heteroskedastic Assumption
Joint Test of Chow-Denning Max $\lvert Z \rvert$ Statistics @ 5 percent level		4.890911 (0.0000)	2.017164 (0.1636)	2.662668 (0.0307)	1.866045 (0.2260)	0.729384 (0.9185)	0.621771 0.9529)
Individual test for Different Lag	2	1.146144* 4.890911** (0.0000)	1.146144* 1.959145** (0.0501)	1.130645* 1.772159** (0.0764)	1.130645* 1.151639** (0.2495)	0.895802* -0.729384** (0.4658)	0.895802* -0.621771** (0.5341)
	4	1.218821* 3.914384** (0.0001)	1.218821* 1.692200** (0.0906)	1.367233* 2.662668** (0.0078)	1.367233* 1.853864** (0.0638)	0.981891* -0.067757** (0.9460)	0.981891* -0.059772** (0.9523)
	8	1.305412* 3.455344** (0.0005)	1.305412* 1.671706** (0.0946)	1.393481* 1.804381** (0.0712)	1.393481* 1.402372** (0.1608)	1.207975* 0.492158** (0.6226)	1.207975* 0.449019** (0.6534)
	16	1.483976* 3.679693** (0.0002)	1.483976* 2.017164** (0.0437)	1.705130* 2.172987** (0.0298)	1.705130* 1.866045** (0.0620)	0.951692* -0.076824** (0.9388)	0.951692* -0.074397** (0.9407)

Note:

* indicates variance-ratio estimates

** indicates z-statistics

The value within the parentheses represents p-value for the test statistics

To examine the consistency of the result presented in Table-5 we have divided the sample period into two sub-periods and perform the joint and individual variance ratio test for each sub-period. The first sub-period starts from November 2001 through December 2005 (which includes 1121 daily, 185 weekly and 50 monthly observations) while the second sub-period starts from January 2006 through August 2010 (which includes 1112 daily, 217 weekly and 56 monthly observations). The test results have been presented in Table-6 and Table-7 respectively.

In the first sub-period, the daily data reports no random walk in both joint as well as individual test under homoskedastic increments test assumption. But under heteroskedastic test assumption, daily data exhibits random walk characteristics in joint variance ratio test estimates. But homoskedastic estimates of individual lag variance ratio test rejects the null hypothesis at 10 percent significant level.

For weekly data, joint variance ratio test under homoskedastic assumption doesn't follow random walk but for heteroskedastic assumption, test statistics supports random walk at 5 percent significance level. In case of individual lag variance ratio test under heteroskedastic assumption, test statistics supports random walk except for lag 4 and 16. But under homoskedastic assumption, all the individual lag test statistics doesn't comply with random walk.

In case of monthly data, test statistic reports that null hypothesis of random walk can not be rejected in both homoskedastic and heteroskedastic test assumptions at 5 percent significance level. This result is true for both joint test and individual lag variance ratio test.

Table-7: Variance Ratio Test for 2nd Sub-Period (January 2006- August 2010)

Test Category		**Daily** *(1112 observations)*		**Weekly** *(217 observations)*		**Monthly** *(56 observations)*	
		Under Homoskedastic Assumption	Under Heteroskedastic Assumption	Under Homoskedastic Assumption	Under Heteroskedastic Assumption	Under Homoskedastic Assumption	Under Heteroskedastic Assumption
Joint Test of Chow-Denning Max $\|Z\|$ Statistics @ 5 percent level		2.101825 (0.1349)	2.220415 (0.1015)	3.002132 (0.0107)	3.048341 (0.0092)	1.456934 (0.4659)	1.499588 (0.4368)
Individual test for Different Lag	2	1.059721* 1.990615** (0.0465)	1.059721* 2.220415** (0.0264)	1.151340* 2.224228** (0.0261)	1.151340* 1.975243** (0.0482)	1.136658* 1.013484** (0.3108)	1.136658* 1.148792** (0.2506)
	4	1.031239* 0.556566** (0.5778)	1.031239* 0.558082** (0.5768)	1.264138* 2.075030** (0.0380)	1.264138* 2.015524** (0.0438)	1.265930* 1.054182** (0.2918)	1.265930* 1.085115** (0.2779)
	8	1.143305* 1.614779** (0.1064)	1.143305* 1.585490** (0.1129)	1.604237* 3.002132** (0.0027)	1.604237* 3.048341** (0.0023)	1.581116* 1.456934** (0.1451)	1.581116* 1.499588** (0.1337)
	16	1.277562* 2.101825** (0.0356)	1.277562* 2.152096** (0.0314)	1.855309* 2.855809** (0.0043)	1.855309* 2.866406** (0.0042)	1.053617* 0.090336** (0.9280)	1.053617* 0.095560** (0.9239)

Note:

* indicates variance-ratio estimates

** indicates z-statistics

The value within the parentheses represents p-value for the test statistics

In the second sub-period (Table-7), daily data exhibit random walk characteristics at 5 percent significance level both at joint and individual lag test for lag 4 and 8 under homoskedastic as well as heteroskedastic test assumption. Weekly data reports no random walk characteristics in both joint test and individual lag test. In the case of monthly data, random walk characteristic has been clearly revealed under both homoskedastic and heteroskedastic assumption in both joint test and individual lag test at 5 percent significance level. Differences in results are found for different data series and for different lags. In general more consistency is observed in monthly data series showing random walk while daily and weekly series exhibit less consistency.

Discussion of the Results

This study extends evidence on the weak-form of the efficient market hypothesis (EMH) for DSE using run test L-B Q statistics, and multiple variance ratio test in DSE for the first time. EMH has become a debatable issue in finance surrounding the methodology used in different tests. These tests are susceptible to errors due to spurious autocorrelation caused by non-synchronous trading a usual feature of emerging markets (Pope, 1989). It follows that presence of autocorrelation may not necessarily indicate market inefficiency (Lucas, 1978; Levich, 1979).

This study is intended to identify the randomness of DSE Gen Index from a sample between November 27 2001 (which is the starting date of the available DSE general index data) and December 31, 2010. During this period we have found 2233 daily, 402 weekly and 106 monthly observations in our sample. We have applied different test methods like Run Test, L-B *Q* Test and finally Multiple Variance Ratio Test to examine whether DSE Gen Index follow random walk or not. In this situation except run test, the L-B Q-test as well as variance ratio test provides a relatively consistent result. In case of run test all data series (i.e. daily, weekly and monthly) are found to be non-random. But other two test i.e. L-B Q-test and variance ratio test provides a mixed result. In case of L-B Q-test daily data are found to be non-random; weekly data are moderately random but monthly data are found to be perfectly random. Variance ratio test, with little exception, also provides the same result as L-B Q-test. In this situation we can conclude that, for short horizon data i.e. daily data, DSE Gen index is found to be non-random but for longer time horizon such as weekly data and monthly, the same variable is found to be random. This inconsistency of the result may be due to the following reasons for daily, weekly and monthly data:

Stock index is theoretically expected to be random for efficient market and an efficient stock market implicitly assume that all market participants have the identical information and have homogenous expectation that they are using in their trading decision. But violation of the assumption of symmetrical distribution of information and homogenous expectation actually lead to the situation that all the market participants shows some sort of dependency with each in their daily trading decision which is ultimately reflected in non-random behavior of daily stock indexes. But reduction of this dependency is found when they spent some time to analyze each and every information and revise their own trading decision. So for a longer period DSE Gen index has been found to be independent and random.

Another important reason for non-randomness in short time horizon data (i.e. daily data) may be due to the practice of circuit breaker and trading halt by the stock exchanges in the different stock transactions which is found to be not comply with the upper and lower bounds. That's why daily data reports some sort of dependency with each other. But that dependency reduces with the passage of time.

Another reason may be the practice of insider trading in the stock market. Insider trader makes their trading decision based on information which is not supposed to be disclosed in the stock market. As a result price trend of stocks doesn't reflect the true picture of the market trend. In addition, noise trading; trading based on rumors also results identical trading decision by the market participants in the short time horizon. But they can revise their trading decision in longer time horizon that leads the stock price follow random walk. Finally, as Dhaka Stock Exchange (DSE) belongs to the category of a frontier market impacted by less liquidity, volatility, infrequent trading, political instability, poor regulation and endemic corruption, all these factors contribute to the stock index to follow random walk in the long run but non-random in the short run.

The economic interpretation of this test results may be due to information asymmetry, flexible attitude of the stock exchange to monitor and regulate daily stock index, lack of individual's homogenous expectation about returns from stock investment, infrequent and non-synchronous trading that arises in the very short horizon.

This may lead one to reach a conclusion that Bangladesh market is not weak-form efficient for shorter time horizon but for longer one. Moreover, the results indicate the existence of heteroskedasticity and autocorrelation in the data due to official intervention and policy changes as is found in other studies of Bark (1991) and Pyun and Kim (1991). It has also been argued that market can result in overshooting and undershooting as well as increase in risk aversion by the market participants through official intervention.

The study suggests that price movements of stocks listed in DSE reflecting a frontier/developing market don't conform to the general random walk behavior of stock price movements. It also raises some questions about the validity of the rejection of random walk as well as about adequacy, nature and content of information set postulated by efficient market hypothesis. Obviously, the information set is not as good as that of developed markets. If weak form variant of random walk hypothesis is considered as necessary and sufficient condition for efficient market, then policy makers will have to improve the degree of 'efficiency'.

Finally, results of this study while invalidating the weak form random walk hypothesis in short term (daily and weekly data) horizon but not long term (monthly data), it has pointed out some questions associated with its implications that need to be addressed for policy guidance. Recently, a new branch of financial economics is being emerged known as behavioral finance is likely to contribute in explaining the market anomalies and conflicting evidence of market efficiency. Future research using different methodologies may be of more appealing for the policy makers.

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