An Emprical Analysis of Weak-Form Efficiency of Dar es Salaam Stock Exchange

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Abstract

This study examines the empirical evidence for efficient market hypothesis in the Dar es Salaam Stock Exchange (DSE). The daily closing stock prices of the market index (All share Index-DSEI) were used, covering the sample period from January 2009 to March 2015. All data were extracted from Dar Es Salaam Stock Exchange (DSE), excluding public holidays and non-trading days. To examine the weak-form efficiency hypothesis, the study used four different statistical tests: serial correlation test-The Ljung-Box test, Unit root tests, non-parametric runs test and the variance ratio test. The results of all four statistical tests employed showed that the daily returns series did not behave randomly for the sample period investigated and hence it was concluded that DSE is not a weak form efficient market. Inefficiency of the market (DSE) general implies that trading strategy such as the technical analysis can be valuable in the market taking into consideration of the other factors. The study recommended that other studies to be conducted using individual shares. This will help in understanding the efficiency of individual stocks as well as the possibility of applying some of trading strategy on individual shares.

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Key words: Stock market, Weak form efficiency, Stock Exchange, efficiency tests, Dar es Salaam stock exchange, Unit root, Variance ratio

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1. Introduction

For past several years, the studies on the behavior of the return in the stock markets have drawn a greater attention among scholars, researchers and academicians. Numerous studies have been conducted in the effort of finding empirical evidence for Efficiency Market Hypothesis (EMH) and the existence of seasonality in stock price behavior. Financial literature has described "Efficiency Market Hypotheses" as the concept that stock prices already reflect available information. According to Arnold (2005) " the efficiency market hypothesis (EMH) implies that, if new information is revealed about the firm , it will be incorporated into share price rapidly and rationally, with respect to the direction of the share price movement and size of that movement" Fama (1970) who categorized efficiency markets into three forms namely: Weak-form efficiency, Semi-strong efficiency and Strong form efficiency markets asserted that "A market in which prices always reflect available information is called efficient.

The extent to which the level of information is incorporated in the stock /share prices is what distinguishes the three forms of efficiency markets. A stock market is said to be weak form efficiency if share prices fully reflect past information ,Semi-Strong efficiency market is the one in which the current share prices fully reflect past as well as available public information and the Strong-form efficiency market refers to the market in whose share prices reflect all information ,both public and private information. (Fama 1970).

Various econometrics tools, statistical tools and techniques have been developed and used in determining the empirical evidence for Efficiency Market Hypothesis (EMH). For well-developed stock markets the focus has been to determine the empirical evidence for Semi-Strong form efficiency hypothesis as well as strong form efficiency hypothesis while the empirical evidence for weak-form efficiency hypothesis has been extensively explored in some of the emerging stock markets in developing countries.

Despite the fact that much have been done in relation to efficiency market hypothesis, the focus has been to the well-established and developed stock markets leaving behind the developing stock markets, such as African stock markets. It is believed that developing stock markets are weak-form inefficiency, however, this idea needs to be empirically investigated and documented and therefore much is desired to be studied and documented from these African stock markets. Therefore the aim of this study is to determine empirical evidence for weak-form of Dar es Salaam Stock Exchange.The significance of this study is based on the fact that, the findings of the study will add new evidence into the few existing empirical evidence and literature available so far in emerging African Stock Markets.Also the study is anticipated to be beneficial to policy makers, businessmen and women, and development agencies who are stake holders of Dar es Salaam Stock Exchange.

In this study, we examine the empirical evidence for efficient market hypothesis in the Dar es Salaam Stock Exchange (DSE). The daily closing stock prices of the market index (All share Index-DSEI) were used, covering the sample period from January 2009 to March 2015. To examine the weak-form efficiency hypothesis, the study used four different statistical tests: serial correlation test-The Ljung-Box test, Unit root tests, non-parametric runs test and the variance ratio test. The findings of all four statistical tests (Serial correlation test, Runs test, Unit root test and Variance ratio tests) employed in this study are consistent , both have revealed that the daily return series of DSEI do not behave randomly and hence based on these findings the null hypothesis of this study which states that 'The Dar es salaam Stock Exchange (DSE) is a weak form inefficient market" cannot be rejected, and therefore it is concluded that DSE is not a weak form efficient market.

The remainder of this study is organized as follows. Section two reviews the literature. Section three shows an empirical strategy and data source. Section four presents and discusses the estimated results. Section five concludes.

2. Literature Review

A vast majority of studies has been undertaken worldwide in the effort of determining the empirical evidence of Efficiency Market Hypothesis (EMH). The empirical evidence from developed stock markets includes the famous and most cited study done by Fama (1965), using runs test, Alexander's filter rule technique and serial correlation test on daily return of 30 individual stocks listed in Dow Jones Industry for the period between 1957 to 1962. Fama found insignificant correlation and hence it was concluded that the Dow Jones Industry Average was weak-form efficient.

Another empirical evidence from developed stock market is the study by Worthington and Higgs (2005) who investigated five developed stock markets namely: Australia, Hong Kong, Japan, New Zealand and Singapore and ten emerging markets. Employing serial correlation test, unit root tests (ADF , PP & KPSS), runs test and variance ratio test on daily return, the study found that out of the five developed market investigated , the random walk hypothesis was only rejected for Australia by unit root tests. More empirical evidences from developed stock market includes Shaker(2013), who tested the weak-form efficiency of the Finnish and Swedish stock markets by employing serial correlation test, Augmented Dickey-Fuller test and Variance ratio test as proposed by Lo and Mckinlay (1988). The study used daily returns of the OMX Helsinki and OMX Stockholm indices data from year 2003 to 2012. The findings of the study show that daily returns do not follow random walks in any of the two countries which imply that both markets are not weak form efficient.

Among the studies of weak form efficiency for emerging African stock markets includes; Mollah (2007) who tested the weak form efficiency in Botswana stock exchange for the period covering 1989 – 2005, using daily returns series and employing runs test, auto correlation test and ARIMA model. The empirical evidence of both statistical test rejected the hypothesis of random walk model and hence it was concluded that Botswana stock exchange is not weak form efficient market.

Similarly, McKerrow (2013), examined the random walks in frontier stocks markets of Botswana, Ivory coast, Ghana, Mauritius and Namibia using monthly time series data for about 16 years and applying naïve random walk, the runs test and the multiple variance ratio test. The findings of the study resulted into mixed conclusion, while the analysis using runs test revealed a rejection of the random walk hypothesis for the markets of Namibia and Ivory Coast and acceptance of random walk hypothesis for the markets of Botswana, Ghana and Mauritius.

Although, there are adequate empirical evidences on the weak form efficiency hypothesis for the developed stock markets, the behavior of stock returns in developing stock markets is not well known and documented. For example, the behavior of security returns in the Dar es Salaam stock exchange is yet to be known and it is not well documented compared to other stock markets in Africa. Therefore, this necessitates the need to undertake study on the behavior of stock returns in DSE, in an effort to fill in this knowledge gap by adding new empirical evidence regarding efficiency market hypothesis of the Dar essalaam stock exchange.

3. Data and Model

The (Sample) data which have been employed in this study comprisedof the daily closing stock prices of the market index (The All share Index-DSEI),and were collected from Dar es salaam stock exchange and have excluded public holidays and non-trading days .

Although the stock prices market index was collected for the purpose of undertaking statistical tests, the actual statistical tests were performed using the natural logarithmic of the relative prices which are proxy of stock return. Therefore, to generate continuously compounded stock returns the following equation was used.

$$R_t = [ln(P_t) - ln(P_{t-1})] = ln\left(\frac{P_t}{P_{t-1}}\right) \quad (1)$$

Where: R_t = Return of the price indices at time t; P_t = Price at time t; P_{t-1}= Price at time t-1

The Sample Period and Sample size

The sample period for this study has covered the period from January, 2009 to March, 2015.The data prior to January 2009 were not accessed, and therefore the study had to use the available data which covers this period. The sample size of the study comprises of 1546 daily observations.

Statistical tests for testing Weak–form Market efficiency

In determining the empirical evidence for weak-form efficiency hypothesis, various statistical tests were used namely: The Kolmogorov-Smirnov – (K-S) test, Serial correlation test- the Ljung-Box Test, non parametric runs test and two types of the Unit root tests- the Argumented Dickey fuller test and The Phillips-Perron Test (PP). Also, the variance ratio test was used to confirm the results obtained from other statistical tests.

Test of goodness – of-fit: (The Kolmogorov-Smirnov – (K-S test)

In order to examine whether the returns series employed in this study follows the normal distribution or not, the Kolmogorov-Smirnov test was employed. This is a non-parametric test which is used to determine how well a random sample of data fits particular hypothesized distribution. The null and alternative hypotheses tested were as follows:

H_0 : The returns series follow a normal distribution
H_1 : The returns series do not follow normal distribution

The null hypothesis of normal distribution of returns series is rejected at the chosen level of significant (α) in favour of alternative hypothesis , if the kolmogorov-Smirnov test statistic (D) is greater than the critical value obtained.

Serial correlation test- Ljung Box Test

The serial correlation test (Ljung Box Test), was the first test to be employed in examining the weak form inefficiency of Dar es Salaam Stock Exchange (DSE). This is the parametric test which determines the serial correlation (ρ_k)/autocorrelation between current returns (r_t) and previous returns (r_{t-k}) of the same series. If the autocorrelation in return series is found (positive or negative) it can be concluded that the return series does not behave in random fashion and hence there is weak form inefficiency in the stock market.

Serial correlation test determines whether the correlation coefficients are significantly different from zero by measuring the correlation coefficient between series returns and lagged returns in the same series. The serial correlation coefficient for lag K can be expressed by the following model.

$$\rho_{(K)} = \frac{Covariance(\mu_t,\mu_{t-1})}{\sigma(\mu_{t-1}),(\mu_{t-1})} = \frac{Covariance(\mu_t,\mu_{t-1})}{Variance(\mu_t)} \quad (2)$$

Similarly can be written as:

$$\rho_{(K)} = \frac{Cov(r_t r_{t-k})}{\sqrt{Var(r_t)}\sqrt{Var(r_{t-1})}} = \frac{E[(r_{t-\mu})(r_{t-k}-\mu)]}{E\left[(r_{t-\mu})^2\right]} \quad (3)$$

Where: $\boldsymbol{\rho}_{(\boldsymbol{K})}$ = Serial correlation coefficient of time series-$\boldsymbol{r_t}$; $\boldsymbol{r_t}$= Return on the security at time t; K = Lag of the period; $\boldsymbol{r_t} - K$ = The return after K lags; Var($\boldsymbol{r_t}$),Var ($\boldsymbol{r_t} - K$) = Variance on return over time period ($\boldsymbol{t}$,$\boldsymbol{t} - K$); Cov ($\boldsymbol{r_t}$,$\boldsymbol{r_t} - K$) = The covariance between two returns.

The serial correlation can be estimated using sample autocorrelation coefficient at lag K given as follows:

$$\rho_{(K)} = \frac{\sum_{t-1}^{N-K}(r_t-\bar{r})(r_{t-k}-\bar{r})}{\sum_{t-1}^{N}(r_t-\bar{r})^2} \quad (4)$$

Where: $\overline{\boldsymbol{\rho}}_{(\boldsymbol{K})}$= Autocorrēlation cōefficient of lag K; N= Number of observations; K = The time lag; r_t = Security return āt time t; r = Sample mean of security/stock return; $r_t - k$ = Return after K lags.

If autocorrelation coefficients $\boldsymbol{\rho}_{(K)}$ are statistically different from zero, it implies that the stock returns are serially correlated and hence the hypothesis of random walk can be rejected, which is similar to rejection of weak-form efficiency hypothesis. To test the significance of serial correlations of return series in this study the Ljung-Box test has been used. The test statistic for the Ljung-Box test statistic is given by

$$Q_{LB} = n(n+2)\sum_{k=1}^{m}\frac{\rho^2 k}{n-k} \tag{5}$$

Where: $\mathbf{Q_{LB}}$ = Test Statistic; n = Sample size or number of observations; ρ_k = is the-k^{th}; autocorrelation for lag K or sample autocorrelation at lag K; m = Number of lags being tested. Using this test statistic, the following null and alternative hypotheses tested were :

H_0 = All autocorrelation up to $\rho_k$are zero
H_1 = At least one autocorrelation up to $\rho_k$is not zero.

Given the value of Q_{LB} obtained, the null hypothesis of all autocorrelation up to $\rho_k$are zero will be rejected if Q_{LB} statistic exceeds critical Q value (x with m degrees of freedom) from Chi-square table (Gujarat 2004) . Alternatively, the P-value can be used to test the hypothesis. The null hypothesis of all zero autocorrelation can be rejected if the P-value obtained from statistical test is less than the chosen level of significance.

Runs Test

Unlike serial correlation test, Runs test is a non- parametric test, which has also been employed to determine the randomness of the return series in DSE. A run can be defined as a succession of identical events or attribute that may be represented by a letter or another symbols, followed by different successions of events or attributes or no event at all (Ndunguru, 2007). Similarly, Spiegel et al (2000) defined run as a 'set of identical (or related) symbols contained between two different symbols or no symbol (such as at the beginning or end of the sequence). In order to perform the run test, the number of actual runs denoted by (R) is computed and then compared with the expected number of runs (m) which can be estimated as:

$$m = \frac{N(N+1)-\sum_{i=1}^{3} n_i^2}{N} \tag{6}$$

Where: m = Expected number of runs; N = Total number of return observations; n_i^ε= Sample size of each category of price change;

For a large number of observations (N>30), the sampling distribution of m is approximately normal and the standard error of σ_m is given by:

$$\sigma_m = \left[\frac{\sum_{i=1}^{3} n_i^2\left[\sum_{i=1}^{3} n_i^2+N(N+1)\right]-2N\sum_{I=1}^{3} N_i^3-N^3}{N^2(N-1)}\right]^{1/2} \tag{7}$$

Then, the standard normal z-statistic used in run test is given by:

$$Z = \frac{R \pm 0.5 - m}{\sigma_m} \tag{8}$$

Where: Z = Z-Test statistic; R = Actual number of runs; M = Expected number of runs; 0.5 = Continuity adjustment, in which the sign continuity adjustment is positive if $R \leq m$ and negative if $R \geq m$

The following null and alternative hypotheses are tested by the runs test:

H_0= The series is random

H_1 = The series is not random

If the number of runs falls below the expected runs i.e Z-value is negative, it will be an indication of the presence of positive serial correlation and if the number of runs exceeds the expected runs i.e when Z-value is positive, it will be an indication of the presence of negative serial correlations. The presence of positive serial correlation in return series indicates the positive dependence of stock returns and hence implies the violation of random walk hypothesis i.e the null hypothesis of randomness of the return series is rejected.
Furthermore the P-value obtained can be used to draw conclusion on the randomness of the return series as tested by run test. If P-value obtained is less than the level of significant (eg. 0.05), the test will be significant at that chosen level of confidence.

Unit Root Tests

Unit root tests are among widely statistical tests used to examine the randomness of the return series. Basically, the test is done to investigate the presence of a unit root i.e non stationary of the return series.

Although the presence of a unit root is not a sufficient condition for the random walk, it is a necessary condition for the random behavior of the series. That is the rationale for many researchers to employ unit root tests in testing the Weak form efficiency hypothesis. For example, Ayyappan et al (2013), Sultan et al (2013), Shaker (2013) and Sania (2014) used unit root tests to examine empirical evidence for Efficiency Market Hypothesis (EMH). The series containing unit root is said to be non -stationary i.e behaving in random fashion which supports the Weak form efficiency hypothesis.

Although there are various types of unit root tests, only two types of unit root tests namely: the Augmented Dickey-Fuller (ADF) and The Phillips-Perron Test (PP) will be employed in this study to investigate the randomness behavior of the return series. Both Augmented Dickey-Fuller (ADF) test and the Phillips-Perron Test (PP) use the following null and alternative hypotheses; and these are the hypotheses that have been pursed in employing unit root tests:

H_0 = The series does contain a unit root (Non-Stationary)

H_1 = The series does not contain a unit root (Stationary).

Unit Root Tests: Augmented Dickey-Fuller (ADF) Test:

The presence of a unit root in a series can be tested by ADF test using three differential-form autoregressive equations:

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{P} \beta_i \, \Delta\gamma Y_{t-1} + \mu_t \qquad (8)$$
$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^{P} \beta_i \, \Delta\gamma Y_{t-1} + \mu_t \qquad (9)$$
$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \alpha_1 t + \sum_{i=1}^{P} \beta_i \, \Delta\gamma Y_{t-1} + \mu_t \qquad (10)$$

Where: Δ = represent first differences; Y_t = the log of price index; α_0 = the constant; α_1= estimated coefficient for the trend; t= trend term; P = number of lagged terms; γ and β_i = coefficients to be estimated; u_t = Error term.

The presence of deterministic elements α_0 (a drift term) and α_1t (a linear time trend) is what differentiate the three regressions. The first equation (8)is concerned with testing a pure random walk model without constant and time trend. The second equation (equation 9) is concerned with testing a random walk with drift and the third equation (equation 10) regards the testing of random walk with drift and deterministic trend. The following null and alternative hypotheses correspond to these models:

Model 1:
- $H_0 : Y_t$ Is random walk or $\gamma = 0$
- $H_1 : Y_t$ Is a stationary process or $\gamma < 0$

Model 2:
- $H_0 : Y_t$ Is random walk around a drift or$(\gamma = 0, \alpha_0 \neq 0)$
- $H_0 : Y_t$ Is a level stationary process or$(\gamma < 0, \alpha_0 \neq 0)$

Model 3:
- $H_0 : Y_t$ is random walk around a trend or ($\gamma = 0, \alpha_1 \neq 0$)
- $H_1 : Y_t$ is a trend stationary process or ($\gamma < 0, \alpha_1 \neq 0$)

After performing the ADF test, if the computed absolute value of the tau statistic ($|\tau|$) exceeds the DF or MacKinnon critical tau values, the hypothesis that $\gamma = 0$ is rejected in which case the time series is stationary. If computed absolute value of the tau statistic ($|\tau|$) does not exceed the critical tau value, the null hypothesis is not rejected, in which case time series is non stationary.

Unit Root Tests: Phillips-Perron Test (PP):

This is another test for unit root which was used in this study. According to Gujarat (2004) 'The ADF test adjust the DF test to take care of possible serial correlation in error terms by adding the lagged difference terms of the regress and. Phillips and Perron use non parametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms', Asteroid and Hall (2007).

Variance Ratio Test
There several version of variance ratio tests, however in testing for the randomness of stock return, the variance ratio test proposed by Lo and Mackinlay (1988) was employed. The variance ratio test proposed by Lo and Mackinlay (1988) is based on the property that the variance of its increment is linear in the sample interval that is if the return series follows the random walk process, then the variance of its q-differences would be q times the variance of its first difference which denoted as:

$$Var(P_t - P_{t-q}) = qVar(P_t - P_{t-1}) \tag{11}$$

Where: q is any positive integer.

Equation 11 shows how the variance ratio test can thus be estimated

$$VR(q) = \frac{\frac{1}{q}Var(P_t - P_{t-q})}{Var(P_t - P_{t-1})} = \frac{\sigma^2(q)}{\sigma^2(1)} \tag{12}$$

Where: $\sigma^2(q) = \frac{1}{q}$ the variance of the q-differences; $\sigma^2(1)$ = the variance of the first differences

Lo and Mackinlay (1988) developed the test statistics for both the null hypothesis of homoscedastic increments Z(q) and the heteroscedastic increments ($Z^*(q)$ of the random walk process given by the following equation:

$$Z(q) = \frac{VR(q)-1}{[\theta(q)]^{1/2}} \approx N(0,1) \tag{13}$$

Where:

$$\theta(q) = \frac{2(2q-1)(q-1)}{3q(nq)} \tag{14}$$

$$Z^*(q) = \frac{VR(q)-1}{[\theta^*(q)]^{1/2}} \approx N(0,1) \tag{15}$$

Where:θ^* = represent the asymptotic variance of the variance of the variance ratio under heteroscedasticity assumption; θ = represent the asymptotic variance of the variance of the variance ratio under homoscedasticity assumption

$$\theta^*(q) = \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q}\right]^2 \hat{\delta}(j) \tag{16}$$

Then,

$$\hat{\delta}(j) = \frac{\sum_{t=j+1}^{nq}(P_t - P_{t-1} - \hat{\mu})^2 (P_{t-j} - P_{t-j-1} - \mu)^2}{[\sum_{t=1}^{nq}(P_t - P_{t-1} - \hat{\mu})^2]^2} \tag{17}$$

Where:$\hat{\delta}(j)$ = heteroscedasticity consistent estimator; $\hat{\mu}$ = Average return; P_j = Average price of security at time t.

Based on the test statistic $Z^*(q)$and $Z(q)$, if variance ratio is greater than one, it will imply that the return series is positive correlated and it can be concluded that the return series are predictable and hence the heteroskedastic and homoskedastic random walk can be rejected and if the variance ratio is less than one it will suggests that the return is negative serial correlated and conditional variances respectively.

4. Empirical Results

4.1 *Test of goodness – of-fit: (The Kolmogorov-Smirnov – (K-S test)*

In order to examine the nature of the distribution of return series employed in this study, a test of goodness of fit –the Kolmogorov Smirnov test was used. The findings of this test are reported in Table 1.

Table.1: One-Sample Kolmogorov- Smirnov Test

		DSEI Daily
N		1546
Normal Parameters[a]	Mean	0.725744
Most Extreme Differences	Std. Deviation	0.446283
	Absolute	0.456
	Positive	0.269
	Negative	-0.456
Kolmogorov-Smirnov Z		17.942
Asymp. Sig. (2-tailed)		0.000

a. Test distribution is Normal.

The results from the test show that the P-value obtained is 0.000, which is below alpha and therefore the test is statistically significant at 1% , 5% as well as 10% levels. This imply that the null hypothesis of returns series follow a normal distribution as measured by Kolmogorov Smirnov test can be rejected in favour of alternative hypothesis which profess that 'return series do not follow normal distribution' and hence it can be concluded that the daily returns series do not follow normal distribution pattern.

The violation of normality assumption is not a strange phenomenon in weak form efficiency studies. Several studies rejected the normality hypothesis. For example,Chaity and Sharmin (2012),Ayyapan et al (2013) and Awais et al (2010).When the returns series are not normally distributed, the non-parametric statistical tests such as runs tests which do not require normal distribution, assumptions are more suitable to be used in the analysis rather than parametric tests, such as autocorrelation tests and unit root tests. Despite this fact, many studies in efficient hypotheses have employed both parametric and non - tests regardless of the rejection of normality assumption, this is due to the fact that under the large sample (i.e. n>30) the normality assumption can be relaxed. Following previous examples from other studies and based on this argument, this study also decided to use both parametric and non- parametric statistical tests.

4.2 Serial correlation Test – The Ljung-Box test

This was the first statistical test to be employed, the test examines if there is correlation of return series between time t and time t-1. The findings of the Ljung-Box test are presented in Table 2.

Table 2: The Ljung-Box test

LAG	AC	PAC	Q-Stat	Prob
1	-0.082	-0.082	10.335	0.001
2	0.052	0.045	14.5	0.001
3	0.026	0.034	15.555	0.001
4	0.030	0.032	16.919	0.002
5	-0.024	-0.022	17.792	0.003
6	0.011	0.003	17.971	0.006
7	0.024	0.025	18.848	0.009
8	0.031	0.035	20.305	0.009
9	0.021	0.025	20.964	0.013
10	-0.057	-0.06	25.989	0.004
11	-0.022	-0.038	26.764	0.005
12	0.018	0.017	27.258	0.007
13	-0.024	-0.014	28.153	0.009
14	-0.012	-0.012	28.384	0.013
15	0.037	0.033	30.506	0.010
16	-0.042	-0.039	33.283	0.007
17	-0.039	-0.045	35.619	0.005
18	0.052	0.054	39.908	0.002
19	-0.026	-0.009	40.928	0.002
20	0.042	0.039	43.761	0.002
21	-0.004	-0.001	43.783	0.002
22	0.016	0.009	44.18	0.003
23	0.013	0.016	44.433	0.005
24	-0.007	-0.009	44.516	0.007
25	0.018	0.024	45.052	0.008
26	0.046	0.045	48.356	0.005
27	0.020	0.013	48.974	0.006
28	-0.056	-0.057	54.000	0.002
29	-0.040	-0.058	56.518	0.002
30	0.025	0.018	57.481	0.002
31	-0.044	-0.025	60.484	0.001
32	0.014	0.014	60.778	0.002
33	0.016	0.013	61.159	0.002
34	-0.008	-0.01	61.259	0.003
35	-0.011	-0.01	61.454	0.004
36	0.045	0.057	64.729	0.002

The Ljung-Box was conducted under 36 lags. The results show that the P-values for all lags are below alpha (0.05) so as to say the test is statistically significant at 5% level. Therefore the null hypothesis of ‘all autocorrelation up to 36 lags are zero” is rejected in favour of alternative hypothesis. The results indicates that there is negative correlation for lag 1, 5, 10, 11, 13, 14, 16, 17, 19, 21, 24, 28, 29, 31, 34 and 35, while for the remaining lags return series are positively correlated. The correlation of the return in time t and time t-1 implies that the daily return series in DSE does not behave randomly as there is a degree of predictability for the future daily returns in DSE.

Based on the findings of the LjungBox , the null hypothesis of the study which says that 'The DSE is weak form inefficient market' is not rejected and therefore it can be concluded that Dar es salaam Stock Exchange is a weak-form inefficient market which implies daily stock returns does not incorporate instantaneously all historical information hence trading strategy such as technical analysis may be valuable in DSE taking into consideration of other factors. Similar findings have been reported in the recent study by Raquib and Alom(2015), studying weak form efficient in Dhaka Stock Exchange , using a sample size of 2924 daily observation of price indices for DSE general index (DGEN) covering period from 2001 to 2013. Employing serial correlation test, the study found that there was movements of autocorrelation at various lags, hence it was concluded that DSE was not weak-form efficiency market following the presence of serial correlation in the return series.

Also Alkhatib and Harsheh (2013), tested the weak form efficiency for Palestine Exchange (PEX), using serial correlation, unit root and runs test on sample of daily closing index returns of the seven indices in PEX for the period covering between Jan 1998 and October 2012. The findings from serial correlation test showed that at lag 1 the return of all seven indices employed in the study were serial correlated and therefore the market was regarded as weak-form inefficient market.

Investigating the random walk hypothesis prices in the Nairobi stock exchange and employing the serial correlation test and runs tests , Muthama and Mutothya (2013), found that the daily price returns for eighteen companies which constitute the Nairobi Stock Exchange (NSE 20) for the period covering July 2008 to June 2011 , did not behave in random fashion and hence the study concluded that the future return price could be predicted on basis of historical prices i.e NSE was weak-form inefficient market for the period investigated. These findings are similar to the findings of this study, however ,the findings contradicts the earlier results on the efficiency of Nairobi Stock Exchange reported by Dickson and Murugu (1994), Githiga (2008) and Anyumba (2010) as cited in Muthana and Mutothya (2013) which failed to find the empirical evidence against Weak form efficiency hypothesis.

4.3 Runs Test

This is a non-parametric test which was employed to examine whether the daily returns series behave randomly. The results for the runs test are shown in the Table 3.

Table 3: Runs test Result

	DSEI Return
Test Value[a]	1
Cases < Test Value	424
Cases >= Test Value	1122
Total Cases	1546
Number of Runs	577
Z	-2.520
Asymp. Sig. (2-tailed)	0.012

a. Median

As shown in the Table 3, the Z- statistic value is negative (-2.520), which indicates that observed runs/ actual runs are less than expected runs. This implies that there is positive serial correlation in daily return series (i.e the series does not behave in random fashion). Furthermore the P-value obtained (0.012) is less that 5% (alpha) , hence the test is statistically significant at 5% level and therefore the null hypothesis of 'series is random' as tested by runs test is rejected in favour of alternative hypothesis .Based on these findings the conclusion drawn from runs test is that the daily return series does not behave randomly hence DSE is a weak form inefficient market ,this conclusion is similar to the conclusion drawn by previous test (Serial correlation test).

Similar findings have been found by Ogege and Mojekwu (2013) investigating the random walk hypothesis in the Nigerian Stock Exchange using monthly price index from 1985 to 2010 and employing runs test and other statistical tests. The results from runs test showed that there was high degree of autocorrelation among the variables as the test was statistically significant at all levels (1%, 5%, 10%) and the null hypothesis of randomness of the return series was rejected hence the Nigerian Stock Exchange was said to be Weak-form inefficient market for the particular period studied.

Using runs test on daily closing values of S&P CNX indices and CNX NIFTY junior indices for the period covering Jan 2000 and March 2013, Kumar and Singh (2013) studied the weak-form efficiency on selected Indian stock indices (CNX NIFTY and S&P NIFTY) and found that the randomness hypothesis as tested by runs test was rejected and hence it was concluded that Indian Stock Market did not exhibit weak form of market efficiency.

Also Mollah (2006) tested the weak-form market efficiency in emerging market of Botswana Stock Exchange using daily returns series of BSE for the period between 1989 to 2005,. Employing non parametric runs test the results of the study depicted that the daily return series violated the random walk model and therefore the BSE was declared to be a weak-form inefficient market.

4.4 Unit root Tests

Although there are several unit root tests, the study employed only two types of unit root tests: namely Augmented Dickey-Fuller test and Phillip Perron Test. The following are the results obtained from these statistical tests.

4.4.1 Augumented Dickey-Fuller Test

The results of this test for both equations; intercept and trend & intercept are reported in Table 4 and Table 5 respectively.

Table. 4: Augmented Dickey Fuller Test: (Intercept)

Null Hypothesis:	DSEI_RETURNS has a unit root		
Exogenous:	Constant		
Lag length:	0 (Automatic - based on SIC, maxlag=23)		
		t-Statistic	**Prob***
Augmented Dickey - Fuller test statistic		-42.61300	0.0000
Test critical values:	1% level	-3.434376	
	5% level	-2.863205	
	10% level	-2.567705	

Table .5: Augmented Dickey Fuller Test results: (Trend & Intercept).

Null Hypothesis:	DSEI_RETURNS has a unit root		
Exogenous:	Constant, Linear Trend		
Lag length:	0 (Automatic - based on SIC, maxlag=23)		
		t-Statistic	**Prob***
Augmented Dickey - Fuller test statistic		-42.91231	0.0000
Test critical values:	1% level	-3.963995	
	5% level	-2.412721	
	10% level	-2.128334	

Using max lag of 23 based on Schwarz Information Criterion (SIC) ,the results show that the absolute value of t- Statistic for both intercept and intercept and trend are greater than the absolute value of Mackinnon critical tau value at 1%, 5%, and 10% level of significant respectively, hence the null hypothesis of presence of unit root in a return series is rejected. These results imply that the daily return series do not have a unit root (i.e the series is stationary) and therefore does not behave in random fashion. Although the presence of a unit root is not a sufficient condition for the random walk, it is a necessary condition, which implies that the series cannot behave randomly if it does not have a unit root. Based on these results, the null hypothesis of this study about the efficiency of DSE is not rejected therefore it can be concluded that DSE is a weak-form inefficient market.

Sania and Rizwan (2014) found similar results while testing weak form efficiency of capital markets, a case of Pakistan using daily data of KSE-100 index for two years from 2009 to 2010 and employed the Augmented Dickey Fuller tests as one of the statistical tests. They found that there was a positive correlation in KSE-100 index and therefore based on the results of ADF test, they concluded that the KSE was not behaving in random fashion and hence it was not a weak form efficient market.

Similarly, Shaker (2013) investigated the weak-form efficiency of Finnish and Swedish stock markets using a sample of daily OMX Helsinki index and OMX Stockholm index for the period of ten years. Using the Augmented Dickey Fuller test among other statistical tests, the findings of the study showed that the return series did not follow random walk for both Finnish and Swedish stock exchange hence the conclusion drawn was that both these markets were not a weak-form efficient markets.

4.4.1 The Phillips-Perron Test (PP)

In order to confirm the stationarity of the return series, the study also employed this test. Similar to the ADF test, the same null and alternative hypotheses were tested. The results for the PP test are shown in the Table 6 and Table 7.

Table 6: The PP test results: Intercept

Null Hypothesis:	DSEI_RETURNS has a unit root		
Exogenous:	Constant		
Bandwidth:	10 (Newey-West automatic) using Bartlett		
		Adj.t-Statistic	**Prob***
Phillips-Perron test statistic		-42.47733	0.0000
	1% level	-3.434376	
Test critical values:	5% level	-2.863205	
	10% level	-2.567705	

Table 7: The PP test results: Trend & Intercept

Null Hypothesis:	DSEI_RETURNS has a unit root		
Exogenous:	Constant		
2Bandwidth:	7 (Newey-West automatic) using Bartlett		
		Adj.t-Statistic	**Prob***
Phillips-Perron test statistic		-42.76451	0.0000
	1% level	-3.963998	
Test critical values:	5% level	-3.412723	
	10% level	-3.128335	

As Tables 6 and 7 shows, for both equations – intercept and trend & intercept, absolute values of test statistic are greater than Mackinnon critical value at all levels (i.e 1%, 5% and 10%), hence the null hypothesis tested by PP test is rejected and it is concluded that the daily return series is stationary (i.e does not behave randomly). A similar conclusion can be drawn using the P-values obtained.

The results of PP test confirm the earlier results obtained by ADF test; both have failed to reject the first null hypothesis of this study. Therefore once again it is concluded that DSE is not a weak-form efficient market. Srinivasan (2010) found similar results when investigating the weak-form efficiency hypothesis for Indian Stock markets using daily observations for two major indices (S&P CNX NIFTY and SENSEX) for the period from July 1997 to August 2010. Applying the unit roots test (Phillip Perron test and ADF), the findings of PP tests clearly revealed that the null hypothesis of unit root was rejected and therefore suggested that Indian Stock market did not follow random walk model. It was therefore not a weak-form efficient market.

Similarly, Abushammaala (2011) studied the weak-form efficiency of Palestine Exchange using daily prices of General index and Al-Qids index for the period covering Jan 2007 to December 2010. The findings from PP test showed that the return series of PEX did not behave randomly and therefore the market was a weak form inefficient market

4.5 Variance Ratio Test

To confirm the results of all previous statistical tests, regarding the empirical evidence of weak-form efficiency in DSE, the study also employed the more robust statistical test- Variance ratio test according to (Lo and Mackilay 1988). The results for this test under both assumptions; heteroskedasticity and homoskedasticity are presented in Table 8 and 9 respectively.

Table 8: Variance Ratio Test results - Heteroskedasticity assumption

Null Hypothesis:	DSEI_RETURNS is a martingale			
Included observations:	1545 (after adjustments)			
Heteroskedasticity estimates robust standard error estimates				
User-specified lags:	2 4 8 16			
Joint Tests		**Value**	**df**	**Probability**
Max|z| (at period 2)*		4.768365	1545	0.0000
Individual Tests				
Period	**Var.Ratio**	**Std.Error**	**z-Statistic**	**Probability**
2	0.438783	0.117696	-4.768365	0.0000
4	0.224973	0.182861	-4.238348	0.0000
8	0.112709	0.223627	-3.967720	0.0001
16	0.059993	0.258465	-3.636880	0.0003

*Probability approximation using studentized maximum modulus with parameter value 4 and infinite degrees of freedom.

Table 9: Variance Ratio Test results – Homoskedasticity assumption

Null Hypothesis:	DSEI_RETURNS is a random walk
Included observations:	1544 (after adjustments)
Standard error estimates assume no heteroskedasticity	
Use biased variance estimates	
User-specified lags:	2 4 8 16

Joint Tests	Value	df	Probability
Max |z| (at period 2)*	22.07445	1544	0.0000
Wald (Chi-square)	493.0789	4	0.0000

Individual Tests

Period	Var.Ratio	Std.Error	z-Statistic	Probability
2	0.438220	0.025449	-22.07445	0.0000
4	0.224091	0.047611	-16.29672	0.0000
8	0.111691	0.075280	-11.800050	0.0000
16	0.058834	0.112020	-8.401733	0.0000

*Probability approximation using studentized maximum modulus with parameter value 4 and infinite degrees of freedom.

The results of variance ratio test (Lo and Macklay 1988) under heteroskedasticity assumption as depicted in Table 8 , shows that the P-value for the joint test is below alpha (0.05) and therefore the test is statistically significant at 5% , which suggests the rejection of the null hypothesis (DSEI_RETURNS is a martingale) of the random walk in daily return series. Similarly, the individual test for all period (2,4,8,16) strongly reject the random walk null hypothesis as the P-values are below 5% level of significance.

Under homoskedasticity assumption (Table 9) the results show that the joint tests (i.e tests of joint null hypothesis for all periods) strongly reject the null hypothesis of a random walk with the P-value of 0.0000 which is obtained using the studentized maximum modulus with infinite degrees of freedom. Considering the individual tests (i.e test of individual period) for period 2,4,10 and 16 the P-value for all period (0.0000) are below alpha (0,05), this also rejects the null hypothesis for random walk under homoskedsticity assumption.

Based on the results of variance ratio test, it is concluded that the daily return series of DSE does not behave in random fashion and hence the null hypothesis of the study cannot be rejected and it is concluded that DSE is not a weak-form efficiency market. The same conclusion has been reached by various studies, for example Nisar and Hanif (2012) who examined the weak-form efficiency hypothesis on the four major stock exchanges of South Asia (India, Pakistan, Bangladesh and Sri Lanka). They used monthly, weekly and daily historical index covering a period of 14 years and applying four statistical tests which include the Variance ratio test. The results of variance ratio test (Lo and Mackilay 1988) done under both homosdedasticity and heteroskedsticity revealed that none of the four major stock markets of South Asia followed random walk and hence the markets were declared weak form inefficient for the particular period.

Besides, Haque et al(2011) investigated the weak form efficiency of Pakistan stock market using weekly return of KSE-100 index over the period between 2000 and 2010. The study used various statistical tests including the variance ratio tests (Lo and Mckanlay 1988). The results of variance ratio test under homoskedasticity and heteroskedasticity assumptions showed that the test was significant at 1% level which clearly rejected the random walk hypothesis and therefore concluded that the Pakistan stock market was not weak-form efficient market for the period between 2000 and 2010.

The findings of all four statistical tests (Serial correlation test, Runs test, Unit root test and Variance ratio tests) employed in this study are consistent , both have revealed that the daily return series of DSEI do not behave randomly and hence based on these findings the null hypothesis of this study which states that 'The Dar es salaam Stock Exchange (DSE) is a weak form inefficient market" cannot be rejected, and therefore it is concluded that DSE is not a weak form efficient market.

5. Conclusion

The purpose of this study was to determine the empirical evidence for Efficiency Market Hypotheses and calendar effects. Specifically the study aimed at achieving the following three specifics objects; to determine the empirical evidence for the weak-form efficiency, secondly to determine the empirical evidence for the day of the week effect and lastly to determine the empirical evidence for month of the year effect. To achieve the first objective of the study, four different statistical tests were employed (serial correlation test-the Ljung –Box test, Unit root tests, runs test and variance ratio test). The results from all four statistical tests are consistent, all have rejected the random walk of daily returns series index hence the first null hypothesis of the study which states that 'Dar es salaam stock exchange is weak form inefficiency market' could not be rejected. The conclusion drawn based of the results obtained from these four statistical tests was that Dar es Salaam stock exchange is a weak form inefficiency market.

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