STOCK MARKET EFFICIENCY IN FRONTIER CAPITAL MARKETS: TESTING WEAK FORM EFFICIENCY OF THE DAR ES SALAAM STOCK EXCHANGE

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENTS FOR MASTER OF BUSINESS ADMINISTRATION DEGREE OF THE OPEN UNIVERSITY OF TANZANIA

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CERTIFICATION

I The undersigned certifies that has read and hereby recommends for acceptance by the Open University of Tanzania the dissertation entitled ***"Stock market efficiency in Frontier Capital Markets: Testing Weak form Efficiency of the Dar es Salaam Stock Exchange"*** in partial fulfilment of the requirements for the Requirements for Master of Business Administration Degree of the Open University of Tanzania.

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Dr. Proches Ngatuni

Supervisor

……

Date

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DECLARATION

I, **January R. L. Kayumbe**, do hereby declare that this dissertation is my own original work and that it has not been submitted for a similar degree in any other University.

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Date

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ABSTRACT

The purpose of the study was to test the weak-form efficiency of the Dar es Salaam Stock Exchange (DSE). Data used include the daily stock prices of four of the indices of the Exchange for the period from December 2006 to December 2012 and 2015 for one of the indices. The four indices are Dar es Salaam Stock Exchange Index (DSEI) which covers both domestic and foreign companies, Tanzania Share Index (TSI) which excludes foreign companies, Industry and Allies Index (IA) and Banking and Insurance Index (BI). Autocorrelation and Runs tests were used to achieve the study objective. The study finds evidence of significant autocorrelation in the share return series at different lags. Similarly, the findings from runs tests revealed that share returns series do not follow random walk theory. Thus, both tests reject the null hypothesis of weak-form market efficiency. This implies that knowledgeable market participants might be able to design trading rules based on the past data and be able to achieve superior returns. It is hereby recommended that the DSE needs to improve on a number of fronts including creating appetite for public and private companies to list, increase liquidity, improve on information flows which is timely released and observe accuracy, extended use of ICT and accommodation of more products. Wider information sharing with investing public need not be overemphasised.

Keywords: Frontier markets, *Dar es Salaam Stock Exchange, efficient market hypothesis, random walk hypothesis, Autocorrelation test, Runs test*

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LIST OF ABBREVIATIONS AND ACCRONYMS

AGM	Annual General Meeting
ARA	Annual Reports and Accounts
ASEA	African Securities Exchange Association
BI	Banking and Insurance Index
CMSA	Capital Markets and Securities Authority
CRDB	CRDB Bank Plc
CSI	Commercial and Services Index
CDS	Central Depository System
DCB	Dar es Salaam Commercial Bank
DSE	Dar es Salaam Stock Exchange
DSEI	Dar es Salaam Stock Exchange Index
EABL	East African Breweries Ltd
EGM	Enterprise Growth Market
EMH	Efficient Market Hypothesis
FSI	Foreign Share Index
IA	Industrial and Allied Index
IID	Independent and Identically Distributed
JHL	Jubilee Holdings Ltd
KA	Kenya Airways
KCB	Kenya Commercial Bank
LDM	Licensed Dealing Member
LSE	London Stock Exchange
MSCI	Morgan Stanley Capital International

NICOL	National Investment Company Ltd
NMB	National Microfinance Bank
NMG	National Media Group
NSE	Nairobi Securities Exchange
PAL	Precision Air Limited
RWH	Random Walk Hypothesis
SIMBA	Tanga Cement Company Ltd
SME	Small and Medium Enterprise
SSA	Sub-Saharan Africa
SWISSPORT	SWISSPORT Tanzania Ltd
WAN	Wide Area Network
TATEPA	Tanzania Tea Packers
TBL	Tanzania Breweries Ltd
TCC	Tanzania Cigarette Company Ltd
TOL	TOL Gases Ltd
TSI	Tanzania Share Index

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Stock markets are public markets for the trading of companies' stocks at prices determined by market forces. Prior to trading, the stocks have to be listed and traded on stock exchanges. There are two types of stock markets and each plays a role related to trading. These types are the primary and the secondary markets. The primary market's role is to facilitate movement of capital from savers to companies and investors for investment (Parkinson & Waweru, 2008). The primary market activities will often put together the resources of small individual savers into sufficiently large capital sums that can be successfully invested by commercial firms on various assets or projects. The secondary market's role, is to facilitate stock trading transactions between willing sellers and buyers through which fair market prices for the existing stocks are established. As a result, this secondary role of stocks/share pricing enable (primary market) new share issues to be priced at, or close to, fair market prices, thus resulting into a fair game between issuers and buyers of those new shares. The roles of both markets are therefore interdependent.

When trading is fair and that all market participants have access to same information, then there is no possibility of some individuals in the market to gain excess returns. A market which fully and correctly reflects all relevant available information in determining stock prices is called efficient market (Fama, 1970). There are three areas of efficiency, that is, allocational, operational and informational efficiencies. Allocational efficiency basically refers to how best scarce resources are allocated to the most productive sector of the economy. Operational efficiency is about the cost of buyers and sellers of stocks on the exchange market. Informational efficiency is about the extent to which available

information is accurately and instanteneously reflected into the stock prices, and this is what the term “Efficient Market Hypothesis (EMH)” implies. The EMH is normally defined and tested in three forms as: Weak-form Efficiency in which the information set includes only the history of prices or returns; Semi-strong form Efficiency where the information set includes past and publicly available information; and Strong-form Efficiency where the information set includes past, public and private information.

Developed stock markets such as USA, United Kingdom, Germany, Japan and other developed economies are always believed to be efficient (Dickinson & Muragu, 1994). According to Morgan Stanley Capital International (MSCI, 2015), there are 23 recognised Developed Markets (DM), 23 Emerging Markets (EM) and 33 Frontier Markets (FM). The 23 developed market country indices included: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, News Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Emerging markets is a term introduced by International Finance Corporation (IFC) in 1980 referring to developing countries with stock markets that were beginning to demonstrate the features of the mature stock markets in the developed markets (Nellor, 2008). The 23 emerging market country indices are: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungry, India, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Qatar, Russia, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates. The term “Frontier markets” was first introduced into the financial language in 1996 when the International Finance Cooperation (IFC) of the World Bank used the phrase to describe a composite of 14 small equity markets (Christopher, 2015). Speidell (2012) makes reference to the definition by MSCI that a frontier market is any country in the world with

a stock market that is not in the MSCI Emerging Markets Index and include countries with capital markets that are functioning but not at the same or close to the level of developed or emerging markets. Chan-Lau (2011) also proposes that, frontier markets are equity markets in developing countries which are smaller in size, less liquid and with more investment restrictions than the typical emerging markets. However, despite of the constraints they are still regarded as investable from the perspective of foreign investors. They offer prospects of higher returns especially as economic growth accelerates on increased capital and infrastructure development.

These countries are from the Caribbean, Europe/Asia and Africa. From Caribbean the countries are Argentine, Belize, Bolivia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Paraguay and Uruguay. From Europe/Asia countries are Armenia, Azerbaijan, Bangladesh, Belarus, Georgia, Iraq, Jordan, Lebanon, Mongolia, Fiji, Pakistan, Serbia, Sri Lanka and Vietnam. From Africa countries are Angola, Congo, Cote D'Ivoire, Ethiopia, Gabon, Ghana, Kenya, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Seychelles, Tanzania, Tunisia, Uganda and Zambia.

According to Ntim, Opong, Danbolt & Dewotor (2011) there is observation that, although there are few countries on the Africa's frontier markets list, it is quite evident that in a relatively short time, Africa appears to have developed impressive stock market sector. With only five (5) stock markets South of Sahara and three (3) in the North by 1980, the number of African markets increased significantly to 26 by the end of 2007. These include: (i) South Africa which is the most advanced as well as the oldest stock market; (ii) a group of medium sized markets including Egypt, Kenya, Nigeria, Morocco, Tunisia and Zimbabwe which have been in existence for relatively longer time; (iii) a group of small but rapidly growing markets including Botswana, Cote D'Ivoire, Ghana, Namibia and

Mauritius; (iv) a group of new markets including Tanzania, Malawi, Mozambique, Sudan, Swaziland, Uganda and Zambia and lastly (v) a group of six markets namely Angola, Algeria, Cameroon, Gabon, Cape Verde, and Rwanda. Despite having been in existence for relatively longer time like Algeria (1993), Cameroon (2001), Gabon (2001), Cape Verde (2005), are not widely known. Some are simply too young e.g. Angola (September, 2007) and Rwanda (January, 2008).

Most of these markets are members of African Securities Exchanges Association (ASEA). According to ASEA Yearbook (2015) country members are Botswana Stock Exchange, Bolsa De Valores De Cabo Verde, Bourse Regionale Des Valeurs Mobilieres, Bourse De Tunis, Casablanca Stock Exchange, Dar es Salaam Stock Exchange, Douala Stock Exchange, Egyptian Stock Exchange, Ghana Stock Exchange, Johannesburg Stock Exchange, Khartoom Stock Exchange, Libya Stock Exchange, Lusaka Stock Exchange, Malawi Stock Exchange, Mozambique Stock Exchange, Nairobi Securities Exchange, Nigerian Stock Exchange, Rwanda Stock Exchange, Stock Exchange of Mauritius, Tunis Stock Exchange, Namibian Stock Exchange, Uganda Securities Exchange and Zimbabwe Stock Exchange. Despite experiencing rapid growth in their number and size, existing evidence suggests that African stock markets remain in the group of Frontier Markets and some of them highly fragmented, small, illiquid, and technologically weak, severely affecting their informational efficiency (Ntim, 2012).

1.2 The Dar es Salaam Stock Exchange

According to the definition coined down by IFC in 1996, the Dar es Salaam Stock Exchange (DSE) is among documented frontier markets (International and Emerging Markets, 2014). The DSE was establishment in 1996 following the establishment of Capital Market Securities Authority (CMSA) in 1994. Although the DSE was incorporated in 1996, trading could not start until 15th April, 1998 and the first company on the list was

TOL Limited (Ziorklui et al, 2001). Listing of other companies both local and cross listed firms continued and by May 2016 there were 23 listed companies of which sixteen (16) are local companies and seven (7) cross listed companies. The vision of the exchange is to be the engine of economic growth for Tanzania and the mission is to be responsive securities exchange that promotes economic empowerment and contributes to the country's economic development through offering a range of attractive and cost-effective products and services (DSE Annual report and financial statements, 2014). The DSE functions, market segments, trading system, lifting of Cap on Institutional and Foreign Investors, and market indices are also discussed.

1.2.1 DSE Functions

The DSE performs seven major functions. These are (i) provision of enabling environment for those wishing to join or exit the market to do so efficiently, and in doing so, it ensures liquidity in the secondary market; (ii) facilitation of price discovery whereby the concepts of demand and supply together with an efficient information processing mechanism takes place and ensure that buyers and sellers of securities transact at fair prices; (iii) facilitation of transparency mostly through disclosure requirement put in place by the DSE in which listed companies are required to promptly disclose all price sensitive information. This helps investors to make informed decisions; (iv) facilitation of government's implementation of privatisation policy through which some of the shares it owns in parastatal organisations could be sold to the public through DSE; (v) facilitate raising of capital by firms through issuing of new securities at the price which lower the cost of capital and improve their chances of increasing operating profits; (vi) creation of wealth through investing in listed securities. It has been proved that shares offer investors the real return because shares out-perform inflation on average and have done so consistently since share markets came into existence (DSE Handbook, 2015). Shares listed at DSE have

performed well above the inflation rate when compared with bank deposits. Bank deposits do not increase in size during difficult times, but shares do increase in value overtime; (vii) to contribute to the cultural transformation of Tanzanians through provision of knowledge revolution geared towards educating Tanzanians on issues related to stock market operations (DSE Handbook, 2015). These functions are meant to ensure smooth operation of the exchange and informing fiscal issuers and investors of the opportunities available for making profit in an efficient market environment.

1.2.2 Market Segments

The market is divided into two market segments known as Main Investment Market Segment (MIMS) and Enterprise Growth Market (EGM) Segment. MIMS is a more formalized segment with more stringent, less accessible and relatively less risky market segment aimed at larger, more established enterprises. In November 2013, the DSE launched its 2nd tier market segment known as Enterprise Growth Market (EGM). The new market segment is an opportunity for Small and Medium Enterprises (SMEs) to raise long-term capital through the exchange (DSE Annual report & Financial Statement, 2014). This is a market segment with less stringent issuance and listing rules of the existing equities, more easily accessible, and therefore riskier segment aimed at start-ups and SMEs. Consequently, EGM is the market segment on which young organizations can grow and mature until they are ready for MIMS listing. With MIMS and EGM, the equities market is thus two tiered (DSE Handbook, 2011, DSE Ltd Annual report & financial statement, 2014).

1.2.3 Trading System

The Automated Trading System (ATS) was introduced in December 2006 aiming to enhance efficiency in the price discovery process and liquidity of the market. This is an automatic system which matches bids and offers using an electronic matching engine. The

Licensed Dealing Members (LDMs) from their respective offices post their orders into the ATS. With the system transmission is supposed to be almost real time and trading information relating to index movements, price and volume movements of traded securities is released on a timely basis. The DSE trade daily from Monday to Friday and the time is from 10.00 am to 03.00 pm per trading day.

1.2.4 De-regulation of Cap on Institutional and Foreign Investors

For many years, foreign investors avoided buying Tanzania's publicly listed securities due to restrictive laws and low liquidity at the Dar es Salaam Stock Exchange (DSE). In September 2014, the government relaxed trading rules for foreign investors allowing them to invest in more than 60 percent of shares in a locally listed firm. The removal of the cap has seen foreign investors account for over 60 percent of daily trading at the DSE. By then, the thinking was for the DSE to have a Derivatives and Real Estate Investment Trusts (REITs) trading platform. Then introduction of more products in the market was also being considered (DSE Annual Report, 2014).

1.2.5 Market Indices

An index is a statistical measurement of the performance of a particular group of securities, using a clearly defined set of rules that makes them comparable regardless of the market conditions. It measures the movement of securities prices on hourly, daily, weekly, monthly, quarterly and yearly basis as desired (DSE Handbook, 2011). DSE Index is grouped into different sectors to enable measuring what happens to respective sectors. They are: All Share Index (DSEI), Tanzania Share Index (TSI), Industrial and Allied Share Index (IA), Banking and Insurance Share Index (BI), Commercial and Services Share Index (CS) and Foreign Share Index (FSI) (DSE Handbook, 2015). Description of each index and companies involved are detailed in Appendix 1. The list of companies under

each index date of listing, number of shares issued at listing and nature of business is as shown in Appendix 2.

1.2.6 Market Indicators

Market indicators are statistical values showing market worthiness and status at any particular time of reference. For this study selected indictors are covering total turnover, volume of shares, deals, market capitalization, exchange rates and main four indices. Appendix 3 presents selected market indicators.

1.3 Statement of the Research Problem

Efficient Markets play a key role of attracting private and public companies, institutions and individuals to participate in the market for the purpose of raising capital for investment and wealth creation. In an efficient market it is believed that all the information is quickly and efficiently incorporated in security prices, thus, no one can boast to be intelligent enough to beat the market. In order to determine whether a certain market is efficient or not, empirical tests have to be undertaken or conducted. Existing literature is confirming that such tests have been conducted worldwide including African stock exchanges. While tests in the developed economies have indicated the stock markets to be efficient, those in frontier and emerging markets including African markets in general have generated mixed results. While some conform to the Efficient Market Hypothesis (EMH) the majority do not. Ntim (2012) argues that African Stock Markets remain highly fragmented, small, illiquid and technologically weak despite experiencing rapid growth in their number and size. The research problem is related to testing the efficiency at least in the weak-form of the DSE which started trading in 1998 but up to June 2016 there were only 23 listed companies. Low listing could be one of the reasons influencing the efficiency of the exchange. Information flow and processing is also an important factor in determining the

efficiency. How efficiently information is incorporated in the prices of securities addressing the issues of independency and random walk theory. This motivated the study to establish if the DSE is efficient at least in the weak-form.

1.4 Research Objectives

1.4.1 General Objective

The main objective of the study was to assess whether the Dar es Salaam Stock Exchange is weak-form market efficient.

1.4.2 Specific Objectives

Specifically, the study is designed to:

(i) Test the independence of daily stock returns in the DSE,

(ii) Examine whether changes in the daily stock returns traded on the DSE as per Random Walk Hypothesis (RWH).

1.5 Relevance of the Research

Tanzania is amongst frontier and emerging economies striving to achieve economic growth through among other things undertaking investment in development programmes and projects in partnerships with local and foreign companies at the same time ensuring that individuals and communities are taking part in this development process. The Tanzania Development Vision (TDV) 2025 is envisaging to become a middle income country by that time. One of the drivers to the targeted achievements is through participating in the capital market through which capital for targeted investments can be raised and also providing ground for buyers and sellers of shares to trade. For business to flourish, fair play should prevail and participants realise the value in the process. The assumption is that in stock markets, fair play can be observed if markets are efficient. Thus, this study has analysed the efficiency of the DSE at least in the weak form. Additionally, the study is

contributing to the development of the increasing empirical literature on market efficiency focusing on African Stock Markets (ASMs). Furthermore, the study adds to the debate as to whether frontier and emerging Africa Stock Markets are efficient at least in the weak-form. More importantly, through this study, tremendous knowledge, skills and experience on market efficiency have been gained and is up for sharing with all stakeholders who have interest in markets performance.

1.6 Significance of the Study

The study adds up to the information and knowledge on the performance of frontier African stock markets and create enthusiasm or a new chapter for other researchers, academicians and students in related subjects to undertake further studies in the area of frontier markets. The study is open for use as the reference material for students and others wishing to undertake research in this area of study. The study also contributes to the empirical studies available to-date, more so on the efficiency of the only stock exchange in Tanzania i.e. the Dar es Salaam Stock Exchange in an effort to cover the existing gap of lack of enough literature and empirical studies for the African Stock Markets. Furthermore, the findings of this study are expected to add knowledge and contribute to the understanding of policy makers, business community and development agencies who have stake in the Dar es Salaam Stock Exchange.

1.7 Organization of the Dissertation

The rest of the dissertation is organised as follows: Chapter 2 provides comprehensive literature review covering theoretical and empirical findings by other researchers. Chapter 3 covers data and research methodology used as well as the hypothesis. Chapter 4 presents and discusses the key findings and Chapter 5 is conclusion and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

This chapter presents a review of related literature. Section 2.2 defines the Efficient Market Hypothesis (EMH). Section 2.3 presents theoretical literature review, while section 2.4 presents a review of related empirical literature. Section 2.5 presents the research gap and section 2.6 is conceptual framework and hypotheses.

2.2 The Efficient Market Hypothesis

According to Fama (1970), an efficient market is defined as a market where there are large numbers of participants moved by profit maximization actively competing, with each other trying to predict future market values of individual securities, and where important current information is almost freely available to all participants. In an efficient market competition among the many knowledgeable participants leads into a situation where, at any point in time actual prices of individual securities already reflect the effects of information based both on events that already occurred and on events which as of now the market expects to take place.

In the case of inefficient markets, some stocks are overpriced and others underpriced, providing chances for knowledgeable individuals to make excess returns while others making losses than warranted by their level of risk exposure. The Efficient Market Hypothesis (EMH) is tested for efficiency in three different forms which are: weak-form, semi-strong form and Strong form efficiency.

2.2.1 The Weak Form

It states that the current stock prices already reflect all historical market data such as the information on past market data including past stock prices, stock volumes, days of the week, etc. A typical weak-form test will be to check for any serial correlation between share prices in a series. The absence of serial correlation implies that the share prices are performing a random walk, thus efficient in the weak-form.

2.2.2 The Semi-strong Form

The form of efficiency states that, in addition to the past prices, all publicly available information including fundamental data on the firm's product line, earnings forecasts, dividends, stock split announcements, quality of management, balance sheet composition, accounting practices, patents held, mergers announcements etc. form part of semi-strong form of efficiency, and would have been incorporated into security prices. Thus, acting on information just made available to the public e.g. dividend or earnings announcements gives no edge in beating the market.

2.2.3 The Strong Form

The form of efficiency states that market prices reflect all information including past prices, publicly available information and all private information. In such a market, prices will always be fair and any investor, even insider traders, cannot beat the market. Since it is not possible, by definition, to know all the private information, the strong form is rarely tested. This is partly because private information is held by individuals, mainly institutional investors such as pension funds who incur significant expenses to generate this information for their own profit and other strategic goals, making public's access to it by analysts and other researchers virtually challenging.

2.3 The Theories or Models of Efficient Markets

Fama (1970) describes theories of Efficient Market hypothesis (EMH) in the form of Expected return or fair Game model, Martingale model, Sub-martingale models and Random walk model in respect to relevant information.

2.3.1 Expected Return or "Fair Game" Models

According to Fama (1970), a market is regarded as efficient in respect to a particular set of information if investors using that information are faced with a fair game; that is, they receive on average the return expected for the risk undertaken and make no consistent abnormal returns. This concept can be expressed in the following way:

$$E(\acute{P}_{j,t} + 1| \varnothing_t) = [1 + E(\acute{r}_{j,t} + 1| \varnothing_t)]P_{jt} \qquad (1)$$

where: E is the expected value operator;

P_{jt} is the price of security j at time t;

$\acute{P}_{j,t} + 1$ is its price at time t+1 (with reinvestment of any intermediate cash income from the security);

$r_{j,t} + 1$ is the one period percentage return $(\acute{P}_{j,t} + 1 – P_{jt})/\varnothing_t$;

$\varnothing_t$ is a general expression for whatever set of information assumed to be "fully reflected" in the price of security at t;

$E(\acute{P}_{j,t} + 1| \varnothing_t)$ is the value of equilibrium expected return projected on the basis of the information $\varnothing_t$ determined from the particular return theory at hand;

$E(\acute{r}_{j,t} + 1| \varnothing_t)$ is further expressed as the value of the equilibrium expected return projected on the basis of information $\varnothing_t$ determined from the particular expected return theory at hand.

The conditional expectation of (1) is meant to imply, however, that whatever return model is assumed to apply, the information $Ø_t$ is fully utilised in determining equilibrium returns. This is the basis in which $Ø_t$ is fully utilised in the formation of price P_{jt}.

The assumptions that the conditions of the market equilibrium can be stated in terms of expected returns which are formed on the basis of (and thus "fully reflect") the information set Øt have a major empirical implication, because they rule out the possibility of trading systems based only on information in Øt that have expected profits or returns in excess of expectations. Thus let

Xj,t+1 be equal to Pj,t+1 – E(Pj,t+1|Øt) (2)

Then

$$E(\acute{X}_{j,t}+1|Øt) = 0 \quad (3)$$

which by definition says that the sequence {Xj,t} is a "fair game" with respect to the information sequence {Øt}, or equivalently let

$$Z_{j,t}+1 = Zj,t+1 - E(\acute{r}_{j,t} + 1| Øt), \quad (4)$$

Then

$$E(\acute{Z}_{j,t} + 1| Øt) = 0 \quad (5)$$

so that the sequence {Zj,t} is also a "fair game" with respect to the information sequence Øt.

The fair game for an investor is an outcome of a market being efficient. If a market is efficient then the results of investing is a fair game. This fair game concept is useful as it allows for the different levels of EMH to be tested.

2.3.2 The Martingale

Making reference to Fama (1970), LeRoy (1989) proposes that "a stochastic process $\boldsymbol{X_t}$ is a martingale with respect to information set $\boldsymbol{Ø_t}$, if $\boldsymbol{X_t}$ has the property $\mathbf{E}(\boldsymbol{X_{t+1}} \mid \mathbf{Øt}) = \boldsymbol{X_t}$,

where: $\boldsymbol{X_t}$ = stock price at time t and $\mathbf{E}(\boldsymbol{X_{t+1}} \mid \mathbf{Øt})$ = Conditional expectation.

Martingale which is also a fair game implies that next day's price as projected on the basis of information **Øt** is expected to be equal to today's price. In other words, martingales hypothesis / model means the expected return is zero.

2.3.3 The Sub-martingale Model

A sub martingale is a kind of stochastic process one in which the expected value of next period's value as projected on the basis of the current period's information, is greater than or equal to the current period's value.

Making reference to expression (1) above that for t and Øt,

$\mathbf{E(\acute{P}j,t+1 \mid Øt)} \geq$ Pjt, or equivalently, $\mathbf{E(\acute{r}j,t+1 \mid Øt) \geq 0}$ (6)

Expression six (6) suggests that the price sequence {Pjt} for security j follows a sub-martingale with respect to the information sequence {Øt}, which means that the expected value of next period's price, as projected on the basis of information Øt is equal to or greater than the current price. If expression (6) holds as an equality (so that expected price changes and returns are zero), then the price sequence follows a martingale.

2.3.4 Random Walk Model

The Random Walk (RW) model or theory is regarded as extension of fair game model. Unlike the Chartists theories and the theory of fundamental analysis that history tend to repeat itself, the random walk theory suggests that price changes have no definitive pattern or trends which can be used to manipulate the system and earn abnormal profits. A study

by Kendall (1953), on 22 United Kingdom stock and commodity price series came up with a ground breaking discovery as he could not identify predictable patterns in the stock prices. Prices seemed to evolve randomly. He observed that prices were likely to go up as they were to go down on a particular day, regardless of past performance. The data provided no way of predicting price movements. At first, Kendall's findings were disturbing to some financial economists. They seemed to imply that the stock market is dominated by erratic market phycologists or demons that it follows no logical rules. Following these findings, economists at first twisted interpretations and concluded that the findings reflected the irrationality of the market, but later came to agree with Kendall's study and it soon became apparent that random price movements indicated a well-functioning or efficient market.

Fama (1965), when describing the random walk theory in relation to market efficiencies said that in an efficient market security price movement will occur randomly i.e. will not follow any patterns or trends. The grip behind the random walk idea is that price changes in the market occur only in response to arrival of genuinely new information. Since new information is unpredictable, the resulting price changes must be unpredictable and random.

The random walk model can be expressed as follows:

$E(r_{j,t+1} | Øt) = E(r_{j,t+1})$, which is basically concluding that the entire distribution is independent of the information **Øt.**

2.3.5 Thin Trading

Thin trading is a situation associated with little trading activity in the market because of lack of buy or sell orders to drive up the volume. Frontier as well as emerging markets in the early stages of their development are typically characterised by thin trading (Harrison

& Moore, 2012). They are also characterised by low levels of liquidity and in some cases less informed investors with limited access to information which is sometimes less reliable. Thin trading which is synonymous to infrequent trading is mostly observed in two forms namely, non-synchronous and non-trading. Non-synchronous trading occurs when the stocks are not necessarily traded at the close of each interval despite the fact that the stock trade every consecutive interval. Non-trading occurs when the stocks do not trade on each consecutive interval.

According to Rayhorn et al. (2007) thin trading is likely to induce biases to the moments of return series due to irregular recording intervals, which give rise to false autocorrelation. Therefore, it is important to take into account thin trading effects when testing for weak-form efficiency in the emerging markets. There are also suggestions that thin trading could be minimised by using index instead of individual stocks (Al-Ahmad, 2012) and more so if weekly or monthly indices are used. This study, however, used daily price indices without adjustment for thin trading.

2.4 Empirical Literature Review

The concept of Market Hypothesis (EMH) dates back in the 1900^{s} where quite a number of mathematicians, economists and scientists were involved (Sewell, 2011). It was the U.S. economist Eugene Fama who contributed most and whose works provided deep understanding of the market efficiency. In subsequent works, Fama (1970), defines an efficient market as the one in which prices always “fully reflect” all available information. In efficient markets, information hunt or gathering and information trading is not profitable because all available information is quickly and instantaneously incorporated in the security prices. This situation leave investors with no incentive to spend time gathering and

analysing information, because they will realise that market prices are an unbiased estimate of the security' intrinsic value (Fama, 1970).

2.4.1 Evidence from Developed Markets

Empirical tests for market efficiency were conducted by different researchers in different times in the developed markets. Kendall (1953), published a ground-breaking empirical study of weekly changes in nineteen (19) indices of British industrial share prices and in spot prices for New York cotton and Chicago wheat. His goal was to take forward the field of technical analysis by introducing statistical accuracy. He was surprised to find that the random component of prices was not connecting to any autocorrelations. Frustrated he concluded that "*the series looks like a wondering one, almost as if once a week the Demon of chance drew a random number from a symmetrical population of fixed dispersion and added it to the current price to determine the next week's price"*. In conclusion Kendall said that past prices data could not be used to predict future prices effectively, rejecting the practice of technical analysis.

Fama (1965) empirically tested 30 stocks listed on the Dow Jones Industrial Average (DJIA) from 1956 to 1962. The findings suggested small positive correlation which was statistically not different from zero and from the run tests, findings were that the number of runs was less than expected. Fama concluded that the DJIA was efficient in the weak-form. However, there are certain empirical tests which indicated different results. Worthington & Higgs (2003) tested for random walks of sixteen (16) developed markets (Australia, Denmark, Belgium, France, Finland, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and Switzerland) and four (4) emerging markets (Czech Republic, Hungary, Poland and Russia). Of the emerging markets only Hungary was found to be efficient and of the developed markets Germany,

Ireland, Portugal, Sweden and United Kingdom were found to be efficient. These results were obtained by employing established parametric and non-parametric testing methods. However, when Lo & Mackinlay (1988) examined US indices using variance ratio tests they found that Random Walk Hypothesis is strongly rejected. Despite of the few incidences of inefficiencies, generally stock markets in developed economies are at least weak-form efficient. Debate is however, on the semi-strong form efficiency in developed markets.

2.4.1.1 Evidence from Emerging Stock Markets Outside Africa

Review of literature from Asian and Middle East Countries which are in the group of new and emerging markets show that most empirical results obtained by using Runs and Serial Correlation tests reject the weak-form efficiency of most markets. Sampled tests include those by Mustafa & Nishat (2007) for Karachi Stock Exchange, Moustafa (2004) testing market efficiency of the United Arab Emirates (UAE) in the period from 2001 to 2003, Patel, Radadia & Dhawan (2012) for India and China markets. Other studies include those by Mobarek & Keasey (2000) who examined the Dhaka Stock exchange; Abraham, Sayyed & Alsakran (2002) for Gulf Stock Markets; Al-Jafari (2011) for Bahrain Securities Market; Al-Saleh & Ajmi (2012) for Saudi Stock Market; Nikita & Suerkano (2012) for Indonesia Stock Exchange.

Poshakwale (1996) tested weak-form efficiency of the Bombay Stock Exchange (BSE) in India using daily national data for the period January 1987 to October 1994. Test methods used were Runs and Serial Correlation. The results of the runs test rejected the hypothesis that the series is random. On the other hand, the evidence of presence of autocorrelation in the series suggested that there is serial dependence between the values. Therefore, the null hypothesis that there are no first order autocorrelation present in the series is rejected. Both tests proved that the Bombay Stock Exchange (BSE) was not weak-form efficient at least

in that period. Mobarek & Keasey (2000) examined the performance of Dhaka Stock Exchange (DSE). The study investigated the evidence of at least weak-form efficiency of the market. The sample included total 2,638 daily observations of the daily price indices for 10 years i.e. from 1988 to 1997. In addition, the study also considered the 30 randomly selected companies which were actively traded. The study used both non-parametric (run tests) and parametric test (autocorrelation test) among others. The transformation of daily share prices into daily returns was achieved by using a formula: $\mathbf{R_{(mt)} = Ln\ (PI_t / PI_{t-1})}$**.** The results provided evidence that the share return series didn't follow the RW Model and the significant autocorrelation coefficient at different lags rejected the null hypothesis of weak-form efficiency.

Abraham, Sayyed & Alsakran (2002) studied weak-form efficiency in three major Gulf stock markets including Kuwait, Saudi Arabia, and Bahrain using the runs and variance ratio tests for the period from October 1992 to December 1998. Their data consists of weekly index values for each of three Gulf stock markets. The results of both tests reject the random walk hypothesis in all markets. Taking into consideration of possible infrequent trading in all three markets, they applied a correction to the observed index by using decomposition of index returns and they failed to reject the random walk hypothesis for the Saudi Arabia and Bahrain markets, but not for the Kuwait market.

Moustafa (2004) examined the behaviour of stock prices in the United Arab Emirates (UAE) stock market using daily prices of 43 stocks included in the UAE market index for the period from 2nd October 2001 to 1st September 2003. When the tests were carried out using the runs tests, the results showed that the returns of 40 stocks out of the 43 were random at 5% level of significance. Although the UAE stock market is still young, small and suffering from infrequent trading, it was found to be weak-form efficient.

Mustafa & Nishat (2007) investigated the efficiency of the Karachi Stock Exchange (KSE) with corrections for thin trading and non-linearity using OLS. Daily, weekly and monthly data were used with three non-overlapping periods (December 1991 to May 1998; May 1998 to September 2001; and September 2001 to May 2003) and one combined period (May 1998 to May 2003). Returns were calculated by the difference of two successive log prices daily of KSE-100 Index:

$$R_t = lnP_t - lnP_{t-1}$$

where P_t is the current KSE-100 index and P_{t-1} is a previous day's KSE-100 index. In all periods and all sub-sample periods, the results indicate that the estimated coefficients were statistically significant. This indicates that the KSE was inefficient during the study period before adjustment for thin trading. It also implies that the KSE did not follow the random walk hypothesis. Furthermore, it shows that the effects of thin trading are an important factor in the efficiency of the Karachi Stock Market. However, results from the combined period (May 1998 – May 2003) supported the random walk hypothesis. A possible reason is that information on the stock market had become more easily available due to the internet, cable, television and newspapers.

Al-Jafari (2011) examined the RWH by testing the weak-form efficiency of Bahrain securities market. The study used daily observations of Bahrain all share index obtained from the monthly bulletin and reports found on the website of Bahrain Bourse. The data covered the period from 1st February 2003 to 30th November 2010. Daily returns were computed as $R_t = ln(P_t / P_{t-1})$, where R_t is a price of stock index at instant t. In order to examine the randomness and the behaviour of Bahrain stock market, parametric and non-parametric tests were employed. These include serial correlation test and the runs test. The results of the study suggest that Bahrain securities market does not follow random walk,

therefore inefficient in the weak-sense. Al-Ahmad (2012) examined the weak-form efficiency of the Damascus Securities Exchange (DSE), one of the most blossoming markets in the MENA region. The study used the daily returns of the DWX index from 31st December 2009 to 30th November 2011, in order to examine whether the returns on the DSE follow a random walk theory. Applying several tests of random walk including autocorrelation test, runs test, unit root test, variance ratio test, the results conclusively revealed that the DSE was not weak-form efficient.

Patel, Radadia & Dhawan (2012) investigated the weak-form market efficiency of Asian four selected stock markets [India – Bombay Stock Exchange SENSEX (BSE), Hong Kong-Hang Seng Index (HIS), Japan-Tokyo Stock Exchange NIKKEI (TSE), and China-Shanghai Stock Exchange (SSE)]. They took a daily closing price of stock markets under the study from 1st January 2000 to 31st March 2011 and also divided full sample in three interval periods, and applied Runs test, autocorrelation, and others including unit root test and variance ratio tests. BSE indicated highest mean returns to the investor followed by SSE Composite and HANGSENG. BSE could be considered as high risk markets as it reported the highest standard deviation. During the period, BSE Sensex, HANGSENG and SSE Composite markets showed positive average daily returns except NIKKEI.

The runs test indicated BSE Sensex and NIKKEI markets are weak-form inefficient whereas HANGSENG and SSE Composite are weak-form efficient. The study further says the time series for the full as well as sample period did not have a presence of unit root in the market under study. According to autocorrelation test it is inferred that the equity market of the Asia region under study remained inefficient for some lag whereas they were efficient for some lag. Nikita & Suekarno (2012) tested the weak-form market hypothesis of the Indonesia Stock Market. Daily closing price of IHSG and LQ45 composite index

between four years' period (2008 – 2011) were taken as samples. The two conventional ways: autocorrelation and runs tests were used to provide evidence on weak-form market efficiency. The conclusion was that during the period of four years from 2008 to 2011, the Indonesia Stock Exchange was inefficient in the weak form. Summary of compiled empirical studies on weak form efficiency on weak-form efficiency selected from markets outside Africa is provided as appendix 4.

2.4.1.2 Studies on the Weak-form of Efficiency from African Countries

In the past, little was known about the efficiencies of most Africa Stock Markets (Mlambo & Biekpe, 2007). In recent times, more empirical works have been undertaken. However, Mody (2004) puts it clear that most of these studies are highlighting that these markets are characterised by limited access to information, liquidity, poor governance, volatility and transaction costs. There are isolated cases where markets have been found to be efficient at least in the weak-form. Dickinson & Muragu (1994) studied the weekly stock price behavior of 30 listed most actively traded securities at the Nairobi Stock Exchange (NSE) for the period from 1979 to 1988 looking at correlation coefficients. Two statistical test methods namely serial correlation and runs tests were employed.

The overall serial correlation results for individual companies were evaluated using the two statistics: the autocorrelation coefficient (AC) for 30 lags and Q statistic. The results of correlation coefficients of successive weekly price returns at all lags were zero meaning that price returns are independent therefore no correlation. Another test by Runs test also indicated that price series of majority of companies are random. The results of both tests were consistent with those of independence. It was then concluded by authors that some small markets such as the NSE may provide empirical results consistent with weak-form efficiency. However, the results are not categorically saying that the market is weak form

efficient, but rather that the results are not contradicting the weak-form of the EMH. Simons & Laryea (2005) examined the weak-form efficiency of weekly equity market indices of Egypt, Ghana, Mauritius and South Africa from 1990 to 2003 employing autocorrelation, runs, and the multiple variance-ratios tests. The securities prices were converted to returns using the formula $\mathbf{R_t=ln(P_t/P_{t-1})}$, where: R_t = market return for period t; P_t = market index for period t; P_{t-1} = market index for period t-1 and ***ln*** = natural log. The log transformation is used to convert the data into continuously compounded rates. The results of the tests are consistent with previous evidence, were the notion of weak-form efficiency is rejected in all the analysed markets except South Africa.

Vitali & Mollah (2010) investigated the weak-form of market efficiency in Africa by testing the Random Walk Hypothesis (RWH) through multi-approach specifically auto-correlation, runs, unit root and variance ratio tests on the daily price indices of Egypt, Kenya, Mauritius, Morocco, Nigeria, South Africa and Tunisia over the period 1999-2009. From the daily closing prices of each index, the continuous compounded daily market returns were calculated using the formula: $\mathbf{R_t = ln(P_t) – ln(P_{t-1}) = ln(P_t/P_{t-1})}$ which is the same as the one used in other studies.

The empirical results reject the RWH for all stock markets indices over the whole sample period with the exception of South Africa over the second sub-period (2007 to 2009). Hence, only South Africa may be regarded as a weak-form efficient market. Rejection of the RWH in the African stock markets indicates that stock prices have patterns that can be used to beat the market. These markets should undergo technological and regulatory modernization in order to improve informational efficiency. Chiwira & Muyambiri (2012) evaluated the presence of Weak-Form efficiency of the Botswana Stock Exchange (BSE) for the period from January 2004 to December 2008 using a number of methods that

specifically assess the Random Walk Model. Test methods used include Runs test and Autocorrelation test among other methods. The study used All Company Index (ACI) which is a weighted average of the two indices called DCI and the FCI. The author says that the methodology was adopted because it mixes both parametric and nonparametric tests. All the tests were investigated on weekly and monthly data for the same period. All the tests show that the BSE is weak-form inefficient. Gimba (2010) tested the weak-form market efficiency in the Nigerian Stock Market. In order to achieve the objective, autocorrelation, runs and variance ratio tests were employed. The data used for this exercise primarily comprised daily and weekly observed returns of the market index and five individual stocks listed on the market. Then the data was adjusted for thin (infrequent) trading that could seriously bias the results of the empirical studies on market efficiency. Generally, all tests conclusively reject the hypothesis of the random walk for the market index and mixed results for one out of the five selected individual stocks.

Enowbi, Guidi, & Mlambo (2009) investigated the evidence supporting the presence of the weak form efficiency of some emerging African stock markets by using both parametric and nonparametric tests. Countries involved include Egypt, Morocco, Tunisia and South Africa for the period from January 2000 to March 2009. The test involved investigating the day of the week effects. Methods used include Autocorrelation test, Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, Kwiatkowski et al (1992) and Wrights test. The study examined the random walk hypothesis of those stock markets. With the exception of South Africa, all other markets were found not to follow the random walk and therefore not weak form efficient. Also results show existence of the day of the week effects, that is the typical negative Monday and positive Friday effects in the stock markets. Al-Jafari & Altaee (2011) investigated the random walk behaviour and efficiency of the Egyptian Equity market for the period from January 1998 to December 2010. This

was achieved through multi-approaches runs, employing unit root, and variance ratio tests on the daily price of EGX 30 index. The empirical results rejected the RWH at the weak-form level, indicating that stock prices do not fully reflect all historical information. Okpara (2010) investigated the weak form efficiency of the Nigerian Stock Market for the period between 1984 to 2006 using runs and autocorrelation tests. It was concluded that the Nigerian Stock Market is weak form efficient and therefore follows a random walk process. This implies that all information conveyed in past patterns of stock prices is impounded into the current price of the stock.

Mlambo & Biekpe (2007) studied 10 African countries stock markets. These are Egypt, Kenya, Botswana, Ghana, Zimbabwe, Morocco, Tunisia, Mauritius, Namibia and the West African Regional Stock Exchange (Bourse Regionale des Valeurs Mobilieres – BRVN) in Cote d'Voire. The data used are the daily closing stock prices and volume traded for individual stocks. The periods investigated were 1989 to 1995 for Botswana, 1990 to 1995 for Ghana and 1992 to 1995 for Cote d'Ivoire. For Kenya and Zimbabwe, the periods investigated were 1990 to 1995 while Morocco was for 1990 to 1994. Mauritius was from 1989 to 1995 and Egypt from 1993 to 1995. The purpose of the study was to investigate if these markets are efficient in the weak form. The runs test methodology was used and the results were mixed.

With the exception of Namibia-NSX, a significant number of stocks rejected the random walk. The weak form efficiency of the Namibia-NSX was attributed with its correlation with JSE. Kenya and Zimbabwe were also concluded as generally weak form efficient, since a significant number of stocks conformed to random walk. All the stocks in Mauritius sample rejected the random walk at the 1% significance level using the runs test. This led to the conclusion that the Mauritius market tend to deviate from random walk

hypothesis. The same conclusion was drawn for Ghana. On the BRVN, Egypt and Botswana there are possibilities of patterns which can influence price changes. However, the author recommended further investigation using more testing methods. By contrast, Magnusson & Wydick (2002) used a partial-autocorrelation test to examine monthly price behavior of eight (8) African stock markets indices, in comparison with nine (9) Asian and Latin American markets from 1989 to 1998 (Chile, Colombia, Greece, Mexico, Pakistan, the Philippines, Portugal, Turkey and Venezuela). Their results suggest that 6 out of 8 analysed African stock markets were weak-form efficient.

Smith, Jefferis, & Ryoo (2002) and Jefferis & Smith (2005) also investigated the price behavior of a group of African stock markets indices. While Smith *et al*. (2002) use Chow & Denning's (1993) multiple variance-ratios test to examine the weak-form in weekly stock market index series from 1990 to 1998 of eight African countries, Jefferis and Smith (2005) apply a GARCH model to investigate serial-dependence in weekly stock indices of the same group of countries from 1990 to 2001. Their results rejected the notion of weak-form efficiency in all the examined markets except South Africa.

Ntim, Opong, Danbolt & Dewotor (2011) investigated and compared weak form efficiency of 24 African continent-wide stock price indices and those of 8 individual African countries' stock price indices between 2000 and 2007. The Conventional Variance ratio test method developed by Lo & MacKinlay (1988) and Wright's (2000) ranks and signs tests were used to examine the weak form efficiency of 32 stock price indices. On the average, it was found that irrespective of the test employed, the returns of all 24 continent-wide stock prices examined in the study are less non-normality distributed compared to the 8 individual stock prices investigated. The authors also report African continent-wide stock price indices having significantly better weak-form informational efficiency than their

national counterparts. Jefferis & Smith (2005) investigated seven African stock markets, South Africa, Kenya, Zimbabwe, Egypt, Morocco, Nigeria and Mauritius in the period starting from 1990s to June 2001 using GARCH approach with a time varying parameter. South Africa was found to be weak form efficient throughout, but Egypt, Morocco and Nigeria were found to be weak-form efficient towards the end of periods. Mauritius depicted slow tendency towards elimination of efficiency while Kenya and Zimbabwe were found to be not efficient throughout the period.

Differences in stock market efficiency was related to turnover, capitalization and the institutional characteristics of markets. A number of policy implications were drawn. First, the results show that the size of the market is important, in that the larger markets are efficient, for some or all of the period examined, while the small markets are not. Summary of empirical studies from previous studies on African Stock markets is provided in appendix 5.

Observations

From the studies on African stock markets, mixed results are observed. Very few markets were found to be weak form efficient, but most markets were weak-form inefficient in the cited periods. The few studies which indicate weak-form efficiency include study by Dickson and Muragu (1994) for Kenya market i.e. NSE, Magnusson and Wydick (2002) for Botswana, Cote d'Ivore, Kenya, Mauritius, South Africa and Nigeria, Okpara (2010) for Nigeria, Mlambo and Biekpe (2007) for Namibia, Kenya and Zimbabwe. It was also noted that South Africa was cited by all studies to be weak-form efficient.

2.5 Research Gap Identified

The DSE started operating in 1998 and has been growing in terms of listed companies, market capitalisation shares and other market indicators. Unlike other African Stock markets where substantial research works on market efficiency is abundant, very limited literature is available on the efficiency of the Dar es Salaam Stock Exchange (DSE).

Therefore, this study contributes to the limited available literature and bridges the gap through testing the efficiency of the DSE in the weak-form.

2.6 Research Hypotheses

A hypothesis is a statement about population parameters. Its plausibility is evaluated on the basis of information obtained from the population. A test usually involves two hypotheses. An assertion about the population in favour of "existing" situation is taken as null hypothesis and denoted as H_0. The other side is the alternative to that null hypothesis known as alternative hypothesis and denoted as H_1. The research hypothesis is concerned with determining whether the DSE is efficient in the weak-form using autocorrelation and runs as test methods. The null (H_0) and alternative (H_1) hypotheses for each of the test methods are as follows:

For Autocorrelation test:

H_0 Successive security return changes are uncorrelated

H_1 Successive security return changes are correlated

This hypothesis is tested by correlation tests where the correlation coefficients between returns in day ***t*** are correlated with lagged returns i.e. day $\mathbf{t_1, t_2, t_3}$, etc.

For Runs test:

H_0 the observed returns series are random (The number of expected runs is close or equal to the number of actual runs), and for

H_1 the observed returns series are not random (The number of expected runs differs significantly from the number of actual runs).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the methodology used to test for weak-form efficiency of the DSE and it is organised in seven sections. Section 3.2 presents research design, section 3.3 discusses survey population of indices and corresponding data range, section 3.4 presents sampling design and procedures, section 3.5 presents variables and measurement procedures, section 3.6 discusses methods of data collection and section 3.7 presents data processing and analysis.

3.2 Research Design

The research design is a plan and roadmap detailing how the research questions and objectives are addressed. The design specifies why the particular research was chosen and where the data will be sourced and means to collect it. It also considers constraints in accessing data, time factor, location and finances in order to obtain the best research work. The classification of research purpose most often used in the research methods' literature is the threefold one i.e. exploratory, descriptive and explanatory (Saunders, Lewis & Thornhill 2009).

An exploratory study is a valuable means of finding out what is happening, to seek new insights, to ask questions and to assess phenomena in a new light. The three principal ways of conducting exploratory research include a search of the literature, interviewing experts on the subject and conducting focus group interviews. The descriptive research is to portray an accurate profile of persons, events or situations. This may be an extension of, or forerunner to, a piece of exploratory research or more often a piece of explanatory

research. According to Saunders, Lewis & Thornhill (2009) studies that establish casual relationships between variables may be described as explanatory research. This research is related to studying a situation or problem and be able to explain the relationships between available variables. In a time series data for instance, one would like to establish the relationship between the data recorded over time. With this understanding, this study, adopted the explanatory research in order to study the accumulated prices data for the purpose of establishing whether the Dar es Salaam Stock Exchange (DSE) is efficient at least in the weak form. This method was preferred over the others i.e. exploratory and descriptive because it considered using only existing stocks prices data stored in the databases of the DSE.

3.3 Study Population

The survey population covers all existing indices on the Dar es Salaam stock exchange covering Dar es Salaam Stock Exchange Index (DSEI), Tanzania Share Index (TSI), Industry and Allies Index (IA), Insurance and Banking Index (BI), Commercial Services Index (CSI), and Foreign Share Index (FSI). Each of these indices was checked for data range, period of coverage and in general completeness.

3.4 Sampling Design and Procedures

The sampling design took into consideration of available six indices mentioned in para 3.3 from which a representative sample was selected. A purposive sampling technique was used in selecting indices with complete set of data for the required range. The key data as far as this study is concerned is the daily closing stock of market index prices of the DSE, the sole stock exchange in Tanzania. After thorough analysis, four indices were selected. Key factors for selection were from the fact that they were found to have the most authoritative statistical indices used by domestic and foreign investors in measuring the

performance of Dar es Salaam Stock Exchange. The four selected indices are Dar es Salaam Stock Exchange Index (DSEI), Tanzania Share Index (TSI), Bank and Insurance Index (BI), and Industrial & Allies Index (IA). The data range used is covering the period from December 21, 2006 to March 27, 2015 for DSEI with a total of 2045 observed data points (Annex 2). The data ranges for TSI, BI and IA with total record of 1,290 data points each run from December 21, 2006 to February 2012.

3.5 Variables and Measurement Procedures

The variables used in the study are returns established from daily index prices of the sampled indices. The daily prices were transformed into daily returns using a natural logarithm transformation to create a time series of continuously compounded returns, represented as $\mathbf{R_t = Ln\ (P_t/P_{t-1})}$, where:

$\mathbf{R_t}$ = Return at time t,

Ln = Natural Logarithm,

$\mathbf{P_t}$ = Stock Price at time t, and

$\mathbf{P_{t-1}}$ = Stock Price at time t-1.

Cited works that adopted same equation include the work by Worthington et al. (2004), Simons & Laryea (2005), Vitali & Mollah (2007), Mustafa & Nishati (2007), Okpara (2010), Gimba (2010), Al-Jafari (2011), Afego (2012) and others

3.6 Methods of Data Collection

The method of data collection involved visiting and accessing the DSE database from which an electronic file (excel spreadsheets) containing requested data was received. On this file there were secondary data for the four indices with 1,290 records each for TSI, BI and IA of daily trading information from December 2006 to February 2012. Also 2,045 data points for DSEI covering a period from 2006 to 2015 were obtained from the same

source. The choice of the starting time is the moment when DSE began to compile data electronically and maintain a computerised database.

3.7 Data Processing and Analysis

Data processing and analysis involves arranging data in the required format that have to undergoing systematic processes resulting into summaries that are then analysed and interpreted towards establishing facts about population or situation.

3.7.1 Data Processing

Data processing involves sequence of operations of data to convert it into useful information and for this case establishing facts about the population. Given the size and age of the DSE, it was thought prudent to use daily stock returns to derive for meaningful statistical analyses and representative of the true distribution of the characteristics of the stock exchange. As a first step, daily stock prices of the four selected indices were plotted against time and the results are as shown in figures 3.1 to 3.4. The referred period for the Dar es Salaam Stock Exchange Index (DSEI) is from December 2006 to February 2015. Its graph shows clearly that changes in prices of stocks were gradual in the first years of operation but became more active from 2013 onwards.

For the Tanzania Share Index (TSI), Industrial and allies Index (IA) and Banking and Insurance Index (BI) cover the period from December 2006 to February 2012. In the first few years of operation i.e. from 2006 to around October 2008 there was stationarity for both TSI and BI, an indication that probably there was no active trading for these categories. It was also observed that from 6th November to December 2008 there was sharp rise in daily prices 2008 prices started rising sharply from over Tsh 2,863.31 to Tsh 6,575.35. and declined back to less than Tsh 1,500.00. For IA declined sharply to less than Tsh 363.48 and continued to fall to Tsh 100.00 on March 03, 2009.

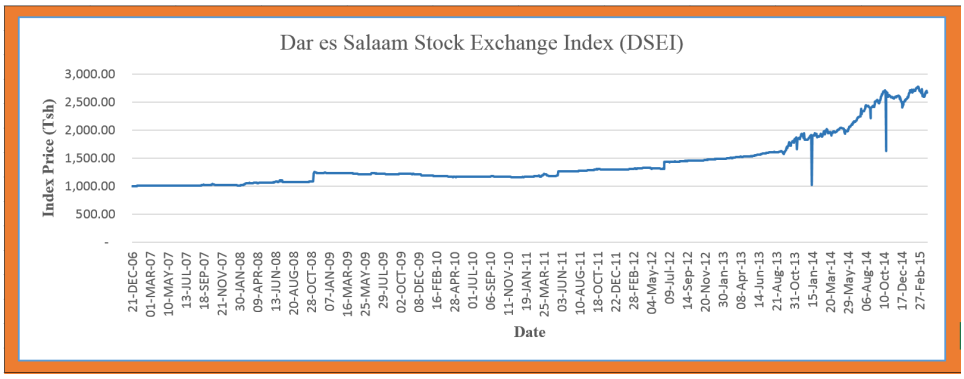

Figure 3.1: Plot of DSEI Price Changes Overtime

Source: Analysed DSE data

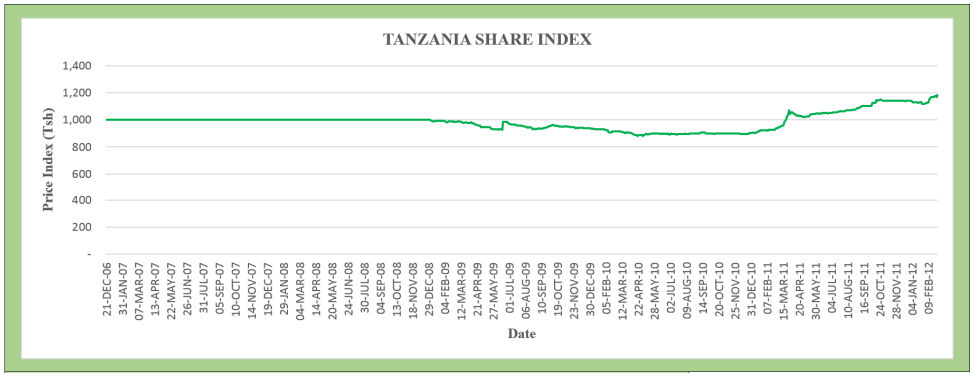

Figure 3.2: Plot of TSI Price Changes Overtime

Source: Analysed DSE data

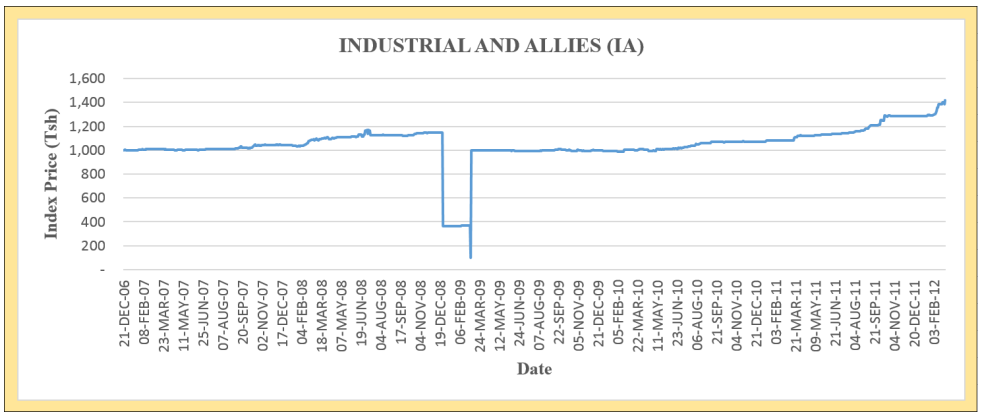

Figure 3.3: Plot of IA Sowing Index Prices Overtime

Source: Analysed DSE data

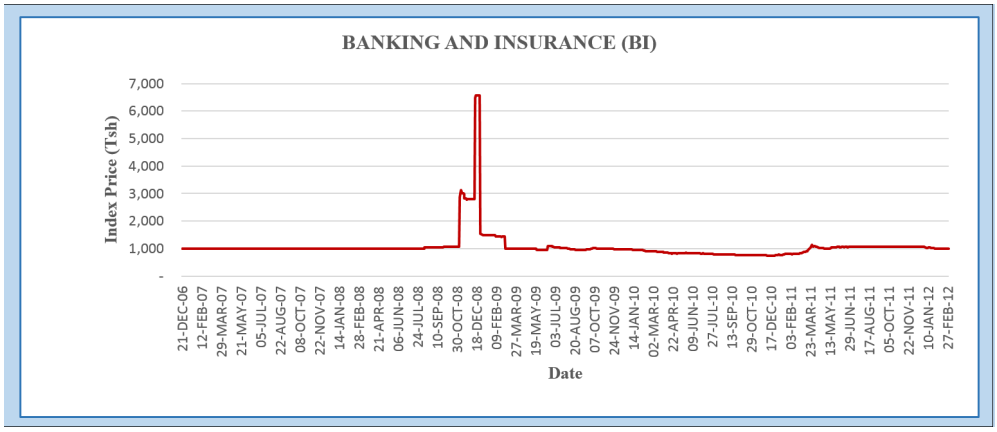

Figure 3.4: Plot of BI Showing Stationarity and Price Spikes

Source: Analysed DSE data

Daily returns were then computed from the price series using the equation $\boldsymbol{R_t = Ln\ (P_t/P_{t-1})}$ as elaborated in paragraph 3.5.

3.7.2 The Analysis

The return data series were then analysed with the purpose of detecting the efficiency at least in the weak-form. Two tests were conducted, namely autocorrelation and runs tests to test whether successive price changes are independent and follow random walk. The tests were carried out using computer software SPSS. The description of each of the methods is provided here below.

a) Autocorrelation test – Ljung-Box Test

Autocorrelation refers to the correlation of a time series between day ***t*** return with its own past and future returns. In other words, the test method measures the relationship between the stock return at current period and lagged returns. To determine the autocorrelation, the following equation was used:

$$\rho_k = \sum_{t-1}^{N-K} (r_t - \bar{r})(r_{t-k} - \bar{r}) / \sum_{t-1}^{N} (r_t - \bar{r})^2 \quad (3.1)$$

Where:

ρ_k = Autocorrelation Coefficient of lag ***K***,

N = number of observations;

r_t = stock return over period ***t***;

$\bar{r}$ = sample mean of stock returns, and

k is the lag of the period.

Statistically, the weak-form of efficiency should be rejected if stock returns are serially correlated, that is ρ_k is significantly different from zero.

To test the joint hypothesis that all autocorrelations are simultaneously equal to zero, the Ljung-Box Q statistic (LQ) is used. The Ljung-Box is a diagnostic tool commonly used to test the quality of fit for time series models (Stoffer & Toloi, 1991). Instead of testing for randomness at each distinct lag, it tests the overall randomness based on a number of lags. The Ljung-Box Q statistics are given by:

$$Q_{LB} = N(N+2) \sum_{j=1}^{k} \frac{S^2 j}{N-j} \quad (3.2)$$

Where:

N is the sample size or number of observations, and

S_j is the ***j****th* autocorrelation.

Under the null hypothesis of zero autocorrelation of the first lag ***k***, autocorrelations ($\rho_1 = \rho_2 = \rho_3 = \ldots = \rho_k = 0$).

The decision rule is that, if Ljung-Box test values are less than 0.05, then the test is significant at 0.05 level and therefore the null hypothesis of zero (0) autocorrelation is rejected. In this study, the number of observations (N) for DSEI was 2045 and for TSI, BI and IA indices was 1290 and the number of lags (K) is 16.

b) The Runs Test (Non-parametric)

A runs test is a strong test for randomness in time series and compares the expected number of runs from a random process with the observed number of runs. A run can be defined as a sequence of consecutive changes with the same sign (Gimba, 2010). In other words, a succession of identical signs (+, -, 0) running through the data. For example, (+ + + +/ - - -/0 /+ +/ - - - -) has 5 runs.

The advantage of this test is that it ignores the distribution of the data; that is it does not require normality (non-parametric) or constant variance of the data. The test is based on the premise that if a series of data is random, the observed number of runs should be close to the expected number of the runs. With runs test, each return is classified according to its position in relation to the mean of return. Hence, a positive change appears when the return is greater than the mean and a negative change when the return is below the mean. Zero change reflects return being equal to the mean. If there is no influence (observations are independent), the sequence is considered random.

To perform the runs test, the number of actual runs denoted by ***R*** is computed and then compared with the expected number of runs denoted by ***E(r)***. Let n_a and n_b respectively

represent observations above and below the sample mean or median, and ***n*** be the number of runs given as $\boldsymbol{n} = \boldsymbol{n_a} + \boldsymbol{n_b}$.

The expected number of runs can therefore be calculated as:

$$E_r = \frac{2n_a n_b}{n - 1} \qquad (3.2.1)$$

The standard normal Z-statistics is given by:

$$Z(r) = \frac{[r - E(r)]}{\sigma(r)} \qquad (3.2.2)$$

This can simply be expressed as: Z = (Observed – Expected)/Standard Error

The Standard Error is represented by:

$$\sigma E(r) = \left[\frac{2n_a n_b(2n_a n_b - n)}{n^2(n-1)}\right]^{1/2} \qquad (3.3.3)$$

For large samples where ***"n"*** is greater than 10, the test statistic Z is compared to a standard normal table. That is, at 5% significance level, a test statistic (Z) with an absolute value greater than 1.96 indicates non randomness. In other words, if the Z value falls outside the range -1.96 and +1.96 the null hypothesis at the 5% level of significance is rejected.

It is also true to say that when the observed number of runs exceeds or falls below expected number of runs, a positive or negative value of Z is obtained. A positive or negative Z value falling outside the range indicate a negative or positive serial correlation in the return series (Gimba, 2010).

CHAPTER FOUR

4.0 FINDINGS AND DISCUSSION

4.1 Overview

This chapter presents findings of the study which was to assess market efficiency of the DSE at least in the weak-form. It is organised as follows: Section 4.2 presents a description of the sample, Section 4.3 presents descriptive statistics, sub-section 4.3.1 present results in line with objective, and section 4.4 discusses the findings.

4.2 Description of the Sample

The sample used in the study is the daily stock price of the four selected indices which were systematically converted into daily returns. The referred four indices are (i) Dar es Salaam Stock Exchange Index (DSEI), (ii) Tanzania Share Index (TSI), (iii) Industrial and Allies Index (IA) and (iv) Banking and Insurance Index (BI). Two test methods i.e Autocorrelation and Runs tests were employed. The tool used in the analysis is a computer software SPSS for all four indices. The breakdown of descriptive statistics showing minimum, maximum, mean, standard deviation, skewness and kurtosis values are presented in Table 5.

Table 4.1: Descriptive Statistics of the DSEI and other Three Indices

Index Return	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
DSEI - Rt	2045	-0.635652	0.627529	0.000481	0.0263517	-0.2	451.137
TSI	1290	-0.059114	0.015248	-0.000133	0.00295	-7.342	134.651
IA	1290	-2.302585	1.303513	-0.00027	0.080421	-12.648	606.993
BI	1290	-2.302585	2.665284	0.000006	0.112297	4.499	410.925

Source: Data analysis by researcher

Table 4.1 clearly indicate the difference between the DSEI which used data from December 2006 to March 2015 and the rest of indices i.e. TSI, IA and BI with data covering the period from December 2006 to February 2012. The skewness values are different from zero (0). The DSEI, TSI and IA are negatively skewed while BI is positively skewed. Similarly, the kurtosis values for all four indices have very high positive values indicating that the returns are highly peaked from the mean.

For normal distribution skewness and kurtosis values are zero (0) and three (3) respectively. In other words, it was observed that all indices have significant skewness and kurtosis clearly indicating that data are not normal. With a normal distribution, skewness is zero or close to zero. Negative values for the skewness indicate that data are skewed towards left while positive values indicate that data are skewed towards right. If the value of kurtosis is close or equal to three (3), it means normal distribution. Thus, any value greater than three indicates that the data set is not normally distributed. From the kurtosis values above, with the kurtosis values much higher than acceptable limits, it is clear the data sets for all four indices are not normally distributed (Jushan & Serena, 2005).

Objective 1: Testing whether the Daily Stock Returns in the DSE are Independent

All four indices were analysed the same way from which tables and graphs were generated and interpretation of results drawn. The guiding principle is that if the value of Autocorrelation Coefficient (ACF) ρ_k is significantly different from zero, it implies that the stock returns are serially correlated. At the same time, if the probability value of Ljung-Box statistic (i.e. LQ) is less than 0.05 it is a confirmation that there is serial correlation in the returns. Table 4.2 summarises the findings of the autocorrelation test method for all four indices.

Table4.2: Summary of Observations on all the Four Indices

Sno	Index	Observations
1	DSEI	DSEI is overall index of the stock market. Autocorrelation test covers the period from December 2006 to March 2015 and the results are showing that six lags (lag 1, 2, 3, 4, 5 and 6) out of 16 lags are deviating significantly from zero. The values of LQ for all lags are less than 0.05.
2	TSI	The first 5 lags have the values protruding beyond the limits of zero significance i.e. not deviating much from zero. All Q-statistic values for all 16 lags are less than 0.05.
3	IA	Lags 1, 2 and 3 proving to be significantly different from zero, all other values are within the limits. However, all values for the Q-statistic are below 0.05.
4	BI	The PAC values of lag 1, 2, 3, 8 and 9 are significantly different from zero and the values of Q-statistic for all 16 lags are below 0.05.

Source: Study results

Details of findings with autocorrelation test method for objective 1 are provided from Table 4.3 to 4.6 and Figures 4.1 to 4.4 below.

Table 4.3: Test Results for Series – DSEI

Lag	AC	PAC	Q-Stat	Prob
1	-0.487	-0.487	485.66	0.001
2	0.016	-0.290	486.16	0.001
3	-0.011	-0.203	486.40	0.011
4	0.001	-0.148	486.40	0.010
5	0.003	-0.104	486.43	0.003
6	0.005	-0.067	486.48	0.005
7	0.006	-0.032	486.56	0.004
8	-0.018	-0.039	487.24	0.013
9	0.008	-0.028	487.39	0.009
10	0.003	-0.014	487.41	0.003
11	-0.008	-0.019	487.55	0.007
12	0.001	-0.018	487.55	0.000
13	-0.013	-0.036	487.88	0.000
14	0.013	-0.024	488.21	0.002
15	0.006	-0.005	488.29	0.005
16	-0.008	-0.007	488.42	0.007

Source: Analysed DSE Data

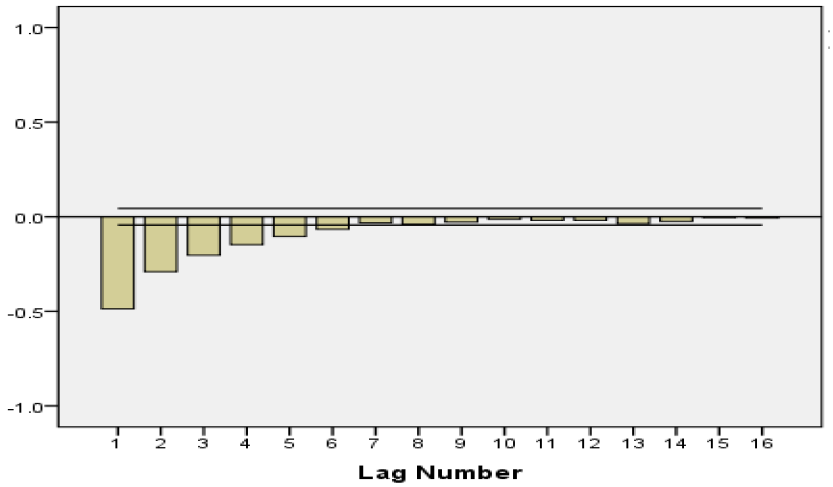

Figure 4.1: Plot of Autocorrelation Function (ACF) for DSEI

Source: Analysed DSE Data

Table 4.4: Test results for Series – TSI

Lag	AC	PAC	Q	Prob
1	0.079	0.079	8.136	0.004
2	0.073	0.067	15.034	0.001
3	0.107	0.097	29.747	0.001
4	0.065	0.046	35.161	0.000
5	0.102	0.083	48.623	0.000
6	0.154	0.130	79.611	0.001
7	0.026	-0.011	80.471	0.000
8	0.000	-0.037	80.472	0.000
9	-0.005	-0.040	80.506	0.003
10	0.020	0.002	81.027	0.002
11	-0.002	-0.024	81.033	0.000
12	0.007	-0.008	81.102	0.000
13	0.018	0.023	81.528	0.000
14	0.000	0.010	81.528	0.000
15	0.007	0.012	81.588	0.001
16	0.000	-0.004	81.588	0.000

Source: Analysed DSE Data

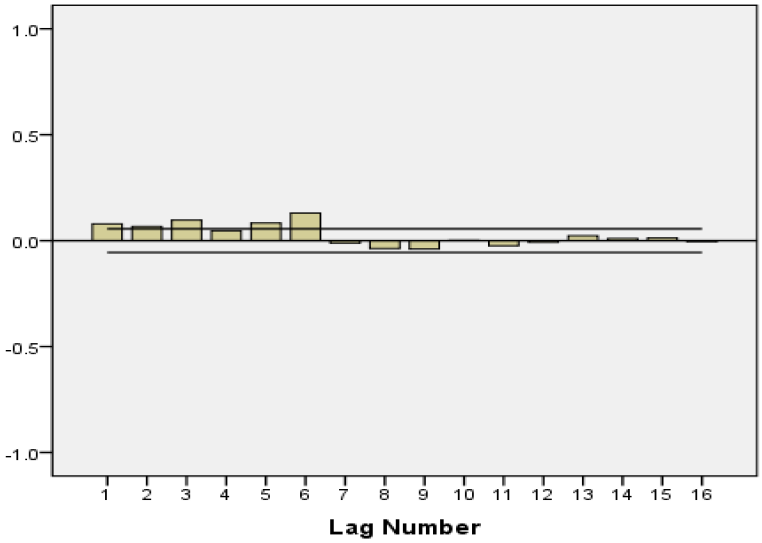

Figure 4.2: Plot of TSI Returns

Source: Analysed DSE Data

Table 4.5: Test Results for series – IA

Lag	AC	PAC	Q Stat	Prob
1	-0.360	-0.360	167.80	0.000
2	0.000	-0.149	167.80	0.000
3	0.000	-0.063	167.80	0.000
4	0.000	-0.027	167.80	0.000
5	0.000	-0.011	167.80	0.000
6	0.000	-0.004	167.80	0.000
7	0.000	-0.002	167.80	0.000
8	0.000	0.000	167.80	0.000
9	0.000	0.000	167.80	0.000
10	0.000	0.000	167.80	0.000
11	0.000	0.000	167.80	0.000
12	0.000	0.000	167.80	0.000
13	0.000	0.000	167.80	0.000
14	0.000	-0.001	167.80	0.000
15	0.002	0.002	167.81	0.000
16	0.000	0.002	167.81	0.000

Source: Analysed DSE Data

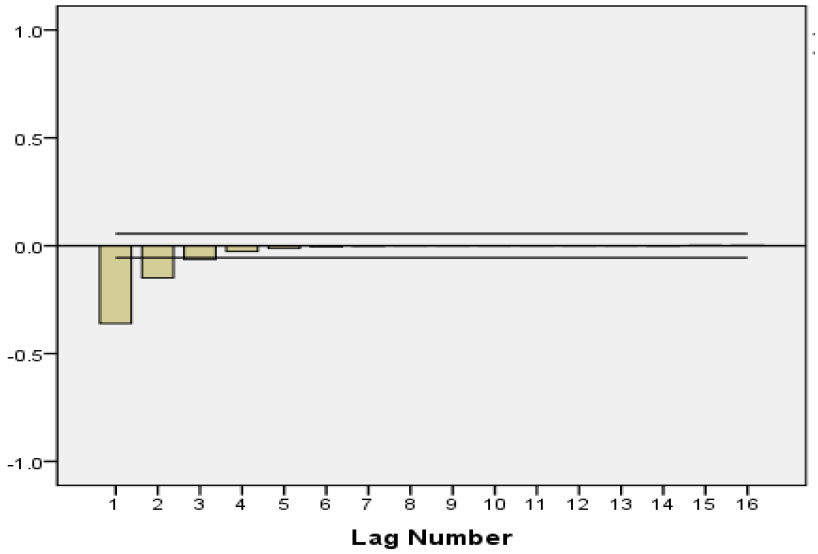

Figure 4.3: Plot of IA Returns

Source: Analysed DSE Data

Table 4.6: Test Results for Series - BI

Lag	AC	PAC	Q-Stat	Prob
1	-0.373	-0.373	180.27	0.000
2	0.003	-0.158	180.29	0.000
3	0.000	-0.069	180.29	0.000
4	0.000	-0.031	180.29	0.000
5	0.001	-0.012	180.29	0.000
6	0.000	-0.006	180.29	0.000
7	0.000	-0.002	180.29	0.000
8	-0.080	-0.096	188.53	0.000
9	0.000	-0.086	188.53	0.000
10	0.000	-0.058	188.53	0.000
11	0.000	-0.036	188.53	0.000
12	0.000	-0.022	188.53	0.000
13	0.000	-0.013	188.53	0.000
14	-0.001	-0.011	188.53	0.000
15	0.001	-0.012	188.53	0.000
16	0.002	-0.018	188.54	0.000

Source: Analysed DSE Data

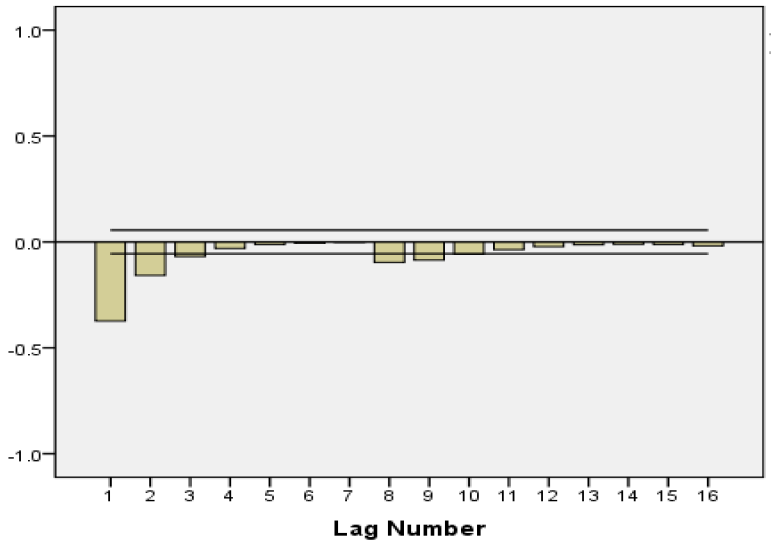

Figure 4.4: Plot of BI Returns

Source: Analysed DSE Data

Objective 2: To examine Whether Changes in the Daily Stock Returns Traded on the DSE follow Random Walk Hypothesis (RWH)

The runs test method was specifically used to test if the successive returns are random. The findings are provided in Table 4.7 which show results of time series data on returns for the sampled four (4) indices. Descriptive features include number of observations, mean, values above mean, values below mean, actual number of runs, Z and P values. The Z – statistic values are -7.520 for DSEI, -8.419 for TSI, -4.2964 for IA and -6.8898 for BI.

These values indicate that actual runs are less than expected runs. The implication is that the daily returns of stocks in the DSE are not randomly distributed. Also, the P-values which are 0.0 for all indices are all less than 5% (alpha), meaning the tests are statistically significant at 5% level, therefore, the null hypothesis that the series are random is rejected.

Table 4.7: Results of the Runs Test

Description	DSEI	TSI	IA	BI
Test Value (Mean)	-0.000481	-0.000133	-0.000270	0.000006
Cases < Test Value	1444	188	273	1153
Cases >= Test Value	602	1102	1017	137
Total Cases	2046	1290	1290	1290
Number of Runs	704	247	380	199
Z	-7.814	-8.4190	-4.2964	-6.8898
Asymp. Sig. (2-tailed)	0.0001	0.0000	0.0000	0.0000

Source: Analysed DSE Data

4.3 Discussion of Findings

Based on the findings of autocorrelation and the Ljung-Box test method the first null hypothesis of the study which says that "Successive security return changes are uncorrelated" is rejected, therefore it can be concluded that the Dar es Salaam Stock Exchange is not weak-form efficient market implying that daily stock returns do not incorporate information contained in past price data/return. This situation leaves the market exposed to manipulation by knowledgeable individuals and make abnormal profit by designing and implementing rules based on patterns in past price data.

The findings from Runs test indicate that the calculated Z - values for the four indices are significantly different from what could be attributed to chance. Test results of Z values are: DSEI (-7.8140), TSI (-8.4190), IA (-4.2964) and BI (-6.8898). All of them have negative values implying that the number of actual runs is significantly less than the expected number of runs. The test provided sufficient evidence to reject the null hypothesis which says that the number of positive runs are as many as are the number of negative runs.

Similar findings were found in the empirical study by Poshakwale (1996) when investigating evidence of weak-form efficiency and day of the week effect in Indian Stock Market from 1987 to 1994 employing autocorrelation and runs tests. The results of runs test and serial correlation test indicate absence of random nature of the series, therefore violation of the weak form efficiency of Bombay Stock Exchange (BSE). Al-Jafari (2011) tested for the weak form efficiency of the Bahrain Securities Exchange (BSE) for the period from 2003 to 2010. The test methods employing were autocorrelation and other statistical packages. It was concluded that the market was weak-form inefficient.

Chiwira & Muyambiri (2012) conducted a test and evaluated the presence of weak-form efficiency in the Botswana Stock Exchange (BSE) using a number of methods that specifically assess the random walk model and came up with similar results. Using selected data for the period from 2004 to 2008, random walk hypothesis was rejected implying that experienced analysts have an advantage of outperforming the market, hence make higher than expected profits through the use of historical data. Mobarek & Keasey (2000) examined the performance of Dhaka Stock Exchange (DSE) for 10 years from 1988 to 1997 using both non-parametric (run tests) and parametric test (autocorrelation test) among others on daily price indices. It was concluded that the share return series didn't follow the Random Walk Model and autocorrelation coefficient at different lags rejected the null hypothesis of weak-form efficiency of the DSE. Gimba (2010) tested weak-form efficiency of the Nigerian Stock Market and concluded that all tests conclusively reject the hypothesis of the random walk for the market index and mixed results for one out of the five selected individual stocks. Enowbi et al (2010) tested the weak form efficiency for Egypt, Morocco, Tunisia and South Africa (January 2000 – March 2009. He concluded that with the exception of South Africa all other markets were found to be not weak form efficient.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Overview

The main objective of the study was to test if the Dar es Salaam Stock Exchange (DSE) is efficient at least in the weak-form. Four (4) indices namely DSEI, TSI, IA, and BI were selected from a population of six 6 indices and used in the tests. The test period was from December 2006 to February 2012 with a total of 1290 observations for TSI, IA, and BI indices. For DSEI the test period runs from December 2006 to March 2015 with a total of 2045 observations or data points. All these data were obtained in electronic form from the DSE. The test methods used are autocorrelation and runs using SPSS as a tool for the tests and confirmed by manual calculations using excel. Section 5.2 is summary of findings, section 5.3 is conclusion, section 5.4 contribution to the knowledge and lastly section 5 suggests areas for further studies.

5.2 Summary of Key Findings

The findings from autocorrelation test on DSEI revealed that the returns in the DSE are not independent, therefore, rejecting the null hypothesis (H_0) which states that successive returns are uncorrelated. In the same way results of the runs test showed that changes in returns are not random, thus rejecting the null (H_0) hypothesis which says the observed returns series are random. Furthermore, the tests for other groups of indices i.e. TSI, BI and IA show that that returns are not independent.

5.3 Conclusion and Implications

From the findings in Section 5.2, that changes in returns are not independent, and not random, implies that experienced investment analysts and skilful market participants adopting the concepts of technical analysis and chartism may use past stocks price/ return

information or historical data to possibly identify trends or patterns and use them to outperform the market, i.e. realise abnormal profits. Basing on these findings, it is hereby concluded that the DSE was not weak-form efficient during the period of study.

The inefficiency is also likely to be contributed by other factors including: (i) the low number of investors participating in the market. The DSE is considered to be a very small stock exchange in-terms of market capitalization, number and size of individual stocks. There are only 23 listed companies as of 2015 despite impressive growth overtime. The majority of Tanzanians have not yet realised the importance of stock exchange as an opportunity for diversifying investments, hence few companies, institutions and individuals are participating in the market. (ii) The maturity argument is also an issue that the more the market has been in operation the more it becomes efficient (Smith et al., 2002; Ntim et al., 2011); (iii) Low liquidity and non-trading may also explain rejection of the weak-form efficiency in the DSE. According to Demirguc-Kunt and Maksimovic (1996), liquid secondary capital markets lower informational asymmetry and transaction costs. Despite the fact the DSE has grown rapidly but suffers from low liquidity.

5.4 Recommendations

Based on the conclusion of the study, it is recommended that DSE should continue to put in place strategies to increase coordinated and timely information dissemination to public, private companies and institutions to join the exchange. These needs to be done through motivating and attracting investors, local and foreign companies to list, increase shares, trading volumes, address stationarity challenges and increase opportunities related to access to capital for investment as well as benefits to shareholders in the listed companies in-terms of dividends, capital gains etc. Intensify the use of a wider communication network to disseminate stock market information. It is also important to note that some of

the proposed measures have already been undertaken but it is emphasised that they should be intensified. It is also noted that awareness creation and information dissemination is done through involvement of students in the higher learning institutions led by universities.

It will also be of value if it intensifies working in conjunction with other entities such as brokerage houses, digital communication networks, the print media, audio and video media for faster dissemination of stock market information. Use of cell-phones for short messages, blogs, platforms and forums could also help to disseminate stock market information. The study also noted efforts taken by DSE and CMSA authorities in protecting the industry and customers. The market surveillance which monitors market trading activities to detect possible market malpractices, investor protection from suffering of losses as a result of Licensed Dealing Member's (LDMs) negligence, investor education through TV and radio programmes (DSE Handbook, 2015). If the number of market participants is significantly increased, will result into increased speed of price discovery through informed agreements and reduced operational cost. Thus the market will be moving towards becoming efficient at least in the weak-form.

5.5 Areas for Further Studies

This study was very inspiring but faced a number of limitations starting with paucity of data. The electronic data which was accessible is from December 2006 to February 2015 for the DSEI leaving behind eight (8) years i.e. from 1998 when the DSE started trading and this is because the data by then were still disaggregated in hard copies. As improvements are consistently recorded it will be a good idea to continue investigations of the market covering same or other periods using same or more indices beyond the four selected under this study. This may consider addition of the Commercial Service (CS) index, Foreign Share (FS) index and others if any. It is also proposed to use similar and

more rigorous test methods such as unit root and Variance Ratio tests and other recent developed models to make a better comparison of the results with those reported in other frontier markets.

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APPENDICES

Appendix 1:

Description of each index and companies involved

Index	Description	No. of Companies
DSEI	The Dar es Salaam Stock Exchange Index (DSEI) is a market cap weighted index with a base reference of 1,000. It includes all stocks listed on the Dar es Salaam Stock Exchange.	23
TSI	The Tanzania Share Index (TSI) is basically associated with Tanzanian firms	16
IA	This focuses on Industrial sector (Industrial & Allied Index - IA). It comprises of Tanzania Oxygen Ltd (TOL), Tanzania Breweries Ltd (TBL), Tanzania Tea Packers Limited (TATEPA), Tanzania Cigarette Company (TCC), Tanga Cement Company Limited (SIMBA) and Tanzania Portland Cement Company Limited (TWIGA)	6
BI	Financial Sector (Bank & Insurance Index-BI). The index covers CRDB Bank Plc (CRDB), National Microfinance Bank (NMB), Dar es Salaam Community Bank (DCB), Mkombozi Commercial Bank (MKCB), Mwalimu Commercial Bank (MCB), YETU Microfinance Plc (YETU), and Maendeleo Plc (Maendeleo),	7
CS	Services Sector (Commercial Services Index - CS). The Index comprises of SWISSPORT, Precision Airways Limited (PAL), Swala Gas and Oil	3
FSI	Foreign Share index (FSI) consists of all cross listed companies. They include Kenya Airways Limited (KA), Jubilee Holdings Limited (JHL), East African Breweries Limited (EABL), Kenya Commercial Bank (KCB), National Media Groups (NMG), Uchumi Supermarket Ltd, Acacia Mining formally known as African Barrick Gold (ABG).	7

Notes: National Investment Company Limited (NICOL) was listed on the DSE on 15 July 2008, but on 6th July 2011 NICOL was officially de-listed due to its failure to comply with listing requirements.

Appendix II:

Company listing date Shares issued and Nature of Business

A: Domestic Listed Companies

S/N	Company	Date Listed	Issued Shares	Nature of Business
1	Tol Gases Limited (TOL)	15/04/1998	42,472,537	Production and distribution of industrial gases, welding equipment, medical gases etc.
2	Tanzania Breweries Limited (TBL)	09/09/1998	294,928,463	Production and distributor of beer, beverages and non-alcoholic drinks
3	Tanzania Tea Packers Limited (TATEPA)	17/12/1999	17,857,165	Production, packing, marketing and distribution of tea and instant
4	Tanzania Cigarette Company Limited (TCC)	16/11/2000	100,000,000	Manufacturing, distribution and marketing of cigarettes
5	Tanga Cement Company Limited (SIMBA)	26/09/2002	63,671,045	Production, marketing and sale of cement
6	Swissport Tanzania Limited (SWISSPORT)	26/09/2006	36,000,000	Airport handling of passengers and cargo
7	Tanzania Portland Cement Company Limited (TWIGA)	29/09/2006	179,923,100	Production, marketing and sale of cement
8	Dar es Salaam Commercial Bank (DCB)	16/09/2008	32,393,236	Commercial Bank
9	National Microfinace Bank Plc (NMB)	06/11/2008	500,000,000	Commercial Bank
10	CRDB Bank Public Limited Company (CRDB)	17/06/2009	2,176,532,160	Commercial Bank
11	Precision Air Services PLC (PAL)	21/12/2011	193,856,750	Air transport services
12	Maendeleo plc (Maendeleo)	04/11/2013	9,066,701	Commercial Bank
13	Swala Gas and Oil (SWALA)	11/08/2014	99,954,467	Mineral Exploration
14	Mkombozi Commercial Bank (MKCB)	29/12/2014	20,615,272	Commercial Bank
15	Mwalimu Commercial Bank (MCB)	27/11/2015	61,824,920	Commercial Bank
16	YETU Microfinance PLC (YETU)	10/03/2016	12,112,894	Microfinance PLC

B: Cross Listed Companies

S/N	Company	Date Listed	Issued Shares	Nature of Business
17	Kenya Airways Limited (KA)	01/10/2004	461,615,484	Passengers and cargo transportation
18	East African Breweries Limited (EABL)	29/06/2005	658,978,630	Holding company of many companies in production of beer in Tanzania, Kenya, Uganda and Mauritius
19	Jubilee Holdings Limited (JHL)	20/12/2006	36,000,000	Holding Company of many insurance Companies in Kenya, Uganda and Tanzania
20	Kenya Commercial Bank Limited (KCB)	17/12/2008	2,950,169,143	Commercial Bank
21	Nation Media Group Limited (NMG)	21/02/2011	157,118,572	News Media Group
22	Acacia Mining PLC	07/12/2011	410,068,499	Mining and Production of Gold
23	Uchumi Supermarket Limited	15/08/2014	265,426,614	Supermarket

Appendix III:

Selected Indicators for the DSE

Indicator	2006	2007	2008	2009	2010	2011	2012	2013	2014
Turnover (TZS' Mill)	1,737	2,274	2,744	3,872	2,998	5,189	4,201	2,062	11,117
Market Cap (TZS'Bill)	2,744	3,128	3,490	4,989	4,933	6,272	12,772	14,058	18,902
All share index or DSEI points	1,009	1,023	1,240	1,192	1,164	1,303	1,485	1,583	2,173
Tanzania Share Index (TSI)	1,000	1,000	1,000	938	902	1,140	1,430	1,840	3,696
BI	1,001	1,044	364	998	1,072	1,285	1,170	1,236	2,648
IA	999	1,000	1,542	964	764	1,056	1,723	1,839	3,461

Source: DSE Handbook (2011) & DSE Market reports 2012, 2013 & 2014

Appendix IV

Summary of empirical studies on Weak-Form Efficiency for markets from outside Africa

No.	Author and Year	Data	Findings/Results
1	Al-Ahmad (2012)	Testing the Weak-Form Efficiency of the Damascus Security Exchange (2009 – 2011)	Autocorrelation tests, Runs test and others including Unit Root tests, Variance ratio tests and the GARCH model. All the tests indicate that returns of the DSE do not follow a random walk and the hypothesis that the DSE is weak-form efficient is rejected.
2	Abraham et al (2002)	Three Gulf stock markets - Kuwait, Saudi Arabia, and Bahrain from Oct 1992 to Dec 1998	Failed to reject the random walk hypothesis for the Saudi Arabia and Bahrain markets, but not for the Kuwait market using runs and variance ratio tests
3	Al-Saleh & Ajimi (2012)	Saudi Stock Market	Runs test, Serial correlation tests and others including Augmented Dickey-Fuller (ADF) unit root test, Phillips-Perron and KPSS were applied.
4	Mobarek & Keasey (2000)	Dhaka Stock Exchange (DSE) for the period of 1988 to 1997	indicate that the share return series didn't follow the RW Model and the null hypothesis of weak-form efficient was rejected.
5	Moustafa (2004)	United Arab Emirates (UAE) stock market (43 stocks) for the period Oct 2001 to Sept 2003	40 stocks out of the 43 were random at 5% level of significance. Although the UAE stock market is still young, small and suffering from infrequent trading, it was found to be weak-form efficient.
6	Mustafa & Nishat (2007)	Karachi Stock Exchange (KSE) (December 1991 to May 1998; May 1998 to September 2001; and September 2001 to May 2003) and one combined period (May 1998 to May 2003).	Autocorrelation and runs test methods were used in and KSE was found to be inefficient during the study period before adjustment for thin trading. It was also found not follow random walk hypothesis after adjustment for thin trading.
7	Nikita & Soekarno (2012)	Testing the weak-form efficiency: Evidence from Indonesia Stock Market (2008 – 2011)	Autocorrelation tests, Runs test. Results show that during the test period Indonesia Stock Market was not efficient in a weak form.
8	Patel, et al	Weak-form market	Results were mixed indicating that the

No.	Author and Year	Data	Findings/Results
	(2012)	efficiency of 4 selected Asian stock markets [India – Bombay Stock Exchange SENSEX, Hong Kong-Hang Seng Index (HIS), Japan-Tokyo Stock Exchange NIKKEI (TSE), and China-Shanghai Stock Exchange (SSE)]	equity market of the Asia region under study remained inefficient for some lag and some were efficient for other lag.
9	Poshakwale (1996)	India Bombay Stock Exchange Jan 1987 to Oct 1994	Used autocorrelation, runs and other statistical test methods. The BSE indicated non-random nature of the series, and therefore market not weak-form efficient
10	Worthington and Higgs (2003)	Latin American Stock Markets: An Empirical Note (Dec 1987 – May 2003). Countries involved include Argentina, Brazil, Chile, Columbia, Mexico, Peru and Venezuela	indicate that none of the markets are characterized by random walks and hence are not weak-form efficient

Appendix V:

Summary of empirical studies on Stock Market Efficiency from Africa

No.	Author and Year	Data	Findings/Results
1	Dickson and Muragu, (1994)	Kenya - 30 listed companies on the NSE from 1979 to 1988	NSE notion of Weak-form efficient not rejected
2	Magnusson and Wydick, 2002	Stock exchanges of 8 African, 9 Asian and Latin America countries from 1989 to 1998	Confirm that 6 out of 8 analyzed African stock markets indices were weak-form efficient.
3	Smith and Jefferis (2002)	eight (8) African countries from 1990 to 1998 by Smith *et al*. (2002) and from 1990 to 2001 by Jefferis and Smith (2005)	rejected the notion of weak-form efficiency in all examined markets except South Africa
4	Jefferis and Smith (2005)	Investigated seven African stock markets, South Africa, Kenya, Zimbabwe, Egypt, Morocco, Nigeria and Mauritius in the period starting from 1990s to June 2001	South Africa was found to be weak form efficient throughout, but Egypt, Morocco and Nigeria were found to be weak-form efficient towards the end of periods (1991-2001). Mauritius depicted slow tendency towards efficiency while Kenya and Zimbabwe were found to be not efficient throughout the period.
5	Simons and Laryea, (2005)	Egypt, Ghana, Mauritius and South Africa from 1990 to 2003	Only South Africa concluded to be weak-form efficient
6	Vitali and Mollah, (2011)	Egypt, Kenya, Mauritius, Morocco, Nigeria and South Africa over the period of 1999 - 2009.	suggests that only South Africa was counted as a weak-form efficient
7	Chiwira and Muyambiri, (2012)	Botswana Stock Exchange (BSE) from 2004 to 2008	The BSE is weak-form inefficient
8	Gimba, (2010)	Nigeria on Nigeria Stock Exchange (NSE) from 2005 to 2009	rejected the hypothesis of the RWH, hence the market not weak-form efficient
9	Enowbi et al (2010)	Egypt, Morocco, Tunisia and South Africa (Jan 2000 – March 2009)	With the exception of South Africa, all other markets were found to be not weak-form efficient.
10	Al-Jafari et al., 2011	Egypt (EGX) from January 1998 to December 2010	rejected the RWH hence not weak-form efficient
11	Okpara, (2010)	Nigeria - Nigerian Stock Market for the period between 1984 to 2006	Market found to be weak form efficient
12	Mlambo and Biekpe (2007)	10 African countries stock markets of (i) Botswana - 1989 to 1995, (ii) Ghana - 1990 to 1995, (iii) Namibia and Cote	Namibia, Kenya and Zimbabwe were generally found to be weak-form efficient. Mauritius and Botswana were rejected. BVRN showed patterns which can influence price changes.

No.	Author and Year	Data	Findings/Results
		d'Ivoire - 1992 to 1995, (iv) Kenya and Zimbabwe - 1990 to 1995, (v) Morocco - 1990 to 1994, (vi) Mauritius - 1989 to 1995, and (vii) Egypt - 1993 to 1995.	
13	Ntim et al (2011)	24 African continent-wide stock price indices and those of 8 individual African countries' stock price indices during 2000 – 2007 period	All 24 continent-wide stock prices are less non-normality distributed compared to the 8 individual stock prices investigated. The authors also report African continent-wide stock price indices having significantly better weak-form informational efficiency than their national counterparts.