AN INVESTIGATION INTO THE WEAK FORM EFFICIENCY OF THE KENYAN GOVERNMENT BONDS AT THE NAIROBI SECURITIES EXCHANGE (NSE)

BY:

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DECLARATION

This project is my original work and has not been presented to any other institution for the award of any academic certificate.

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IRENE NASSUNA-D63/75579/2012 Date

This project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

This study is dedicated to the Almighty God and to my mother Elizabeth D'souza. Mum, you instilled the drive and discipline to handle any task with enthusiasm and determination. Your love and support during this journey has been invaluable.

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ABSTRACT

This study investigates the Weak form Efficiency of the Kenyan Government Bonds at the Nairobi Securities Exchange. According to Weak form Efficient Market Hypothesis literature, a price series is considered to be weak form efficient if it is non-stationary, uncorrelated and of normal distribution. Therefore the objectives of this study were to establish whether the bonds prices are non-stationary, uncorrelated and that they follow a normal distribution.

A subsample of forty government bonds which are listed on the Nairobi Securities Exchange and were outstanding as at 30th June 2013 was used in the analysis. Secondary daily price data of the forty government bonds for the period between January 2009 and June 2013 were used to test efficiency. KPSS unit root was used to test non-stationarity, autocorrelation test was used to check for correlation, K-S and Shapiro Wilk tests and Skewness Kurtosis were used to check for normality while runs test was used to check for randomness. The KPSS unit root test results implies that the data series are non-stationary while autocorrelation test results indicates there is correlation between the past and future prices. K-S and Shapiro Wilk tests results as well as Skewness and Kurtosis results indicate that the price series does not follow a normal distribution while runs test results indicates the price series as not being random.

The results of this study show that although the price series are found to be non-stationary, they are also found to be correlated and having a non-normal distribution. Therefore based on the results, the Kenyan Government Bonds at the Nairobi Securities exchange cannot be said to be weak form efficient. Efficiency can be improved by CBK's actions to actively promote financial literacy in order to elicit more players and activity in the bonds market. This will increase market confidence through increased participation and therefore further enhance market deepening.

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ABBREVIATIONS

ATS	Automated Trading System
CBK	Central Bank of Kenya
EMH	Efficient Market Hypothesis
FTSE	Financial Times Stock Exchange
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GARCH-M	Generalized Autoregressive Conditional Heteroskedasticity Mean
GCC	Gulf Co-operation Council
Gretl	Gnu Regression, Econometrics and Time-series Library
KPSS	Kwiatkowski, Phillips, Schmidt and Shin
K-S	Kolmogorov-Smirnov
Kshs	Kenya Shillings
NSE	Nairobi Securities Exchange

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The concept of efficient markets definition and theory has developed and evolved over time. Bachellier (1900) was among the first to examine capital market efficiency. He observed that past, present and future events are reflected in the market place but often show no apparent relation to price changes. Keynes (1923) stated that investors on financial markets are rewarded not for knowing better than the market what the future has in store, but rather for risk bearing which he said to be a consequence of the EMH. Friedman (1953) pointed out that due to arbitrage, the case for EMH can be made even in situations where the trading strategies of investors are correlated.

Samuelson (1965) showed that in an informationally efficient market, price changes must be unforecastable if they are properly anticipated, that is, if they fully incorporate the information and expectations of all market participants. Fama (1965) defined efficient capital markets as one where there should not exist a significant correlation between the security prices over time. Roberts (1967) coined the term 'Efficient Market Hypothesis' and distinguished between weak form and strong form tests which became the classic taxonomy in Fama (1970) . He defined a market to be weak form efficiency if all past prices and returns on an asset are incorporated into its current price; A semi strong efficient market is one where all publicly available information about an asset is fully reflected in its current price; A strong efficiency market is one where all information whether public or private is incorporated into its price.

Fama (1970) defined an efficient market as a market in which prices always fully reflect available information. He looked at three theories on market efficiency namely Fair Game, Submartingale and Random walk. He also looked at three types of tests on market efficiency namely weak form, semi strong form and strong form tests. On Weak form tests, he found that prices contained historical information which could be predicted from historical price trends. On semi strong form tests, all public information was already reflected in the prices. On strong form tests, all public and private information are reflected in the prices and continues to state that no monopolistic information can entail profits meaning it is not possible to profit through insider trading. Secondly, Fama (1970) showed that the notion of market efficiency could not be rejected without an accompanying rejection model of market equilibrium. This concept came to be known as the Joint hypothesis problem. Grossman (1976) described a model that showed that informationally efficient price systems aggregate diverse information perfectly, but in doing so the prise system eliminates the private incentive for collecting information

Fama (1991) revised his initial definition of the Efficient Market Hypothesis and noted "that prices reflect information to the point where the marginal benefits of acting on information (profits to be made) do not exceed marginal costs". This came about because he initially assumed that there was no cost to gathering and analysing the information and that transaction cost was zero. He thought of market efficiency being a continuous process and not discrete and that the lower the transaction costs, the higher the efficiency of the market. Malkiel (1992) suggested that a capital market is said to be efficient if it fully and correctly reflects all relevant information in determining security prices but also showed that some markets are inefficient as a result of signs of non-random walk. Fama (1998) later revised the definition of an

efficient market and stated that one may observe in efficient markets that the expected value of abnormal returns is zero, but the chance generates deviations from zero anomalies in both directions.

1.1.1 Efficiency

According to Fama (1970), in an efficient market, the price that one pays for an asset should ideally reflect all available information. A market is said to be efficient if the prices of financial assets rapidly adjust to the arrival of new information thereafter reflecting all available and relevant information. Efficient market hypothesis generally supports the idea that no economic agent can consistently achieve above normal returns compared to the market return (Fama, 1970). This implies that investors cannot consistently predict asset prices in order to beat the market. However there are several instances where the EMH theory is refuted with strong evidence showing that investors can indeed predict asset prices. There has been several documented evidence where some authors attribute market inefficiency to various anomalies. Some authors have also turned to behavioural finance studies in order to try and show that inefficiency is also caused by behavioural tendencies of various market players.

Malkiel (2003) referred to efficient market hypothesis as being associated with random walk which means that price changes are impendent of each other. He argued that today's news will reflect immediately on the prices and that tomorrow's price will only change with tomorrow's news which will be independent of the price changes today. He further argued that new by definition is unpredictable hence resulting price changes must be unpredictable and random.

There are three forms of efficient markets that are generally accepted namely weak form, semi strong form and strong form (Brealey and Mayers, 2005). Weak form

efficiency market is one where all past prices and returns on an asset are incorporated into its current price; A semi strong efficient market is one where all publicly available information about an asset is fully reflected in its current price; A strong efficiency market is one where all information whether public or private is incorporated into its price (Brealey and Mayers, 2005).

1.1.2 Weak Form Efficiency

Weak form efficiency implies that current asset prices fully reflect all past market information (Brealey and Mayers, 2005).Therefore a market is said to be weak form efficient if the current prices fully reflect past information (Roberts, 1965). This goes to imply that past prices and other historical information should not have a relationship with future prices meaning that it is not possible to predict future prices using past prices. This further implies that technical analysis cannot be used to successfully predict future prices thus one should gain very little from using any trading rules based on past prices. Therefore consistently achieving average profits in a weak form efficient market is not possible.

1.1.3 Government Bonds

Capital markets play a very important role in the development of an economy (Bekaert, Garcia and Harvey, 1995). The primary role is to allow for transfer of funds from areas in the economy that are in excess to those that are in deficit in order to finance capital investment projects. This can be done through the issuance of stocks or bonds to investors in order to provide the borrower with funds to carry out their businesses. The borrowers range from private sector companies, public sector organisations or the government. Most governments use the capital markets to raise funds in order to carry out various projects in their countries. This is done through the

issuance of treasury bonds to the public, both local and foreigners in order to bridge the budget deficit so as to enable the government to carry out its agenda. One of the benefits of a bond market is that the government can borrow medium term to long term funds which is cheaper compared to if they had to borrow short term money from the money markets. Public debt can be very costly therefore it is crucial for a capital market to be efficient so as to allow for efficient pricing of assets.

1.1.4 Weak Form Efficiency and Government Bonds

Extensive literature and research on market efficiency has been done on equity markets although the same cannot be said about fixed income markets. There are important differences between the bond and stock markets. In particular, the stock market is much more liquid while in contrast the bond market is relatively illiquid. More attention has been focused on stock markets because they are more vibrant and developed compared to bond markets. However the same tests applied on equity markets can be applied on bond markets in order to test for efficiency as the EMH theory refers to security prices which can either be bonds or stocks.

A capital market is said to be weak form efficient if the current prices fully reflect past information (Roberts, 1965). Some studies have been conducted to test weak form efficiency of government bonds. Afonzo and Teixeria (1998) found mixed results when testing for weak form efficiency of government bonds in the Euro area. Some countries were found to be efficient while others were not therefore challenging the belief that daily rates of return can be viewed as independent random variable. Baghestani (2009) using the term structure theory that suggests in an efficient market bond prices follow a random walk, showed, using 10 year US Treasury bonds and Moody Aaa corporate bonds for the period 1988-2005, that bond rates were generally

unbiased. Pessando (1978) tested the joint hypothesis that Canadian bond market is efficient and the variation in long term bond rates is solely due to expectations effects. He found the joint hypothesis to be true in that the bond market was efficient and that the long term rates is solely due to expectations effects.

The empirical studies above show there is mixed conclusions on weak form efficiency of bond markets as some markets have been found to be efficient while others are not. This study therefore seeks to establish the efficiency in weak form of the Kenyan government bonds that are listed on the NSE.

1.1.5 Nairobi Securities Exchange

Nairobi Securities Exchange is a securities market in Kenya that supports trading, clearing and settlement of equities, debt, derivatives and other associated instruments. It was formed in 1954 and has seen many changes that continue to see the market develop further. The Kenyan government bond mechanics at the NSE has evolved over time. The first Treasury bond was listed in February 1997 and soon after Treasury bond trading began in April 1997. In July 2002, the Kenyan government stopped the use of non-auction based system and switched to a multi price bid auction system to allow prices to be determined through market demand and supply forces. However the trading was still being done using the outcry method until November 2009 when NSE automated the trading of government bonds. It introduced the automated trading system in order to increase efficiency and liquidity of government bonds. By December 2009, all government bonds were loaded into the ATS system. In November 2011, Kenya debuted its first bond index, FTSE NSE Bond Index so as to provide a benchmark for government bond portfolios. (NSE archives)

Kenyan government bonds are issued by Central Bank of Kenya on behalf of the government on a monthly basis and the auctioned papers could either be new issues or re-opens of previously issued papers. Once issued, the bonds can begin to trade the following day in the secondary bond market, NSE. The major player in the Kenyan government bond market is banking institutions which hold about 50% of government securities in most instances. Other players include Pension funds, Insurance companies, Parastatals and other investors such as SACCO's, self-help groups, listed and private companies, educational institutions, religious institutions and individuals (CBK archives).The NSE provides a platform for government bond trading and operates during five days week days a week with a settlement period of T+3. It is a fairly active market having both foreign and local investors participating although most of the trades are done on the government bonds since the listed corporate bonds are illiquid. In 2012 the secondary bond market recorded a total bond turnover of Kshs 549.8 billion compared to Kshs 432.5 billion in 2011. All the same the bond market continues to show improvement in terms of liquidity and turnover (NSE archives).

1.2 Research Problem

EMH theory says that in an efficient market, security prices should ideally reflect all relevant information (Fama, 1970). Furthermore, weak form efficiency implies that current price information should reflect all available past information. It thus follows that in a weakly efficient market, all past information should reflect in the current price. It is therefore expected for a market to be considered weak form efficient, the current security prices (in this case government bond prices) should have incorporated historical information.

There have been several disagreements disputing the concept that markets are efficient. Behavioural economists believe that cognitive behaviours such as overconfidence, information bias etc. lead to market inefficiency. Calendar effects are also said to cause market inefficiency. Some documented evidence on bond market calendar effects include Chang and Pinegar (1986) showed that January effect was present in bonds while Jordan and Jordan (1991) tested day of the week effect and found equal mean returns by the day of the week could not be rejected. They also conducted another test on week of the month effect and found the anomaly to be present. Frantzmann (1989) analyzed pricing anomalies in German bond markets and found significant day of the week with Tuesday's return being lower than returns on the other days of the week.

A number of local studies have been undertaken in a bid to establish market efficiency. Owido, Onyuma and Owuor (2013) conducted a study to measure the efficiency of the NSE by checking for randomness and independence of the returns using GARCH and OLS. Results showed that the daily returns were non-random and that the returns were dependent on previous returns. They therefore found the NSE to be inefficient in weak form. (They used the NSE 20 share index which is a shares index to test for efficiency). Njimanted (2012) tested efficiency of five markets in Africa, with Kenya's NSE being one of the markets under investigation. GARCH-M, ADF and variance ratio tests were used to test efficiency. The results indicated that the five markets were found to be inefficient because the random walk hypothesis was rejected. (Stock price data was used to test efficiency). Anyumba (2010) carried out an empirical test of the random walk model for the NSE and found it to follow random walk therefore classifying it as weak form efficient. (The NSE 20 and NASI indices which are stocks indices were used in the study).The studies above used

shares price data to test efficiency of stocks. Patoda and Jain (2012) showed results that indicated stock and bond markets are independent of each other with most of the variations in indices being explained by past value of each respective market. My study therefore differs from the above mentioned studies because it shall use bond price data as it seeks to establish whether the Kenyan Government bonds are efficient. It seeks to answer the question: Are the Kenyan Government Bonds that trade on the NSE of weak form efficiency such that the prices are independent of each other?

1.3 Research Objectives

The objectives of this study are;

1. To determine whether the bond prices are non-stationary.
2. To determine whether the past and future bond prices are uncorrelated.
3. To determine whether the bond prices follow a normal distribution.

1.4 Value of the Study

Most governments borrow money from their respective domestic markets in order to bridge budget deficits and be able to fund various projects and recurrent expenditures. It is thus the government's aim to borrow at the least possible cost however this may not be case in an inefficient market. The Kenyan government can therefore benefit from the conclusion of this study by knowing the kind of bond market it operates in. An efficient market will greatly reduce government's borrowing costs while an inefficient one can be developed further to remove the inefficiencies.

A majority of the public sector organisations lack funds to carry out or expand their businesses so they mostly rely on financial institutions which are often costly. The financial institutions are also unable to fully meet the funding needs of some of the big organisations. On the other hand, capital markets are generally known to be a

cheaper alternative source of funding and huge sums of capital can be obtained. Therefore private and public sector can greatly benefit from the conclusion of this study because if the market is found to be efficient, they can source for cheaper funds.

Many investors both local and foreign participate in the Kenyan government bond market, individuals and institutions alike. In an inefficient bond market, bond pricing can be distorted. However in an efficient market, the investors will have the comfort of knowing that the yield curve gives correct pricing for the bonds. This will give the bond market more credibility leading to a more vibrant and liquid market.

Capital markets are used to transfer funds from sectors that are in excess to those that are in short supply for the further development of businesses and in tandem the economy. Efficient capital markets allow for efficient transfer of excess funds at the most reasonable cost. This is beneficial to the overall economy because any extra costs that would have been paid for in the case of an inefficient market can be used for other purposes. The economy in general will therefore stand to benefit from the conclusion of this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a literature review on market efficiency. The study begins with the theoretical view of market efficiency. It then takes a look at some of the Weak Form EMH literature and concludes with a review of various empirical studies that have been undertaken in a bid to test efficiency of markets.

2.2 Theoretical Review

This study takes a look at some theories on market efficiency namely Fair game Theory, Submartingale Theory and Random Walk Theory.

2.2.1 Fair Game Theory

The role of “fair game" models in the theory of efficient markets was first recognized and studied rigorously by Mandelbrot (1966) and Samuelson (1965). From Fama (1970), the definitional statement that in efficient market prices “fully reflect” available information is so general that it has no empirically testable implications. To make the model testable, the process of price formation must be specified in more detail by defining exactly what is meant by the term "fully reflect. "One possibility would be to posit that equilibrium prices (or expected returns) on securities are generated as in the "two parameter" Sharpe (1964) and Lintner (1965) world.

The value of the equilibrium expected return projected on the basis of the information set would be determined from the particular expected return theory at hand. The conditional expectation is meant to imply, however, that whatever expected return model is assumed to apply, the information set is fully utilized in determining

equilibrium expected returns. And this is the sense in which the information set is "fully reflected" in the formation of the current price.

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

2.2.2 Submartingale Theory

From Fama (1970), the price sequence for a security follows a submartingale with respect to the information sequence which is to say that the expected value of next period's price, as projected on the basis of the information set, is equal to or greater than the current price. Therefore if that holds as an equality (so that expected returns and price changes are zero), then the price sequence follows a martingale.

A submartingale in prices has one important empirical implication. Consider the set of "one security and cash" mechanical trading rules by which we mean systems that concentrate on individual securities and that define the conditions under which the investor would hold a given security, sell it short, or simply hold cash at any time t. Then the assumption that expected returns conditional on information set are non-negative directly implies that such trading rules based only on the information set cannot have greater expected profits than a policy of always buying-and-holding the security during the future period in question.

2.2.3 Random Walk Theory

From Fama (1970), in the early treatments of the efficient markets model, the statement that the current price of a security "fully reflects" available information was

assumed to imply that successive price changes or more usually, successive one-period returns, are independent. In addition, it was usually assumed that successive changes (or returns) are identically distributed. Together the two hypotheses constitute the random walk model. It was later argued that the random walk model is regarded as an extension of the general expected return or "fair game" efficient markets model in the sense of making a more detailed statement about the economic environment. The "fair game" model just says that the conditions of market equilibrium can be stated in terms of expected returns, and thus it says little about the details of the stochastic process generating returns. A random walk arises within the context of such a model when the environment is such that the evolution of investor tastes and the process generating new information combine to produce equilibria in which return distributions repeat themselves through time. Thus it is not surprising that empirical tests of the "random walk" model that are in fact tests of "fair game" properties are more strongly in support of the model than tests of the additional (and, from the viewpoint of expected return market efficiency, superfluous) pure independence assumption.

2.3 Weak Form EMH Literature

In an efficient market, the prices fully reflect all relevant information therefore the prices or returns should follow a random walk or unpredicted behaviour (Fama 1970). If they are not characterised by a random walk, then future prices and returns can be predicted using past prices and returns. This study thus takes a look at three measures that are commonly used to check for weak form efficiency of prices and returns namely Non- stationarity, Autocorrelation and Normality.

2.2.1 Non Stationarity

Dickey and Fuller (1981) suggested that non-stationarity is one of the conditions for random walk which supports weak form efficiency. Stationarity is defined as a quality of a process in which the statistical parameters (mean and standard deviation) of the process do not change with time. Therefore a series would be said to be non-stationary if the statistical parameters change with time and it would thus be considered to have a unit root. Rahman and Saadi (2008) highlighted that a unit root is a necessary pre-requisite for the random walk hypothesis but not a sufficient condition. More specifically, the presence of a unit root per se is not sufficient to imply a random walk since the return series must also be serially uncorrelated or serially independent.

2.2.2 Autocorrelation

Bachelier (1900) implied that successive price changes should not be serially correlated in an efficient market. If price changes are serially correlated then the price series is said to be non-random hence not weak form efficient. Autocorrelation has been one of the common ways to measure randomness of price series and considered most as one of the most reliable measures used to check dependence or independence of price changes. Autocorrelation measures correlation between a series of prices or returns and lagged series in the same series. A significant autocorrelation indicates the existence of a relationship in the trend which implies that the series is not independent.

2.3.3 Normality

Prices in efficient markets should follow a random walk with price movements that obey the normality condition (Bachelier, 1900). It is therefore presumed that if stock prices move in a random fashion then its distribution should conform to normal distribution. If changes in prices follow a normal distribution, then the price series can be said to be random (Fisher and Jordan (1991). According to Fama (1965), it is required for any random walk model to establish the shape of distribution of the series. Normality can be tested using numerical methods such as normality statistical tests, skewness and kurtosis.

2.4 Review of Empirical Studies

There have been various empirical studies on efficient markets though most of the research has been done using stock markets. The reason behind this is stock markets are more vibrant and developed meaning that stocks trade more frequently than bonds. All the same there are few studies available on the efficiency of government bond markets.

Pessando (1978) tested the joint hypothesis that Canadian bond market is efficient and the variation in long term bond rates is solely due to expectations effects. He found the joint hypothesis to true in that the bond market was efficient and that the long term rates are solely due to expectations effects.

Pesando (1979) showed that long term interest rates in an efficient market will approximately follow a martingale sequence and thus exhibit random walk characteristics in the absence of time varying term premiums. He also noted that the claims that short term rates will follow a random walk in an efficient market obtains

only from the direct assumption that the equilibrium return on one period rates follows a random walk.

Baghestani (2009) using the term structure theory that suggests in an efficient market bond prices follow a random walk, showed, using 10 year US Treasury bonds and Moody Aaa corporate bonds for the period 1988-2005, that bond rates were generally unbiased. He however noted that for blue chip company bonds, the forecasts were found to be biased and inferior to random walk.

Afonzo and Teixeria (1998) found mixed results when testing for weak form efficiency of government bonds in the Euro area. They found some countries to be efficient while others were not therefore challenging the belief that the daily rates of return tested can be viewed as independent random variables.

Weak form efficiency (2004) was tested on the Sri Lanka Government bond market using Unit Root test, Correlogram test, Histogram-normality test and Auto Regressive Conditional Heteroscadasticity (ARCH) test. The results showed it was impossible to conclude that the said market is of weak form efficiency meaning that the bonds were not weak form efficient thus it was possible to beat the market using historical data to predict future prices.

Patel, Patel and Ranpura (2011) tested weak form efficiency of Indian Stock Markets namely Bombay Stock Exchange and National Stock Exchange. Daily returns were tested using Unit root test, autocorrelation and runs tests. Unit root test results showed that the tested data was found to be stationary while runs test results showed non-randomness. Autocorrelation results showed autocorrelation in the period between August 2001 and July 2004 but no autocorrelation thereafter. Therefore overall results indicated that the Indian stock market was weak form inefficient for the whole period.

Ali, Naseem and Sultana (2013) tested random walk and weak form efficiency from the SAARC region namely Pakistan, India, Sri Lanka and Bangladesh. Autocorrelation, Ljung-Box Q Statistic, Run test, unit root test and variance root test were used to test efficiency. The data tested were found to have a non-normal distribution, autocorrelation was found to be present and the indices were non-stationary at order 1(0) and stationary at order 1(1). Runs test revealed that the daily returns could be predicted while Variance test results found the markets to be non-random. Therefore the markets were found to be weak form inefficient.

Zahid, Ramzan and Ramzan (2012) tested random walk behaviour and efficiency of Pakistani Stock Market in order to investigate weak form efficiency of Karachi Stock Exchange. The returns were found to be non-normal using kurtosis, skewness, Jarque Bera and Kolmogorov Smirnov test. Autocorrelation and runs test showed the data to be non-random therefore the market was found to be weak form inefficient.

Worthington and Higgs (2006) examined weak form efficiency of twenty seven emerging markets using daily returns. Unit root tests, autocorrelation and runs test as well as variance ratio tests were used to test the market efficiency. The serial correlation and runs tests concluded that most emerging markets are weak-form inefficient. Unit root tests showed weak form efficiency in many emerging markets but with exceptions. Variance tests showed the markets as being weak form inefficient. Therefore in overall Hungary, Jordan and Israel are weak-form market efficient, with Egypt, Korea, Malaysia and Argentina meeting at least some of the requirements of a random walk.

Ajao and Osayuwu (2012) tested weak form efficiency Hypothesis in Nigerian Capital Market using end month value of the All share Index. Serial correlation was

used to test for independence of successive price movement while runs test was used to test randomness of the price movements. Serial correlation test results showed low significant correlation coefficient while runs tests showed the index value to be random. It was concluded that the Nigerian capital market was independent and random therefore it could be said to be weak form efficient.

Elango and Hussein (2008) tested efficiency of seven stock markets in the GCC countries using daily prices. They used Kolmogorov-Smirnov test to test for normality and runs test to check for randomness. They rejected the null hypothesis that the returns follow a normal distribution from the Kolmogorov-Smirnov test results. Results from runs test indicated that the returns did not follow a random walk. They therefore rejected the hypothesis pertaining to random walk and weak form efficiency of the GCC markets.

2.5 Summary of Literature Review

From the various reviews of empirical studies, Pessando (1978) found Canadian bond market to be efficient and Ajao and Osayuwu (2012) found the Nigerian Capital Market independent and random therefore it could be said to be weak form efficient. On the other side, Sri lanka bond market was found to be weak form inefficient. Patel, Patel and Ranpura (2011) found Indian Stock Markets namely Bombay Stock Exchange and National Stock Exchange to be weak form ineffcienct and Ali, Naseem and Sultana (2013) found the SAARC region namely Pakistan, India, Sri Lanka and Bangladesh to be weak form inefficient as well. Zahid, Ramzan and Ramzan (2012) also found Pakistani Stock Market to be weak form inefficient as well as Elango and Hussein (2008) who rejected the hypothesis pertaining to random walk and weak form efficiency of the GCC markets. Mixed results were also observed e.g. Afonzo and

Teixeria (1998) found mixed results when testing for weak form efficiency of government bonds in the Euro area. Worthington and Higgs (2006) found Hungary, Jordan and Israel to be weak-form market efficient, with Egypt, Korea, Malaysia and Argentina meeting at least some of the requirements of a random walk.

From the various reviews of empirical studies, some markets have been found to be weak form efficient while others have been found to be inefficient in the weak form. Therefore there is no general consensus from the various researchers when it comes to the weak form market efficiency as a result of the differing empirical results. This study therefore seeks to fill the research gap by contributing further to the existing empirical evidence that will assist in moving closer to a general consensus.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter took a look at the research methodology that was used to carry out this study. The target population, sample size and sample technique used have been specified as well as the data collection method stating the source of information. The chapter lastly took a look at the techniques that were used to analyse the collected data together with the model and software package to be used.

3.2 Research Design

The research design used was hypothesis testing. The study setting used was the Kenyan government bonds that trade in the NSE using daily closing prices for a period of four and a half years five years from 1st January 2009 to 30th June 2013. This research design was chosen because it enabled the analysis of the bonds so as to determine the weak form efficiency through hypothesis testing.

3.3 Population

The target population used was all fifty seven government bonds that were outstanding as at 30th June 2013, which are listed on the NSE in Kenya and have traded in the period of 1st January 2009 to 30th June 2013. This is because the study wished to establish the weak form efficiency of the Kenyan government bonds hence the target population of the government bonds.

3.4 Sample Design

The technique used was simple random sampling where the criteria of regular government bonds was used thereby excluding infrastructure and special bonds resulting to a sample of fifty government bonds picked from the population. A sub sample of forty government bonds was then picked from the sample based on the criteria of bonds that have traded for a period of more than one year. The daily closing clean bond prices from the sub sample were then used to test for efficiency using various tests.

3.5 Data Collection

The government bonds clean price data used for analysis was secondary data which was collated from daily bond price lists which NSE disseminates at the end of each trading day. The data was of quantitative type. The reason for this is that Kenyan government bonds trade on the NSE therefore it forms a reliable and independent source of data.

3.6 Data Analysis

The data analysis was done using the random walk model (Fama, 1970) shown in the following equation:

$$P_t = P_{t-1} + e_t \quad (1)$$

Where:

P_t= Price of bond at time t

P_{t-1} = Price of bond at time t-1

e_t = random error term that is independently and identically distributed with mean zero and variance σ^2.

Equation (1) indicates that the price of a bond at time t is equal to price of the bond at time t-1 plus a random error *e.* This means that the change of price which is given by $e_t = P_t - P_{t-1}$ is independent of past price changes.

In order to test for non-stationarity, correlation and normality, a number of econometrics techniques were used. To test for non-stationarity of the government bond prices, the unit root test KPSS was used. To test correlation between past and future government bond prices, autocorrelation test was used. To test for normality of the government bond prices, K-S and Shapiro Wilks tests as well as Skewness and Kurtosis were all used. To test for randomness of the government bonds, runs test was used. The analysis of the data was done using SPSS package version 21.0 except for the unit root KPSS test as unit root tests are not available on SPSS. Gretl version 1.9.12 was instead used.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

This chapter takes a look at data analysis and presentation of the findings. It contains the description of the test results of the data analysis as well as the summary and interpretation of the results obtained. It also takes a look at the major findings and comparison of previous studies.

4.2 Data Presentation

4.2.1 Descriptive Statistics

B1 in appendix B shows descriptive statistics of the sampled forty government bonds which was done using SPSS package version 22. It shows standard deviation values ranging from $2.20663 < s < 25.32614$. In terms of standard deviation, the results show that the top five bonds with lowest standard deviation were FXD1/2012/2, FXD4/2011/2, FXD1/2012/5, FXD1/2011/20 and FXD3/2012/2. The five top bonds found to have the highest standard deviation were FXD2/2007/15, FXD1/2007/15, FXD3/2007/15, FXD1/2010/15 and FXD1/2009/15.

4.2.2 Testing Non Stationarity

B2 in appendix B shows results for the unit root test namely KPSS test (including trend) which was done to check for non-stationarity of the government bond prices using Gretl package version 1.9.12. A lag of three was used as well as a 95% confidence interval when carrying out the test. The test results show test statistic

values ranging $0.1988 < t < 5.2131$ and a critical value of 0.148 for all the tested bonds.

4.2.3 Testing autocorrelation

B3 in appendix B shows results for autocorrelation test which was done to check for autocorrelation of the government bond prices using SPSS package version 22. The data was transformed to natural logarithm and a lag of three was used. A 95% confidence interval was used when carrying out the test. The autocorrelation results show that all the tested bonds had an autocorrelation figure of more than zero at all the three lags. The results also showed the Box Ljung statistic as having a p value of < 0.001 for all the tested bonds.

4.2.4 Testing Normality

B4 in appendix B shows results for K-S and Shapiro Wilk tests which were done to check for normality of the government bond prices using SPSS package version 22. A 95% confidence interval was used when carrying out the test. The p values obtained from the K-S test results were found to be < 0.001 for all the tested bonds. The p values obtained from the Shapiro Wilk test results were also found to be < 0.001 for all the tested bonds.

B5 in appendix B shows results for Skewness and Kurtosis which were also done to check for normality of the government bond prices using SPP package version 22. A 95% confidence interval was used when carrying out the tests. Skewness results show thirty four bonds having a positive skewness statistic in the range $0.03 < s < 0.984$ and six bonds having a negative skewness statistic in the range $-0.653 < s < -0.034$. Kurtosis results show eight bonds having a positive kurtosis statistic in the range

$0.127 < k < 8.432$, thirty bonds having a negative kurtosis statistic in the range of $-1.580 < k < -0.036$ and two bonds having zero kurtosis statistic.

4.2.5 Testing Randomness

B6 in appendix B shows results for runs test which was done to check for randomness of the government bond prices using SPSS package version 22. The mean of the bond prices of individual bonds was used as the cut point. A 95% confidence interval was used when carrying out the test. The test results show p values of < 0.001 for all the tested bonds.

4.3 Summary and interpretation of findings

B1 in appendix B shows the descriptive statistics of the sampled forty government bonds. In terms standard deviation, the results show that the top five bonds with lowest standard deviation were FXD1/2012/2, FXD4/2011/2, FXD1/2012/5, FXD1/2011/20 and FXD3/2012/2. This shows that in the tested period, these five bonds were found to have the lowest risk. The five top bonds found to have the highest standard deviation were FXD2/2007/15, FXD1/2007/15, FXD3/2007/15, FXD1/2010/15 and FXD1/2009/15. This shows that in the tested period, these five bonds were found to have the highest risk.

B2 in appendix B shows results for the unit root test namely KPSS test (including trend) which was done to check for non-stationarity of the government bond daily prices. The hypothesis tested was:

H_0: Price series is stationary against H_1: Price series is non stationary

The test results show test statistic values ranging $0.1988 < t < 5.2131$ and a critical value of 0.148 for all the tested bonds. If the test statistic is higher than the critical

value, then the null hypothesis is rejected. From the results, the test statistic values are higher than the critical values for all the tested bonds. We therefore reject the null hypothesis that the price series are stationary at 5% significance level and conclude that the price series of the bonds have a unit root and is thus considered to be non-stationary.

B3 in appendix B shows results for autocorrelation test which was done to check for autocorrelation of the government bond daily prices. The hypothesis tested was:

H_0: Price series are autocorrelated against H_1: Price series are not autocorrelated

The autocorrelation results show that all the tested bonds had an autocorrelation figure of more than zero for all the three lags. Thus from the autocorrelation results, all the tested government bond prices were found to have positive autocorrelation. The results also showed the Box Ljung statistic as having a p value of < 0.001 for all the tested bonds. Since the Box Ljung statistic results show all p values being < 0.05 for all the tested bonds, they can be said to be non-significant. The null hypothesis that price series are autocorrelated could thus not be rejected at 5% significance level. It can therefore be concluded that the prices for all the tested bonds were found to be autocorrelated implying that the past and future prices are not independent.

B4 in appendix B shows results for K-S and Shapiro Wilk tests which were done to check for normality of the government bond daily prices. The hypothesis tested was:

H_0: Prices are normally distributed against H_1: Prices are not normally distributed.

The p values obtained from the K-S test results were found to be < 0.001 for all the tested bonds. Since all the p values for all the tested bonds are < 0.05, they can be said to be significant. The null hypothesis that prices are normally distributed is thus rejected at 5% significance level. It can therefore be concluded that the prices for all

the tested bonds do not follow a normal distribution. The p values obtained from the Shapiro Wilk test results were found to be < 0.001 for all the tested bonds. Since all the p values for all the tested bonds are < 0.05, they can be said to be significant. The null hypothesis that prices are normally distributed is thus rejected at 5% significance level. It can therefore be concluded that the prices for all the tested bonds do not follow a normal distribution.

B5 in appendix B shows results for Skewness and Kurtosis which were also done to check for normality of the government bond daily prices. Skewness results show thirty four bonds as having a positive skewness statistic in the range $0.03 < s < 0.984$ which means the prices are skewed to the right while six bonds we found to have a negative skewness statistic in the range $-0.653 < s < -0.034$ which means the prices are skewed to the left . Kurtosis results show eight bonds having a positive kurtosis statistic in the range of $0.127 < k < 8.432$, thirty bonds having a negative kurtosis statistic in the range of $-1.580 < k < -0.036$ and two bonds having zero kurtosis statistic. A series is said to be perfectly normal if it has a skewness statistic of zero and a kurtosis statistic of zero. Although two bonds were found to have zero kurtosis statistic, they had a non-zero skewness statistic. Therefore from the results of both parameters, it can be concluded that all the tested bonds cannot be said to follow a normal distribution because their skewness and excess kurtosis statistic values are non-zero.

B6 in appendix B shows results for runs test which was done to check for randomness of the government bond daily prices. The hypothesis tested was:

H_o: Price series is random against H_1: Price series is not random

The test results show p values of < 0.001 for all the tested bonds. Since all the p values for all the tested bonds are < 0.05, they can be said to be significant. The null hypothesis that price series is random is thus rejected at 5% significance level. It can therefore be concluded that the prices for all the tested bonds are not random.

The major findings of this study from the test results show that the tested bonds failed to meet all the weak form EMH measures which require the bond prices to exhibit non-stationarity, zero autocorrelation between past and future prices as well as normal distribution. Although all the tested bonds were found to exhibit non-stationarity, all the past and future prices were found to be autocorrelated and the price series did not follow a normal distribution. Therefore based on these findings, the Kenyan Government bonds cannot be said to be weak form efficient.

Liew, Qiao and Wong (2008) investigated the linearity and stationarity properties of government bond returns for the G7 economies namely Canada, France, Germany, Italy, Japan, United Kingdom and United States. On testing stationarity, the results show that the bond returns were found to be stationary. (2004) tested weak form efficiency of the Sri Lanka Government bond market using econometric techniques namely Unit Root test, Correlogram test, Histogram-normality test and Auto Regressive Conditional Heteroscadasticity (ARCH) test. The unit root test showed that all the series were found to be stationary. Correlogram tests showed correlation in between yields of the series confirming stationarity. Distribution of price changes show that the median and standard deviation tend to vary around the mean, implying a stationary time series. The ARCH test the showed autoregression and correlation in all the series tested. Therefore based on the overall results of the tests, it was concluded that the said market was not weak form efficient.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study set out to investigate the weak form efficiency of the Kenyan Government Bonds at the NSE. The study was carried out with the objectives of determining whether the bond prices are non-stationary, whether the past and future bond prices are uncorrelated and whether the bond prices follow a normal distribution.

The study setting used was the Kenyan government bonds that trade in the NSE using daily closing prices for a period of four and a half years from 1st January 2009 to 30th June 2013. The target population was all fifty seven government bonds that were outstanding as at 30th June 2013. A sample of fifty government bonds was picked from the population and a sub sample of forty government bonds was then picked from the sample and their daily closing clean bond prices used to test for efficiency. The data used was of secondary nature and was collated from daily bond price lists which NSE disseminates at the end of each trading day. Unit root test was used to check for non-stationarity of the price series, autocorrelation test was done to check if past and future prices were uncorrelated and K-S & Shapiro Wilk and Skewness & Kurtosis were used to check for normality of the distributions. Runs test was also done to check for randomness of the price series.

The findings of the tests carried out revealed the following: Test on non-stationarity showed that the price series for all the tested bonds contained a unit root implying non-stationarity. Test on autocorrelation show that the past and future prices for all tested bonds were found to be positively correlated. Tests on normality showed that

the price data of all the tested bonds did not follow a normal distribution. Test on randomness showed that the price series was not random for all the tested bonds.

5.2 Conclusion

On testing non-stationarity, test results showed the price series as being non-stationary for all the tested bonds implying the existence of a unit root. However Rahman and Saadi (2008) highlighted that a unit root is a necessary pre-requisite for the random walk hypothesis but not a sufficient condition. The price series must also be serially uncorrelated to qualify as being random.

Results of the test that were used to check whether the past and future bond prices are correlated revealed that there was positive correlation between the past and future prices for all the tested bonds. This goes to show that the prices are not random and hence can be predicted implying that the bonds tested were not weak form efficient.

Results of the tests that were done to check normality of the bond prices showed that all the prices of all the tested bonds did not follow a normal distribution. It can therefore be concluded that the tested Kenyan Government Bonds cannot be said to be weak form efficient.

The runs test which was done to check randomness of the bond prices revealed results that showed the price series for all the tested bonds as not being random. It can thus be concluded that the tested government bonds cannot be said to be weak form efficient.

Using all the three measures of weak form EMH; that the prices should exhibit non-stationarity, that past and future prices should have no correlation and that prices should follow a normal distribution, it can be concluded that the Kenyan Government

Bonds at the NSE are not weak form efficient because test results conducted on the government bonds showed otherwise.

5.3 Policy Recommendations

Currently, bidding for primary bond auctions are done manually by filling in a form and taking it to CBK offices. Once the auctions are carried out, investors contact CBK to find out if their bids were successful or unsuccessful. This can be a very cumbersome and slow process. It is recommended that CBK introduces an online bidding system that will ease the bidding process and obtaining of auction results in order to increase efficiency in the whole process.

A number of government bonds listed on the NSE are very illiquid. CBK can enhance their liquidity by regularly reopening them at future auctions. This not only improves their liquidity but can also reduce government costs especially if the prevailing rates at the time of the reopen are lower than when the bond was previously issued.

CBK should actively promote financial literacy in the country in order to elicit more players and activity in the bonds markets. Currently, the major players are institutions like commercial banks, insurance companies, pension funds etc. with some of them holding the securities up to maturity. Having more players will increase market confidence and therefore further enhance market deepening.

The Sell Buy Backs transactions need to be regulated in a strict manner in order to avoid counterparties losses. There have been occasions where the counter party fails to honour the end of their deal when the time comes thereby resulting to huge losses and lawsuits which portray a negative image of the bond market. It is also recommended that counterparties be revealed to the investors in the Sell Buy Back transactions.

5.4 Limitations of the study

A bond index with data of more than three years of the Kenyan Government Bonds was not available because the FTSE NSE Government Bond Index was introduced in November 2011. Therefore daily bond prices were instead used in this study. A bond index would have been preferred for use when assessing the bonds efficiency.

Obtaining secondary data of the daily government bond prices was very challenging as the various market players did not have the data for a longer period as would have been preferred. Furthermore NSE which forms the originator of the price lists provides the data at a fee which is very costly hence the study was done using a shorter time period of four and a half years.

The Kenyan Government Bonds are fairly active hence a good number of them do not trade frequently. This illiquidity greatly affects the prices of the bonds and in turn the perceived efficiency of the said market. A more vibrant market would have been preferred when testing the market efficiency.

Most of the empirical studies available on weak form efficiency are on stock markets. Fewer have been done on government bonds and even on those, very few are available. Also most studies available tied efficiency of the government bonds to other areas such as macro-economic conditions, correlation between bond markets of different countries in the same region et cetera.

5.5 Suggestions for further studies

The study was conducted using daily bond prices because the newly introduced FTSE NSE Government Bond index did not have data lasting more than three years. Therefore it would be interesting for a future study to be conducted to test weak form efficiency using the bond index once more than three years of data becomes available.

Another study to test efficiency can be done using returns recorded on the bonds taking into account both capital gains and coupons. This will aid in the testing of efficiency using a different variable hence provide further testing of the weak form efficiency of the government bonds.

Further studies can be done to establish the current root causes of the Kenyan government bond market inefficiencies and recommend ways of improving the efficiency. This will aid in further development of the bond market thus attracting more players both locally and internationally leading to a more vibrant market.

Other studies can also be done such as testing co-integration of the Kenyan government bonds with government bonds of other countries such as those in the East Africa Region or other bond markets in Africa. This will provide information on the relationship between returns of the bonds in the different markets. This valuable information will enable investors to diversify their investments across markets which will be found to be dissimilar in term of the bod returns relationship.

REFERENCES

Afonso, A. &Teixeria J. (1998). Non Linear Tests of Weakly Efficient Markets: Evidence from Government Bond Markets in the Euro Area. *Separata 3 Dos Cadernos Do Mercado De Valores Mobiliarios.*

Ajao M. G. and Osayuwu R. (2012). Testing the Weak Form of Efficient Market Hypothesis in Nigerian Capital Market. *Accounting and Finance Research.* 1(1).

Ali S., Naseem M. A. & Sultana N. (2013). Testing Random Walk and Weak Form Efficiency Hypotheses: Empirical Evidence from SAARC Region. *Elixir International Journal*, 56.

Asiri, B. (2008). Testing Weak-Form Efficiency in the Bahrain Stock Market. *International Journal of Emerging Markets*, 2(1), 38-53.

Ayumba, P. A. (2010). An empirical test of the random walk model for the Nairobi Stock Exchange. Retrieved from http://erepository.uonbi.ac.ke:8080/xmlui/handle/123456789/13989

Bachellier, L. (1900).Theorie de la Speculation. *Annales Scientifiques de l'E´cole Normale Supe´rieureSe´r.* 3(17), 21–86.

Baghestani, H. (2009).Forecasting in efficient bond markets: Do experts know better? *International Review of Economics & Finance*, 18(4), 624.

Bernstein, P. L. (1999). A new look at the efficient market hypothesis. *The Journal of Portfolio Management,* 25(2),1–2.

Bekaert, G., Garcia M. G. P. & Harvey C. R. (1995). The role of Capital Markets in Economic Growth. *Texto Para Discussao,* No 342.

Brealey, R.A., Myers, S.C. &Allen, F. (2005).*Corporate Finance*: 8th Edition. New York: McGraw-Hill Irwin, pp. 295

Brooks C. (2008). *Introductory Econometrics for Finance.*2nd Edition. Cambridge University Press, pp. 318

Chang E. & Pinegar (1986). Return seasonality and tax loss selling in the market for long term government and corporate bonds. *Journal of Financial Economics*, 17, 391-415.

Chien, C. and Jun, D. (2010).Stock prices and the efficient market hypothesis: evidence from a market stationary test with structural breaks. *Japan and the world economy,* 22, 49-58.

Dickey D. A. & Fuller W. A. (1981).Likelihood Ration for Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49, 4

Elango, R. & Hussein M. I. (2008). An Empirical Analysis on The Weak-Form Efficiency of The GCC Markets Applying Selected Statistical Test. *International Review of Business Research Papers*, 4(1).

Fama, E. F., Fisher, L., Jensen, M. C. & Roll, R. (1969).The adjustment of stock prices to new information. *International Economic Review,*10(1), 1–21.

Fama, E. F. (1965). Random Walks in Stock Market Prices. *Financial Analyst Journal*, 55-59.

Fama, E. F. (1970).Efficient Capital Markets: A review of Theory and Empirical Work. *The Journal of Finance,* 25(2), 383–417.

Fama E.F.(1991). Efficient capital markets: II. *The Journal of Finance*,46(5), 1575–1617.

Fama, E.F. (1998). Market Efficiency, long-term returns, and behavioural finance. *Journal of Financial Economics,* 49(3), 283–306.

Frantzmann, H.J. (1989), *Saisonalitäten und Bewertung am deutschen Aktien- und Rentenmarkt*, Fritz Knapp Verlag, Frankfurt a. M.

Greene, M.T., & Fielitz, B.D. (1977). Long-term dependence in common stock returns. *Journal of Financial Economics, 4*(3), 339-349.

Grossman, S. (1976).On the efficiency of competitive stock markets where traders have diverse information. *The Journal of Finance*,31(2), 573–585.

Grossman, S. J. & Stiglitz, J. E. (1980), On the impossibility of informationally efficient markets. *The American Economic Review*,70(3), 393–408

Harry R. (1967).Statistical versus clinical prediction of the stock market. *Unpublished manuscript*.

Haugen, R. A. (1995). The New Finance: The Case Against Efficient Markets. *Contemporary Issues in Finance, Prentice Hall, Englewood Cliffs.*

Hamid, K., Suleiman M. T., Shah S. Z. A. & Akash R. S. I. (2010).Testing the Weak form of Efficient Market Hypothesis: Empirical Evidence from Asia-Pacific Markets. *International Research Journal of Finance and Economics,* 58, 121-133.

Keynes, J. M. (1923). Some aspects of commodity markets. *Manchester Guardian Commercial, European Reconstruction Series, Section 13, 29 March, Reprinted in The Collected Writings of John Maynard, Keynes, Volume XII, London: Macmillan, 1983,* 784–786

Keim, D. B. (1983). Size-Related Anomalies and Stock Return Seasonality: Further Empirical Evidence. *Journal of Financial Economics,*12, 13-32.

Latif, M., Arshad S., Fatima M., &Farooq S.(2011).Market Efficiency, Market Anomalies, Causes, Evidences and some behavioural aspects of market anomalies. *Research Journal of Finance and Accounting,* 2(9),ISSN 2222-1697.

Liew V. K, Qiao Z. & Wong W. (2008). Linearity and stationarity of G& government bond returns. MPRA Paper No. 24836

Lo, A. W. (1991). Long-term memory in stock market prices.*Econometrica,*59(5), 1279–1313.

Lo, A. W. & MacKinlay, A. C. (1999). A Non-Random Walk Down Wall Street. *Princeton, NJ. Princeton University Press.*

Mandelbrot, B.B. (1971). When can price be arbitraged efficiently? A limit to the validity of the random walk and martingale models. *Review of Economics and Statistics*, *53*(3), 225-236.

Malkiel, B. (1992).Efficient market hypothesis. In Newman P., Milgate M.and EatwellJ. (eds.). *New Palgrave Dictionary of Money and Finance, Macmillan, London.*

Malkiel, B. G. (2003).The efficient market hypothesis and its critics. *The Journal of Economic Perspectives,*17(1), 59–82.

Malkiel, B. G. (2005). Reflections on the efficient market hypothesis: 30 years later. *The Financial Review,*40(1), 1–9.

Mandelbrot, B. (1966). Forecasts of Future Prices, Unbiased Markets, and Martingale Models. *Journal of Business*, 39, 242-55.

Mishkin, F. S. (1978).Efficient Markets Theory: Implications for Monetary Policy. *Brookings Papers on Economic Activity*, 3, 707—52.

Narayan, P.K., & Narayan, S. (2007). Mean reversion in stock prices: new evidence from panel unit root tests. *Studies in Economics and Finance, 24*(3), 233-244.

Narayan, P.K., & Prasad, A. (2007). Mean reversion in stock prices: new evidence from panel unit root tests for seventeen European countries. *Economics Bulletin*, 3(34), 1-6.

Narayan, P.K., & Smyth, R. (2007). Mean reversion versus random walk in G7 stock prices: evidence from multiple trend break unit root tests. *Journal of International Financial Markets, Institutions and Money, 17*(2), 152-166.

Njimanted G. F. (2012). An investigation into the volatility and Stock Returns Efficiency in African Stock Exchange. *International Review of Business Research Papers*, 8 (5), 176 – 190.

Owido P. K., Onyuma S. O., & Owuor G. (2013). A Garch Approach to Measuring Efficiency: A case Study of Nairobi Securities Exchange. *Research Journal of Finance and Accounting, 4(4).*

Ozdemir, Z.A. (2008). Efficient market hypothesis: evidence from a small open-economy. *Applied Economics, 40*(5), 633-641.

Patel N. R. , Patel B. K. & Ranpura D (2011). Testing Weak Form Market Efficiency Of Indian Stock Markets. *SS international journal of business and management research, 1(3)*

Patoda R. & Jain K. (2012). Assimilation between Bond Market and Stock Market. *Global Journal of Management and Business Research*,12 (20)

Pessando, J. (1978). On the Efficiency of Bond Market: Some Canadian Evidence. *Journal of Political Economy*,86(6),1057 – 1076.

Pessando, J. (1979).On the Random Walk Characteristics of Short and Long term Interest Rates in an Efficient Market. *Journal of Money, Credit and Banking*, forthcoming.

Pessando, J. (1979).On forecasting interest rates: An efficient Markets Perspective. *NBER working paper 410.*

Rahman, A., & Saadi, S. (2008). Random walk and breaking trend in financial series: an econometric critique of unit root tests. *Review of Financial Economics*, 17(3), 204-212.

Samuelson, P. A., (1965). "Proof that Properly Anticipated Prices Fluctuate Randomly. *Industrial Management Review*, 6(2), 41-49.

Sichei, M. M., Tiriongo, S. K.& Shimba C. (2012).Segmentation and efficiency of the interbank market in Kenya. *KBA Centre for Research on Financial Markets and Policy Working Paper Series.*

Shleifer, A. (2000). Inefficient Markets: An Introduction to Behavioral Finance. *Oxford University Press, Oxford.(First published 2000).*

Smirlock, M. & Starks L. (1986). Day of the week Effects in Stock Returns. *Journal of Financial Economics* ,17,197-210.

Timmermann, A.& Granger, C. W. J. (2004).Efficient market hypothesis and forecasting. *International Journal of Forecasting*, 20(1), 15–27.

Reilly,F.K. & Brown, K.C. (2009).*Investment Analysis and Portfolio Management*, 9th Edition, South Western College.

Worthington, A.C., Higgs, H. (2003). Evaluating financial development in emerging capital markets with efficiency benchmarks Journal of Economic Development, 31(1).

Zahid F. M., Ramzan S. & Ramzan S. (2012). A Parametric and Non-Parametric Approach for Testing Random Walk Behavior and Efficiency of Pakistani Stock Market. *International Journal of Science and Technology*, 2(5).

APPENDICES

APPENDIX A

A1: List of Population of Kenyan Government Bonds

	Issue Number	Tenor	Issue Date	Maturity date
1	FXD2/2003/10	10	25-Aug-03	12-Aug-13
2	FXD1/2006/8	8	27-Feb-06	17-Feb-14
3	FXD1/2006/10	10	27-Mar-06	14-Mar-16
4	FXD1/2006/9	9	24-Apr-06	13-Apr-15
5	FXD2/2006/10	10	29-May-06	16-May-16
6	FXD1/2006/12	12	28-Aug-06	13-Aug-18
7	FXD1/2006/11	11	25-Sep-06	11-Sep-17
8	FXD2/2006/7	7	25-Dec-06	16-Dec-13
9	FXD1/2007/8	8	26-Feb-07	16-Feb-15
10	FXD1/2007/15	15	26-Mar-07	7-Mar-22
11	FXD1/2007/12	12	28-May-07	13-May-19
12	FXD2/2007/15	15	25-Jun-07	6-Jun-22
13	FXD1/2007/7	7	30-Jul-07	21-Jul-14
14	FXD1/2007/10	10	29-Oct-07	16-Oct-17
15	FXD3/2007/15	15	26-Nov-07	7-Nov-22
16	FXD1/2008/10	10	25-Feb-08	12-Feb-18
17	FXD1/2008/15	15	31-Mar-08	13-Mar-23
18	FXD1/2008/20	20	30-Jun-08	5-Jun-28
19	FXD2/2008/10	10	28-Jul-08	16-Jul-18
20	FXD3/2008/5	5	25-Aug-08	19-Aug-13
21	FXD3/2008/10	10	29-Sep-08	17-Sep-18
22	FXD4/2008/5	5	27-Oct-08	21-Oct-13
23	FXD1/2009/10	10	27-Apr-09	15-Apr-19
24	FXD1/2009/5	5	21-Sep-09	15-Sep-14
25	FXD1/2009/15	15	26-Oct-09	7-Oct-24
26	FXD1/2010/15	15	29-Mar-10	10-Mar-25
27	FXD1/2010/10	10	26-Apr-10	13-Apr-20
28	FXD1/2010/5	5	24-May-10	18-May-15
29	FXD1/2010/25	25	28-Jun-10	28-May-35
30	FXD2/2010/10	10	1-Nov-10	19-Oct-20
31	FXD2/2010/5	5	29-Nov-10	23-Nov-15
32	FXD2/2010/15	15	27-Dec-10	8-Dec-25
33	FXD1/2011/5	5	31-Jan-11	25-Jan-16
34	SDB1/2011/30	30	28-Feb-11	21-Jan-41
35	FXD1/2011/20	20	30-May-11	5-May-31
36	FXD3/2011/2	2	26-Sep-11	23-Sep-13
37	FXD4/2011/2	2	28-Nov-11	25-Nov-13
38	FXD1/2012/2	2	30-Apr-12	28-Apr-14

39	FXD1/2012/5	5	28-May-12	22-May-17
40	FXD1/2012/10	10	25-Jun-12	13-Jun-22
41	FXD2/2012/2	2	27-Aug-12	25-Aug-14
42	FXD1/2012/15	15	24-Sep-12	6-Sep-27
43	FXD3/2012/2	2	29-Oct-12	27-Oct-14
44	FXD1/2012/20	20	26-Nov-12	1-Nov-32
45	FXD4/2012/2	2	24-Dec-12	22-Dec-14
46	FXD1/2013/2	2	25-Feb-13	23-Feb-15
47	FXD1/2013/15	15	25-Feb-13	7-Feb-28
48	FXD2/2013/2	2	25-Mar-13	23-Mar-15
49	FXD1/2013/5	5	29-Apr-13	23-Apr-18
50	FXD2/2013/15	15	29-Apr-13	10-Apr-28
	Infrastructure bonds			
51	IFB1/2010/8	6	1-Mar-10	22-Feb-16
52	IFB 2/2010/9	6	30-Aug-10	22-Aug-16
53	IFB1/2009/12	6	23-Feb-09	16-Feb-15
54	IFB2/2009/12	6	7-Dec-09	30-Nov-15
55	IFB1/2011/12	12	3-Oct-11	28-Sep-15
	Special Bonds			
56	SFX1/2007/10	10	1-Jun-07	19-May-17
57	SFX1/2007/15	15	1-Jun-07	13-May-22

Source: CBK

A2: List of Sample of Kenyan Government Bonds

	Issue	Tenor	Issue Date	Maturity date
1	FXD2/2003/10	10	25-Aug-03	12-Aug-13
2	FXD1/2006/8	8	27-Feb-06	17-Feb-14
3	FXD1/2006/10	10	27-Mar-06	14-Mar-16
4	FXD1/2006/9	9	24-Apr-06	13-Apr-15
5	FXD2/2006/10	10	29-May-06	16-May-16
6	FXD1/2006/12	12	28-Aug-06	13-Aug-18
7	FXD1/2006/11	11	25-Sep-06	11-Sep-17
8	FXD2/2006/7	7	25-Dec-06	16-Dec-13
9	FXD1/2007/8	8	26-Feb-07	16-Feb-15
10	FXD1/2007/15	15	26-Mar-07	7-Mar-22
11	FXD1/2007/12	12	28-May-07	13-May-19
12	FXD2/2007/15	15	25-Jun-07	6-Jun-22
13	FXD1/2007/7	7	30-Jul-07	21-Jul-14
14	FXD1/2007/10	10	29-Oct-07	16-Oct-17
15	FXD3/2007/15	15	26-Nov-07	7-Nov-22
16	FXD1/2008/10	10	25-Feb-08	12-Feb-18
17	FXD1/2008/15	15	31-Mar-08	13-Mar-23
18	FXD1/2008/20	20	30-Jun-08	5-Jun-28
19	FXD2/2008/10	10	28-Jul-08	16-Jul-18
20	FXD3/2008/5	5	25-Aug-08	19-Aug-13
21	FXD3/2008/10	10	29-Sep-08	17-Sep-18
22	FXD4/2008/5	5	27-Oct-08	21-Oct-13
23	FXD1/2009/10	10	27-Apr-09	15-Apr-19
24	FXD1/2009/5	5	21-Sep-09	15-Sep-14
25	FXD1/2009/15	15	26-Oct-09	7-Oct-24
26	FXD1/2010/15	15	29-Mar-10	10-Mar-25
27	FXD1/2010/10	10	26-Apr-10	13-Apr-20
28	FXD1/2010/5	5	24-May-10	18-May-15
29	FXD1/2010/25	25	28-Jun-10	28-May-35
30	FXD2/2010/10	10	1-Nov-10	19-Oct-20
31	FXD2/2010/5	5	29-Nov-10	23-Nov-15
32	FXD2/2010/15	15	27-Dec-10	8-Dec-25
33	FXD1/2011/5	5	31-Jan-11	25-Jan-16
34	SDB1/2011/30	30	28-Feb-11	21-Jan-41
35	FXD1/2011/20	20	30-May-11	5-May-31
36	FXD3/2011/2	2	26-Sep-11	23-Sep-13
37	FXD4/2011/2	2	28-Nov-11	25-Nov-13
38	FXD1/2012/2	2	30-Apr-12	28-Apr-14
39	FXD1/2012/5	5	28-May-12	22-May-17
40	FXD1/2012/10	10	25-Jun-12	13-Jun-22
41	FXD2/2012/2	2	27-Aug-12	25-Aug-14
42	FXD1/2012/15	15	24-Sep-12	6-Sep-27

43	FXD3/2012/2	2	29-Oct-12	27-Oct-14
44	FXD1/2012/20	20	26-Nov-12	1-Nov-32
45	FXD4/2012/2	2	24-Dec-12	22-Dec-14
46	FXD1/2013/2	2	25-Feb-13	23-Feb-15
47	FXD1/2013/15	15	25-Feb-13	7-Feb-28
48	FXD2/2013/2	2	25-Mar-13	23-Mar-15
49	FXD1/2013/5	5	29-Apr-13	23-Apr-18
50	FXD2/2013/15	15	29-Apr-13	10-Apr-28

Source: CBK

A3: List of Sub Sample of Kenyan Government Bonds

	Issue	Tenor	Issue Date	Maturity date
1	FXD2/2003/10	10	25-Aug-03	12-Aug-13
2	FXD1/2006/8	8	27-Feb-06	17-Feb-14
3	FXD1/2006/10	10	27-Mar-06	14-Mar-16
4	FXD1/2006/9	9	24-Apr-06	13-Apr-15
5	FXD2/2006/10	10	29-May-06	16-May-16
6	FXD1/2006/12	12	28-Aug-06	13-Aug-18
7	FXD1/2006/11	11	25-Sep-06	11-Sep-17
8	FXD2/2006/7	7	25-Dec-06	16-Dec-13
9	FXD1/2007/8	8	26-Feb-07	16-Feb-15
10	FXD1/2007/15	15	26-Mar-07	7-Mar-22
11	FXD1/2007/12	12	28-May-07	13-May-19
12	FXD2/2007/15	15	25-Jun-07	6-Jun-22
13	FXD1/2007/7	7	30-Jul-07	21-Jul-14
14	FXD1/2007/10	10	29-Oct-07	16-Oct-17
15	FXD3/2007/15	15	26-Nov-07	7-Nov-22
16	FXD1/2008/10	10	25-Feb-08	12-Feb-18
17	FXD1/2008/15	15	31-Mar-08	13-Mar-23
18	FXD1/2008/20	20	30-Jun-08	5-Jun-28
19	FXD2/2008/10	10	28-Jul-08	16-Jul-18
20	FXD3/2008/5	5	25-Aug-08	19-Aug-13
21	FXD3/2008/10	10	29-Sep-08	17-Sep-18
22	FXD4/2008/5	5	27-Oct-08	21-Oct-13
23	FXD1/2009/10	10	27-Apr-09	15-Apr-19
24	FXD1/2009/5	5	21-Sep-09	15-Sep-14
25	FXD1/2009/15	15	26-Oct-09	7-Oct-24
26	FXD1/2010/15	15	29-Mar-10	10-Mar-25
27	FXD1/2010/10	10	26-Apr-10	13-Apr-20
28	FXD1/2010/5	5	24-May-10	18-May-15
29	FXD1/2010/25	25	28-Jun-10	28-May-35
30	FXD2/2010/10	10	1-Nov-10	19-Oct-20
31	FXD2/2010/5	5	29-Nov-10	23-Nov-15
32	FXD2/2010/15	15	27-Dec-10	8-Dec-25
33	FXD1/2011/5	5	31-Jan-11	25-Jan-16
34	SDB1/2011/30	30	28-Feb-11	21-Jan-41
35	FXD1/2011/20	20	30-May-11	5-May-31
36	FXD3/2011/2	2	26-Sep-11	23-Sep-13
37	FXD4/2011/2	2	28-Nov-11	25-Nov-13
38	FXD1/2012/2	2	30-Apr-12	28-Apr-14
39	FXD1/2012/5	5	28-May-12	22-May-17
40	FXD1/2012/10	10	25-Jun-12	13-Jun-22

APPENDIX B

B1: Descriptive Statistics

	Issue	N	Minimum	Maximum	Mean	Std. Deviation
1	FXD2.2003.10Yr	1125	85.03	130.38	97.9484	7.43448
2	FXD1.2006.8Yr	1125	87.35	128.38	106.6801	12.76605
3	FXD1.2006.10Yr	1125	93.36	144.20	114.4033	14.40310
4	FXD2.2006.9Yr	1125	100.42	139.53	116.3740	11.10529
5	FXD2.2006.10Yr	1125	93.76	146.53	114.9866	14.45252
6	FXD1.2006.12Yr	1125	95.12	155.03	118.5422	15.13839
7	FXD1.2006.11Yr	1125	95.27	148.91	113.5648	13.64036
8	FXD2.2006.7Yr	1125	88.13	123.53	103.2431	9.20531
9	FXD1.2007.8Yr	1125	93.73	133.47	110.5400	10.43833
10	FXD1.2007.15Yr	1125	81.93	170.47	121.4500	21.22954
11	FXD1.2007.12Yr	1125	87.09	151.13	113.4314	17.67192
12	FXD2.2007.15Yr	1125	77.23	170.51	118.7897	20.61075
13	FXD1.2007.7Yr	1125	81.17	122.40	101.3552	8.73102
14	FXD1.2007.10Yr	1125	76.00	158.98	103.4868	13.99304
15	FXD3.2007.15Yr	1125	72.97	159.94	109.1959	21.24792
16	FXD1.2008.10Yr	1125	68.83	132.62	102.7604	13.86672
17	FXD1.2008.15Yr	1125	79.80	158.98	108.6747	19.53250
18	FXD1.2008.20Yr	1125	84.96	185.20	118.5691	18.95834
19	FXD2.2008.10Yr	1021	77.72	134.86	103.3765	16.11346
20	FXD3.2008.5Yr	1125	86.12	117.11	100.3900	7.65371
21	FXD3.2008.10Yr	1125	75.57	134.29	99.2954	12.14841
22	FXD4.2008.5Yr	1125	83.64	120.98	100.7506	8.20513
23	FXD1.2009.10Yr	1047	77.05	134.52	100.9864	13.90419
24	FXD1.2009.5Yr	946	83.28	122.12	100.6902	10.63680
25	FXD1.2009.15Yr	923	86.29	174.93	116.6646	25.32614
26	FXD1.2010.15Yr	815	55.70	162.43	100.4819	24.89000
27	FXD1.2010.10Yr	797	66.75	126.46	94.0741	18.10150
28	FXD1.2010.5Yr	778	73.65	114.21	94.9140	12.94365
29	FXD1.2010.25Yr	754	61.41	138.39	97.6990	19.23454
30	FXD2.2010.10Yr	664	74.96	112.41	89.9702	11.69347
31	FXD2.2010.5Yr	648	70.45	112.45	89.8566	10.16124
32	FXD2.2010.15Yr	629	65.38	116.32	86.7656	15.25103
33	FXD1.2011.5Yr	606	71.63	108.73	91.9016	9.84654
34	SDB1.2011.30Yr	584	66.82	104.16	87.8330	8.24029
35	FXD1.2011.20Yr	523	66.45	103.04	77.5345	4.68115
36	FXD3.2011.2Yr	417	84.51	97.32	89.4378	5.48235
37	FXD4.2011.2Yr	397	97.50	116.05	109.1517	3.62995
38	FXD1.2012.2Yr	287	96.36	106.89	101.5001	2.20663
39	FXD1.2012.5Yr	273	85.90	109.90	101.1022	4.14948
40	FXD1.2012.10Yr	229	77.35	131.01	105.3817	7.40516

B2: KPSS Test results

	Issue	Sample size	Lag	Test Statistic	Critical values
1	FXD2.2003.10Yr	1125	3	2.8321	0.148
2	FXD1.2006.8Yr	1125	3	3.7675	0.148
3	FXD1.2006.10Yr	1125	3	3.5413	0.148
4	FXD2.2006.9Yr	1125	3	5.0193	0.148
5	FXD2.2006.10Yr	1125	3	3.9553	0.148
6	FXD1.2006.12Yr	1125	3	4.0197	0.148
7	FXD1.2006.11Yr	1125	3	3.1603	0.148
8	FXD2.2006.7Yr	1125	3	3.0387	0.148
9	FXD1.2007.8Yr	1125	3	5.2131	0.148
10	FXD1.2007.15Yr	1125	3	3.7187	0.148
11	FXD1.2007.12Yr	1125	3	3.2461	0.148
12	FXD2.2007.15Yr	1125	3	4.3875	0.148
13	FXD1.2007.7Yr	1125	3	4.2339	0.148
14	FXD1.2007.10Yr	1125	3	3.8258	0.148
15	FXD3.2007.15Yr	1125	3	3.2598	0.148
16	FXD1.2008.10Yr	1125	3	3.4243	0.148
17	FXD1.2008.15Yr	1125	3	3.3440	0.148
18	FXD1.2008.20Yr	1125	3	3.9887	0.148
19	FXD2.2008.10Yr	1125	3	2.3812	0.148
20	FXD3.2008.5Yr	1125	3	3.2657	0.148
21	FXD3.2008.10Yr	1125	3	3.3062	0.148
22	FXD4.2008.5Yr	1125	3	3.2896	0.148
23	FXD1.2009.10Yr	1047	3	3.3257	0.148
24	FXD1.2009.5Yr	946	3	2.3193	0.148
25	FXD1.2009.15Yr	923	3	1.5514	0.148
26	FXD1.2010.15Yr	815	3	0.9007	0.148
27	FXD1.2010.10Yr	797	3	1.8680	0.148
28	FXD1.2010.5Yr	778	3	2.8461	0.148
29	FXD1.2010.25Yr	754	3	1.0833	0.148
30	FXD2.2010.10Yr	664	3	1.7805	0.148
31	FXD2.2010.5Yr	648	3	2.0407	0.148
32	FXD2.2010.15Yr	629	3	1.2775	0.148
33	FXD1.2011.5Yr	606	3	0.8451	0.148
34	SDB1.2011.30Yr	584	3	0.8423	0.148
35	FXD1.2011.20Yr	523	3	0.6524	0.148
36	FXD3.2011.2Yr	417	3	0.5164	0.148
37	FXD4.2011.2Yr	397	3	1.9541	0.148
38	FXD1.2012.2Yr	287	3	0.1988	0.148
39	FXD1.2012.5Yr	273	3	0.4604	0.148
40	FXD1.2012.10Yr	229	3	0.2467	0.148

B3: Autocorrelation Test results

		Autocorrelations					
	Issue	Lag	Autocorrelation	Std. Errora	Box-Ljung Statistic		
					Value	df	Sig.b
1	FXD2.2003.10Yr	1	.983	.030	1090.275	1	.000
		2	.966	.030	2143.695	2	.000
		3	.949	.030	3160.787	3	.000
2	FXD1.2006.8Yr	1	.993	.030	1111.954	1	.000
		2	.986	.030	2210.447	2	.000
		3	.980	.030	3296.260	3	.000
3	FXD1.2006.10Yr	1	.992	.030	1109.900	1	.000
		2	.985	.030	2206.305	2	.000
		3	.979	.030	3288.698	3	.000
4	FXD2.2006.9Yr	1	.995	.030	1118.917	1	.000
		2	.991	.030	2229.438	2	.000
		3	.987	.030	3331.647	3	.000
5	FXD2.2006.10Yr	1	.993	.030	1112.751	1	.000
		2	.987	.030	2213.360	2	.000
		3	.982	.030	3303.602	3	.000
6	FXD1.2006.12Yr	1	.968	.030	1056.245	1	.000
		2	.935	.030	2043.002	2	.000
		3	.910	.030	2979.012	3	.000
7	FXD1.2006.11Yr	1	.988	.030	1100.310	1	.000
		2	.975	.030	2174.262	2	.000
		3	.963	.030	3222.258	3	.000
8	FXD2.2006.7Yr	1	.991	.030	1107.538	1	.000
		2	.983	.030	2199.073	2	.000
		3	.977	.030	3276.720	3	.000
9	FXD1.2007.8Yr	1	.995	.030	1116.394	1	.000
		2	.990	.030	2223.114	2	.000
		3	.985	.030	3320.237	3	.000
10	FXD1.2007.15Yr	1	.974	.030	1069.623	1	.000
		2	.953	.030	2094.503	2	.000
		3	.933	.030	3078.451	3	.000
11	FXD1.2007.12Yr	1	.974	.030	1070.527	1	.000
		2	.951	.030	2091.221	2	.000
		3	.930	.030	3068.215	3	.000
12	FXD2.2007.15Yr	1	.972	.030	1065.256	1	.000
		2	.950	.030	2084.311	2	.000
		3	.929	.030	3059.884	3	.000
13	FXD1.2007.7Yr	1	.977	.030	1077.800	1	.000
		2	.964	.030	2126.284	2	.000

		3	.952	.030	3150.665	3	.000
14	FXD1.2007.10Yr	1	.977	.030	1078.201	1	.000
		2	.957	.030	2114.390	2	.000
		3	.940	.030	3113.616	3	.000
15	FXD3.2007.15Yr	1	.964	.030	1049.135	1	.000
		2	.939	.030	2044.167	2	.000
		3	.916	.030	2992.062	3	.000
16	FXD1.2008.10Yr	1	.983	.030	1090.714	1	.000
		2	.970	.030	2153.987	2	.000
		3	.961	.030	3198.339	3	.000
17	FXD1.2008.15Yr	1	.976	.030	1073.921	1	.000
		2	.952	.030	2096.456	2	.000
		3	.930	.030	3073.935	3	.000
18	FXD1.2008.20Yr	1	.952	.030	1022.849	1	.000
		2	.914	.030	1966.536	2	.000
		3	.886	.030	2854.317	3	.000
19	FXD2.2008.10Yr	1	.969	.031	962.387	1	.000
		2	.942	.031	1872.824	2	.000
		3	.917	.031	2736.289	3	.000
20	FXD3.2008.5Yr	1	.990	.030	1105.473	1	.000
		2	.980	.030	2189.049	2	.000
		3	.969	.030	3250.998	3	.000
21	FXD3.2008.10Yr	1	.973	.030	1068.911	1	.000
		2	.949	.030	2084.953	2	.000
		3	.933	.030	3069.493	3	.000
22	FXD4.2008.5Yr	1	.986	.030	1096.435	1	.000
		2	.973	.030	2165.819	2	.000
		3	.960	.030	3208.188	3	.000
23	FXD1.2009.10Yr	1	.990	.031	1028.453	1	.000
		2	.980	.031	2037.573	2	.000
		3	.972	.031	3032.005	3	.000
24	FXD1.2009.5Yr	1	.978	.032	907.468	1	.000
		2	.968	.032	1797.500	2	.000
		3	.954	.032	2662.183	3	.000
25	FXD1.2009.15Yr	1	.971	.033	872.976	1	.000
		2	.945	.033	1700.371	2	.000
		3	.920	.033	2486.659	3	.000
26	FXD1.2010.15Yr	1	.959	.035	752.395	1	.000
		2	.926	.035	1454.269	2	.000
		3	.893	.035	2108.285	3	.000
27	FXD1.2010.10Yr	1	.962	.035	740.299	1	.000
		2	.925	.035	1425.158	2	.000
		3	.896	.035	2069.226	3	.000

28	FXD1.2010.5Yr	1	.993	.036	769.685	1	.000
		2	.987	.036	1530.756	2	.000
		3	.980	.036	2283.357	3	.000
29	FXD1.2010.25Yr	1	.983	.036	731.769	1	.000
		2	.967	.036	1439.852	2	.000
		3	.958	.036	2135.775	3	.000
30	FXD2.2010.10Yr	1	.957	.039	610.577	1	.000
		2	.918	.039	1173.693	2	.000
		3	.892	.039	1706.155	3	.000
31	FXD2.2010.5Yr	1	.979	.039	623.635	1	.000
		2	.964	.039	1229.098	2	.000
		3	.949	.039	1816.680	3	.000
32	FXD2.2010.15Yr	1	.961	.040	583.893	1	.000
		2	.924	.040	1124.061	2	.000
		3	.894	.040	1630.298	3	.000
33	FXD1.2011.5Yr	1	.954	.041	554.220	1	.000
		2	.912	.040	1062.147	2	.000
		3	.872	.040	1527.021	3	.000
34	SDB1.2011.30Yr	1	.814	.041	388.590	1	.000
		2	.705	.041	681.096	2	.000
		3	.585	.041	882.364	3	.000
35	FXD1.2011.20Yr	1	.902	.044	427.639	1	.000
		2	.802	.044	766.299	2	.000
		3	.756	.044	1067.700	3	.000
36	FXD3.2011.2Yr	1	.991	.049	412.254	1	.000
		2	.981	.049	817.803	2	.000
		3	.972	.049	1216.687	3	.000
37	FXD4.2011.2Yr	1	.946	.050	358.332	1	.000
		2	.916	.050	694.919	2	.000
		3	.898	.050	1018.801	3	.000
38	FXD1.2012.2Yr	1	.859	.059	214.008	1	.000
		2	.718	.059	364.029	2	.000
		3	.601	.059	469.486	3	.000
39	FXD1.2012.5Yr	1	.827	.060	188.902	1	.000
		2	.752	.060	345.544	2	.000
		3	.683	.060	475.403	3	.000
40	FXD1.2012.10Yr	1	.758	.066	133.388	1	.000
		2	.576	.066	210.823	2	.000
		3	.385	.065	245.450	3	.000

B4: K-S and Shapiro Wilk Tests results

Tests of Normality

	Issue	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
1	FXD2.2003.10Yr	.108	1125	.000	.959	1125	.000
2	FXD1.2006.8Yr	.142	1125	.000	.926	1125	.000
3	FXD1.2006.10Yr	.135	1125	.000	.895	1125	.000
4	FXD2.2006.9Yr	.248	1125	.000	.849	1125	.000
5	FXD2.2006.10Yr	.157	1125	.000	.904	1125	.000
6	FXD1.2006.12Yr	.124	1125	.000	.951	1125	.000
7	FXD1.2006.11Yr	.195	1125	.000	.891	1125	.000
8	FXD2.2006.7Yr	.164	1125	.000	.924	1125	.000
9	FXD1.2007.8Yr	.106	1125	.000	.950	1125	.000
10	FXD1.2007.15Yr	.221	1125	.000	.862	1125	.000
11	FXD1.2007.12Yr	.202	1125	.000	.899	1125	.000
12	FXD2.2007.15Yr	.240	1125	.000	.844	1125	.000
13	FXD1.2007.7Yr	.183	1125	.000	.902	1125	.000
14	FXD1.2007.10Yr	.197	1125	.000	.907	1125	.000
15	FXD3.2007.15Yr	.212	1125	.000	.882	1125	.000
16	FXD1.2008.10Yr	.247	1125	.000	.850	1125	.000
17	FXD1.2008.15Yr	.204	1125	.000	.880	1125	.000
18	FXD1.2008.20Yr	.141	1125	.000	.914	1125	.000
19	FXD2.2008.10Yr	.172	1021	.000	.936	1021	.000
20	FXD3.2008.5Yr	.154	1125	.000	.934	1125	.000
21	FXD3.2008.10Yr	.134	1125	.000	.953	1125	.000
22	FXD4.2008.5Yr	.168	1125	.000	.950	1125	.000
23	FXD1.2009.10Yr	.177	1047	.000	.895	1047	.000
24	FXD1.2009.5Yr	.165	946	.000	.931	946	.000
25	FXD1.2009.15Yr	.142	923	.000	.891	923	.000
26	FXD1.2010.15Yr	.180	815	.000	.911	815	.000
27	FXD1.2010.10Yr	.171	797	.000	.917	797	.000
28	FXD1.2010.5Yr	.125	778	.000	.900	778	.000
29	FXD1.2010.25Yr	.116	754	.000	.944	754	.000
30	FXD2.2010.10Yr	.172	664	.000	.892	664	.000
31	FXD2.2010.5Yr	.134	648	.000	.912	648	.000
32	FXD2.2010.15Yr	.149	629	.000	.890	629	.000
33	FXD1.2011.5Yr	.074	606	.000	.959	606	.000
34	SDB1.2011.30Yr	.140	584	.000	.945	584	.000
35	FXD1.2011.20Yr	.112	523	.000	.940	523	.000
36	FXD3.2011.2Yr	.273	417	.000	.716	417	.000
37	FXD4.2011.2Yr	.099	397	.000	.975	397	.000
38	FXD1.2012.2Yr	.202	287	.000	.939	287	.000
39	FXD1.2012.5Yr	.153	273	.000	.946	273	.000
40	FXD1.2012.10Yr	.198	229	.000	.889	229	.000

B5: Kurtosis and Skewness Tests results

	Issue	N	Skewness		Kurtosis	
		Statistic	Statistic	Std. Error	Statistic	Std. Error
1	FXD2.2003.10Yr	1125	.520	.073	.394	.146
2	FXD1.2006.8Yr	1125	-.034	.073	-1.259	.146
3	FXD1.2006.10Yr	1125	.723	.073	-.621	.146
4	FXD2.2006.9Yr	1125	-.141	.073	8.432	.146
5	FXD2.2006.10Yr	1125	.785	.073	-.420	.146
6	FXD1.2006.12Yr	1125	.604	.073	-.205	.146
7	FXD1.2006.11Yr	1125	.693	.073	-.400	.146
8	FXD2.2006.7Yr	1125	.332	.073	-.311	.146
9	FXD1.2007.8Yr	1125	.030	.073	-1.036	.146
10	FXD1.2007.15Yr	1125	.943	.073	-.238	.146
11	FXD1.2007.12Yr	1125	.721	.073	-.621	.146
12	FXD2.2007.15Yr	1125	.984	.073	-.199	.146
13	FXD1.2007.7Yr	1125	.796	.073	-.279	.146
14	FXD1.2007.10Yr	1125	.234	.073	1.546	.146
15	FXD3.2007.15Yr	1125	.872	.073	.000	.146
16	FXD1.2008.10Yr	1125	.877	.073	-.504	.146
17	FXD1.2008.15Yr	1125	.973	.073	.127	.146
18	FXD1.2008.20Yr	1125	.609	.073	-.632	.146
19	FXD2.2008.10Yr	1021	.265	.077	-1.111	.153
20	FXD3.2008.5Yr	1125	.555	.073	-.199	.146
21	FXD3.2008.10Yr	1125	.627	.073	.164	.146
22	FXD4.2008.5Yr	1125	.372	.073	-.702	.146
23	FXD1.2009.10Yr	1047	.736	.076	-.675	.151
24	FXD1.2009.5Yr	946	.482	.080	-.876	.159
25	FXD1.2009.15Yr	923	.831	.080	-.364	.161
26	FXD1.2010.15Yr	815	.606	.086	-.839	.171
27	FXD1.2010.10Yr	797	.150	.087	-1.376	.173
28	FXD1.2010.5Yr	778	.117	.088	-1.391	.175
29	FXD1.2010.25Yr	754	.226	.089	-.782	.178
30	FXD2.2010.10Yr	664	.386	.095	-1.302	.189
31	FXD2.2010.5Yr	648	-.340	.096	-1.134	.192
32	FXD2.2010.15Yr	629	.748	.097	-.504	.195
33	FXD1.2011.5Yr	606	.084	.099	-.800	.198
34	SDB1.2011.30Yr	584	-.653	.101	.000	.202
35	FXD1.2011.20Yr	523	.354	.107	2.821	.213
36	FXD3.2011.2Yr	417	.512	.120	-1.580	.238
37	FXD4.2011.2Yr	397	-.423	.122	-.036	.244
38	FXD1.2012.2Yr	287	.390	.144	-.160	.287
39	FXD1.2012.5Yr	273	-.418	.147	.713	.294
40	FXD1.2012.10Yr	229	.117	.161	2.340	.320

B6: Runs Test results

	Issue	Test Value a	Cases < Test Value	Cases >= Test Value	Total Cases	Number of Runs	Z	Asymp. Sig. (2-tailed)
1	FXD2.2003.10Yr	97.9484	542	583	1125	8	-33.138	.000
2	FXD1.2006.8Yr	106.6801	600	525	1125	8	-33.137	.000
3	FXD1.2006.10Yr	114.4033	620	505	1125	15	-32.712	.000
4	FXD2.2006.9Yr	116.2755	485	640	1125	5	-33.313	.000
5	FXD2.2006.10Yr	114.9866	706	419	1125	5	-33.303	.000
6	FXD1.2006.12Yr	118.5422	691	434	1125	15	-32.676	.000
7	FXD1.2006.11Yr	113.5648	744	381	1125	7	-33.160	.000
8	FXD2.2006.7Yr	103.2431	560	565	1125	5	-33.317	.000
9	FXD1.2007.8Yr	110.5400	575	550	1125	3	-33.437	.000
10	FXD1.2007.15Yr	121.4500	747	378	1125	15	-32.624	.000
11	FXD1.2007.12Yr	113.4314	754	371	1125	17	-32.480	.000
12	FXD2.2007.15Yr	118.7897	657	468	1125	13	-32.820	.000
13	FXD1.2007.7Yr	101.3552	732	393	1125	14	-32.706	.000
14	FXD1.2007.10Yr	103.3991	723	402	1125	9	-33.039	.000
15	FXD3.2007.15Yr	109.1959	719	406	1125	19	-32.394	.000
16	FXD1.2008.10Yr	102.7604	811	314	1125	5	-33.267	.000
17	FXD1.2008.15Yr	108.6747	707	418	1125	13	-32.792	.000
18	FXD1.2008.20Yr	118.5691	641	484	1125	33	-31.610	.000
19	FXD2.2008.10Yr	103.3765	592	429	1125	19	-30.813	.000
20	FXD3.2008.5Yr	100.3900	704	421	1125	16	-32.603	.000
21	FXD3.2008.10Yr	99.2954	657	468	1125	13	-32.820	.000
22	FXD4.2008.5Yr	100.7506	720	405	1125	9	-33.041	.000
23	FXD1.2009.10Yr	100.9864	623	424	1047	9	-31.861	.000
24	FXD1.2009.5Yr	100.6902	589	357	946	17	-29.668	.000
25	FXD1.2009.15Yr	116.6646	504	419	923	21	-29.069	.000
26	FXD1.2010.15Yr	100.4819	469	346	815	20	-27.204	.000
27	FXD1.2010.10Yr	94.0741	421	376	797	22	-26.756	.000
28	FXD1.2010.5Yr	94.9140	454	324	778	2	-27.838	.000
29	FXD1.2010.25Yr	97.6990	396	358	754	2	-27.404	.000
30	FXD2.2010.10Yr	89.9702	352	312	664	18	-24.463	.000
31	FXD2.2010.5Yr	89.8566	325	323	648	21	-23.903	.000
32	FXD2.2010.15Yr	86.7656	341	288	629	25	-23.171	.000
33	FXD1.2011.5Yr	91.9016	325	281	606	22	-22.921	.000
34	SDB1.2011.30Yr	87.8330	226	358	584	69	-18.253	.000
35	FXD1.2011.20Yr	77.5345	287	236	523	22	-21.036	.000
36	FXD3.2011.2Yr	89.4378	274	143	417	2	-20.342	.000
37	FXD4.2011.2Yr	109.1517	173	224	397	15	-18.520	.000
38	FXD1.2012.2Yr	101.5001	182	105	287	15	-15.191	.000
39	FXD1.2012.5Yr	101.1022	145	128	273	16	-14.727	.000
40	FXD1.2012.10Yr	105.3817	156	73	229	12	-13.498	.000

a. Mean