# Benchmark Bond Programme and Yield Curve Development in Kenya

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## Operational Definition of Terms

| | |
|---|---|
| Benchmark Bond | A bond that provides a standard against which the performance of other bonds can be measured. Government bonds are almost always used as benchmark bonds. |
| Bond Market | A financial market where securities such as bonds or notes are issued (primary market) or bought and sold (secondary market). |
| Liquidity | It is the ease with which an investor can sell or buy a bond immediately at a price close to the mid-quote which is the average of the bid–ask spread. |
| Liquid market | Market with numerous buyers and sellers of securities thus many bid and ask offers, low spreads and low volatility and it is easy to execute a trade quickly, at a desirable price and low cost. |
| Liquidity premium | Refers to the yield spread between a liquid bond and a similar but less liquid bond. |
| Financial market | A market where financial securities (such as equities, bonds, currencies and derivatives) are traded at prices that reflect supply and demand. |
| Public Debt | All outstanding financial liabilities of the Government arising from past borrowing which includes guaranteed bonds to state agencies. |
| Public Debt Management (PDM) | The process of establishing and executing a strategy for managing government bonds in order to raise the required funding levels, achieve its risk and cost objectives, and to meet any other sovereign bonds management goals such as developing and maintaining an efficient market for government securities. |
| MTDS and DSA | Frameworks formulated by the World Bank (WB) and the International Monetary Fund (IMF) for prudent PDM and take cognizance of the Global Goals for Development (GGD) concerned with promoting long run public debt sustainability in developing nations |
| Volatility | Size of cash flows or returns is high during good times and low during bad times |
| Yield Curve | A curve on a graph in which the yield of fixed-interest securities is plotted against the length of time they have to run to maturity. |

## Abbreviations and Acronyms

| | | |
|---|---|---|
| ATS | - | Automated Trading System |
| BBP | - | Benchmark Bond Programme |
| CBK | - | Central Bank of Kenya |
| CDS/CSD | - | Central Securities Depository |
| CDSC | - | Central Depository & Settlement Corporation |
| CFDDM | - | Consultative Forum for Domestic Debt Market |
| CMA | - | Capital Markets Authority |
| DSA | - | Debt Sustainability Analysis |
| EMH | - | Efficient Market Hypothesis |
| ETS/ATS | - | Electronic Trading System |
| GARCH | - | Generalized Autoregressive Conditional Heteroskedasticity |
| FV | - | Face Value |
| GDP | - | Gross Domestic Product |
| ILF | - | Intraday Liquidity Facility |
| IMF | - | International Monetary Fund |
| MLF | - | Market Leaders Forum |
| MTDS | - | Medium Term Dent Strategy |
| NT | - | National Treasury |
| NSE | - | Nairobi Securities Exchange |
| PDM | - | Public Debt Management |
| REPO | - | Repurchase Agreement |
| SSA | - | Sub Saharan Africa |
| T-Bill | - | Treasury Bill |
| T-Bond | - | Treasury Bond |
| WAY | - | Weighted Average Yield |

## Abstract

Primary and secondary bond market data and Ordinary Least Squares (OLS) and Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) techniques were used to investigate the effect of the benchmark bond programme on the development of the yield curve in Kenya from the year 2000 to 2016. Both simple and multivariate OLS showed that demand for bonds as measured by subscription rate and bid to cover ratios at the primary market were significant determinants of the level and direction of two and five-year benchmark bond yields, and not 10-year bonds. The GARCH results indicated that volatility persistency was highest in the 2-year benchmark bond yield, followed by the 5-year and then 10-year yield. In addition, the coefficient for volatility clustering was significant at 1% level, only for the 2-year yield. These outcomes indicated evidence for the 2-year benchmark yield being weak form efficient and the possibility that the medium-long term bond market was on course towards semi-strong efficiency. The findings provide evidence of positive impact of the benchmark bond programme on the development of the yield curve in Kenya thus providing insights for the need to continue strengthening and enhancing the programme to include larger bond issuances and liability management operations. Initiatives to increase demand of bonds at the primary market and level of trading in the secondary market which affect the direction and volatility of yields of bonds should be encouraged and enhanced. The results also provide lessons for the larger MEFMI region to continue supporting reforms for increasing the efficiency of the bond market.

# CHAPTER ONE

# INTRODUCTION

A bond market (also bonds or credit market) is a financial market where securities such as bonds or notes are issued (primary market) or bought and sold (secondary market). A liquid bond market is a market with numerous buyers and sellers of securities thus many bid and ask offers, low spreads and low volatility and it is easy to execute a trade quickly and at a desirable price. Changes in supply and demand of securities have impact on the market price of those securities (Flood, Liechty, and Piontek, 2015). Bond market liquidity is a component of market efficiency. The latter is the degree to which prices of securities reflect all available and relevant public and private information. A liquid and efficient market exhibits among other features; fair pricing of securities informed by market fundamentals, high liquidity, high demand and supply and competition, diversified investors (local and foreign investors), and diversified securities, low return volatility, large market size, market depth with high cross-border integration, modern electronic trading platforms, many intermediaries, and pro-growth legal and regulatory framework (Dudley, 2015).

## 1.1 Overview of Government Bond Market Liquidity and Pricing/Yield

A liquid bond market allows investors to buy or sell bonds with minimal or no delay, at a price nearer to the current market price and at low cost. Liquid bonds contribute more to the concentration of market liquidity. A variety of factors determine the level of market liquidity including frequency and size of bond issuance, market structure, nature of bonds being traded, structural changes in the market such as regulatory constraints and tighter risk management, market cycles – normal times or periods of shocks (Hendershott, Terrence and Madhavan, 2015). The determination of policies to support bond market liquidity is important to every country. Instances where bond market liquidity is constrained include the existence of small number of large holders of different outstanding bonds, resulting in thin, occasional and uneven trading of the bonds. In addition, institutional investors sometimes hold large volume of bonds to maturity with infrequent trades. As a result, it becomes difficult to matching buyers and sellers in given bonds thus increasing liquidity of bonds. Market makers, typically banks and securities firms, however become useful in helping to find matches between buyers and sellers, promoting liquidity of the bond market. The readiness of market makers to execute trades on an immediate basis facilitates price discovery and supports market liquidity. Market makers are vital to smooth market

functioning due to their willingness to absorb transitory imbalances in supply and demand (Fender and Lewrick, 2015).

An illiquid and inefficient bond market is characterized by a number of undesirable features depending on supply and demand conditions for securities including among others; few issuers of securities, few instruments with short maturities, volatility of returns and price, small market size, few deals and low turnover of trades (Brunnermeier, Markus, and Lasse, 2010). In addition, such a market has pricing inefficiency and lacks reliable yield curve and if present it is unstable. Further, this market is shallow with high concentration of certain class of investors, limited international (cross-border) linkages, low number of investors with limited diversification (narrow investor base), few intermediaries and rigid legal and regulatory frameworks that do not encourage innovation and growth of a vibrant capital market.

Some of the reasons why governments especially in the developing world, should encourage the development of the domestic bond market include growing budgetary deficits and infrastructure development needs; increasing bank financing limitations, dwindling foreign financing sources as the developed world has also been facing debt burdens (e.g. Greece) and global focus has shifted to combating terrorism and climate change. In addition, a vibrant domestic government bond market is critical for the growth of the wider financial sector and for economic stability, provides pricing benchmark for corporate sector financing, provides an important window for the conduct of monetary policy and promotes resilience to financial shocks hence financial stability.

Governments are likely to face challenges if they fail to promote the development of the local bond markets. Firstly, for countries experiencing budget deficits, growing Government financing needs are largely unmet. Most countries in Africa are experiencing increasing development financing needs (in addition to growing recurrent expenditure), as they seek to expand key economic sectors, social infrastructure and stimulate economic activity. For some countries which are currently exploring commodities such as oil and gas, initial costs are high calling for huge capital injection as they wait to reap economic benefits in future (Yibin, Phelps and Stotsky, 2013).

Secondly, according to Marques and Gelos (2016), fiscal dependence becomes a norm where overreliance on external financing sources reduces a country's independence in the management of public finance and financing needs. Foreign sources of finance attach stringent conditions and

unfavourable covenants affecting sovereignty of countries. There is a double mismatch risk, in terms of currency risk when value of foreign currency in which the bonds is denominated appreciates, and refinancing risk associated with the maturity of the loans. Short maturity loans are riskier to the borrowing government as obligations are due sooner than later. In an open economy, foreign financing sources increase vulnerability to external or global shocks significantly reducing country's resilience.

Thirdly, Government faces high cost and risk of borrowing in the domestic market. In an illiquid and inefficient market, bond issuers such as governments incur high bond service costs as investors demand high premiums to cater for illiquidity risk of securities in their portfolios (Christensen and Gillan, 2016). In addition, issuance of long term bonds (a preference of governments to reduce refinancing risk) becomes difficult because of low demand and uncertainty by investors. Short maturities of bonds increase refinancing risk to the issuer. A liquid bond market is competitive and offers lower prices for securities as determined by market fundamentals, creating investor confidence. This supports uptake of large volumes of long term bonds at lower cost and risk.

Fourthly, there is overreliance on banking sector financing by Government and private sector. As banks exploit the government by overpricing the bonds, the Government faces increased borrowing costs and risks due to dependence on banks' financing as a captive source. Most commercial banks in Africa are affiliates of foreign parent banks thus exposing the financial sector to global market swings resulting from market sentiment and negative risk perception by foreign investors (Wong, Gilley and Gonzalez, 2015). In addition, financial crisis or bank failures may largely impact on government financing needs as banks' financial capabilities are limited.

Finally, an illiquid and inefficient Government bond market results in lack of a benchmark for risk free investment and corporate market. Generally, Government bond investment is regarded as risk free and is the basis on which other products are priced with a premium for among others, liquidity and credit risk. The risk free rate in the Capital Asset Pricing Model (CAPM) is in most cases assumed to be the Government bond yield. A well-developed Government bond market provides reliable tools such the yield curve and bond indices, for pricing financial market instruments and is a prerequisite for the growth of corporate bonds market. Where the bond market is illiquid and

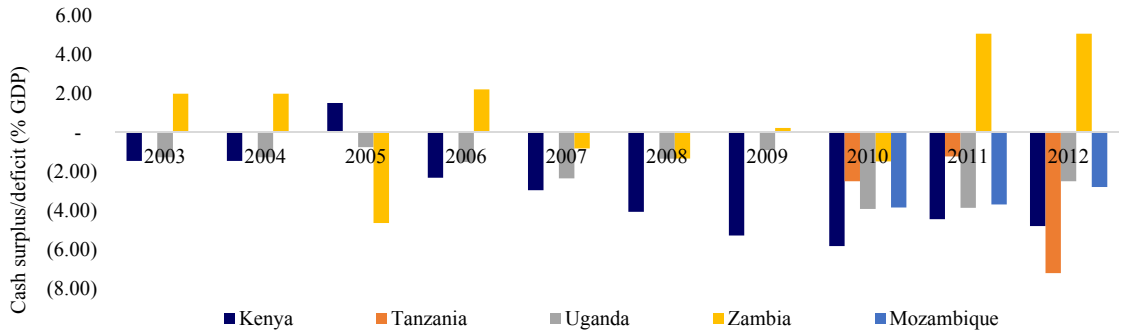
inefficient, the benchmark for risk free pricing is unavailable, significantly hampering the growth of the capital market (Dick-Nielsen, Jens, Feldhutter, and David, 2012).

## 1.2 Stylized facts on the Government Bond Market in Kenya

In 2007, there were deliberate efforts to implement reforms to develop the Government bond market, some of which had first been muted in 2001. Such reforms included the benchmark bond program, product diversification through instruments such as infrastructure bonds and the horizontal repo for the money market, and installation of modern electronic platforms for government securities at the primary and secondary markets. The reforms were aimed at helping to meet the objectives of domestic government borrowing including achieving financing requirements of the government at lowest cost and risk and promote the growth of the secondary market for government securities. The implementation of these reforms has resulted to a number of positive outcomes which are discussed in Chapter Two of this paper. Under the benchmark bond programme for instance, reopening of benchmark tenors has helped to reduce fragmentation of bonds in the market, increase turnover in the secondary market, lower interest rates, strengthen the yield curve, contribute to lower issuance costs arising from narrower bond yield spreads.

Figure 1.1 shows the trends of fiscal balance measured as a proportion of budget surplus or deficit to GDP for Kenya and selected countries in the MEMFI region for comparison purposes. Kenya's fiscal deficit has been growing at a faster rate over the years indicating growing financing need perhaps as the country is undertaking infrastructure development projects among other reasons.

**Figure 1: Trends of Fiscal Balances (Deficit/Surplus)**




*Source: World Development Indicators, 2012*

On single bond size basis, average amount received and accepted in the post reform period (2008 to 2016) increased to Kes 15.21bn and Kes 9.73bn compared from Kes 5.81bn (161.68% growth) and Kes 3.70bn (162.99% growth) in the pre-reform period (2001 to 2007) respectively. Even with this growth, appropriate benchmark sizes per bond required to ignite trading activity and liquidity in the secondary market has not been achieved. This has been contributing to a less efficient benchmark yield curve. On secondary trading of government bonds, average annual turnover of bonds in the post reform period (2008-2016) increased to Kes 354.64bn (803.08% growth) from Kes 39.27bn in the pre-reform period (2001-2007) respectively Even with this growth, the secondary market is still illiquid with many inactive small bonds which results in an inefficient benchmark yield curve.

## 1.3 Problem Statement

Most countries in Africa have been reliant on external financing such as concessional loans and grants for funding capital spending and government deficits, a few countries with limited access to global capital markets. The western world has shifted financing focus to issues such as combating terrorism and climate change which has affected donor flows to Africa. If access to alternative financing sources such as bond markets is not seriously considered, many African countries will continue to face difficulties in financing critical needs. Studies that have discussed lack of focus on the development of bond markets in SSA include Skeel (2010) and Thakor (2012) who observed that most studies in SSA concentrated on banking sector and stock markets with little focus on bond markets. Different research work by Kablan (2010) and Beck et al. (2011) observed that there was little attention on development of Government and corporate bond markets in Africa and with no deliberate reforms to strengthen bond market liquidity.

According to Thupayagale (2015), there has been little research focus on bond market liquidity with numerous studies concentrated on global equity markets presenting evidence for and against weak form efficiency. For Kenya, findings indicated that even with the implementation of market development reforms, Kenya's local currency bond market remained illiquid and inefficient. Statistical significance of long memory parameters suggesting that bond yield changes and volatility represented an important description of Kenya's bond market liquidity. The smaller size of post reform period long memory parameters indicated that some good progress had been made

and that strengthening of market reforms still needed to be considered as a matter of priority in Kenya.

Ngugi and Agoti (2010) in their study on *"Microstructure elements of the bond market in Kenya"* noted that majority of bond markets in Africa are in their infant stage of development offering minimal alternative source of financing for Governments and the private sector. A highly liquid, efficient and less volatile market is more preferred as it facilitates greater participation by firms and investors. In addition, a key prerequisite for the development of corporate bonds market is the growth of Treasury bond market.

Although Kenya's domestic government bond market has been relatively superior over many other bond markets in Africa, it is still at its nascent stage of development characterized by undesirable features of illiquidity and inefficiency. Kenya's budgetary financing needs have been rising faster than her peers in the region and Africa (figure 1.1) which calls for a reliable domestic government bond market as one of the financing sources. Although average maturity of bonds has been increasing from 0.5 years in 2001 to highest level of 7.91 years in 2015, it has not reached the targeted 10 years envisaged in the government's Medium Term Debt Strategy (MTDS). Average maturity of government securities has shortened due to increased issuance of short dated bonds as market conditions for issuance of medium-long term bonds have not been favorable.

But even with the foregoing developments, the following factors have contributed to a less efficient term structure of interest rates (Crown Agents Report[1], 2009):

i. There do not exist liquid government bonds at regular intervals throughout the time span for which the term structure has to be developed. There are many outstanding bond series across short to medium term maturity spectrum, contributing to market illiquidity. The benchmark bonds programme is being implemented to reduce the number of outstanding bond series and only have few large size bonds in the market.

[1] A report on *"Framework to establish a robust Primary Market for Debt Securities in Kenya"* reviewed the Market Structure and Framework for Strengthening Domestic Debt in Kenya (under World Banks' FLSTAP - Financial and Legal Sector Technical Assistance Programme for Kenya)

ii. The term structure is defined in terms of yield to maturity of zero coupon bonds, but most of the benchmark government bonds pay coupons, and a zero coupon yield cannot be directly inferred from the prices of coupon paying bonds
iii. Less diversified investor base, where banks still remain a captive market dominating Government securities. Initiatives to separate wholesale and retail segments of the markets are in place.
iv. Uncertainties about government borrowing programme. The National Treasury is working on initiatives to increase transparency to the market.
v. Lack of a full-electronic auction framework for government securities. Various electronic channels to access government securities are under implementation.
vi. Lack of an Over The Counter (OTC) market for government securities. Initiatives to have in place OTC platform for Treasury bills and bonds are in high gear.
vii. Less accommodative regulatory environment – to allow innovations such as short selling. The relevant laws are being reviewed for amendment.

From the foregoing, the domestic government bond market in Kenya has not achieved the level of development to result in a reliable and efficient yield curve. There is need to find out whether the reforms being implemented to develop the market are achieving the intended impact. There is an information gap on the strength of relationships between key variables that represent the reforms being undertaken such as the level of issuance needed to impact on efficiency of the bond market through narrower bond yields and more stable and firmer yield curve.

This study was focused on the period from 2000 to 2016 during which key reforms for public debt management and bond market development were conceived and begun to be implemented. Deliberate reforms to develop the domestic government securities market were initiated in 2001 when restructuring of domestic public debt was undertaken. The implementation of key market development initiatives (such as the benchmark bond program) begun in 2007. This study referred to the period between before 2000 as the pre-reform period, 2001-2007 as the reform period while 2008 to 2016 was the post reform period. The study assessed the effect of the benchmark bond programme (BBP) on the development of the yield curve in Kenya from the year 2000 to 2016.

The benchmark bonds programme is represented by microstructure variables that are specific to the bond instruments and the performance of the bond market. Other variables that influence bond yields and the bond market in the macroeconomic, financial and structural environment have not been included in this study because of the need to focus on the effect of microstructure elements of the government bond market on bond yields.

## 1.4 Objectives of the Study

*General Objective*

This study aimed to determine the effect of the implementation of the benchmark bond programme on the development of the yield curve in Kenya during the period from 2000 to 2016.

*Specific Objectives*

The specific objectives of the study were to:

(i) Determine the scale of significance of the bond portfolio size (stock and turnover of bonds) on bond yields.

(ii) Examine the effect of bond demand (subscription rates and bid-to-cover ratios) on bond yields.

(iii) Evaluate the informational efficiency of government bonds through long memory analysis of changes and volatility of bond yields.

## 1.5 Research Hypothesis

The following research hypotheses were tested:

$H_0$: Bond portfolio size (stock and trading turnover) does not have significant effect on bond yields

$H_0$: Bond demand (subscription rates, bid-to-cover ratio) do not have significant effect on bond yields

$H_0$: There is evidence against EMH in the Kenyan government bond market

## 1.6 Significance of the Study

This study is relevant to Kenya's medium-long term development blue print 'Vision 2030' where the economic pillar promotes financial sector development and prudent public finance management for economic growth. Governments are critical in supporting domestic capital market development through prudent monetary and fiscal (public finance) management policies. This

study was intended to inform policy makers and stakeholders in Kenya on the effectiveness of PDM reforms being undertaken such as the benchmark bond programme (BBP), and perhaps provide impetus for enhanced implementation of the programme. The study also targeted to offer insights on the development of the government bond market to MEFMI region countries.

## 1.7 Scope of the Study

This study seeks to determine the effect of the benchmark bond programme on the development of the yield curve during the period 2000 to 2016 in Kenya. The study focuses on government bond market because there is little data available on corporate bond market.

## 1.8 Limitations of the Study

Other variables not included in this study that may be related to the efficiency of the Government bond market in Kenya were not studied because of the need to reduce the number of study variables, enhance focus on microstructure elements of the benchmark bond programme in Kenya and lack of data. The corporate bonds market was excluded due to inadequate data.

## 1.9 Organization of the Study

The rest of the paper is structured as follows; Chapter Two presents an overview of domestic government bond market in Kenya while Chapter Three presents a literature review on domestic government bond markets and the conceptual framework. The research methodology is presented in Chapter Four, discussion of empirical findings in Chapter Five and conclusion and recommendations in Chapter Six.

# CHAPTER TWO

# OVERVIEW OF DOMESTIC GOVERNMENT BOND MARKET IN KENYA

## 2.1 Primary Market for Treasury Bonds

### 2.1.1 Stock of Bonds

Figures 2.1 shows the growth of the stock of government securities from the year 2000. The stock increased from Kes 170.98bn in 2000 to Kes 1,869.5bn in 2016 (a growth of 993.4%), with faster growth from 2009 (289.6% growth to 2016), reflecting increased market demand for government securities. The stock of Treasury bonds compared to Treasury bills was highest in 2011 at 85.54% compared to its lowest level of 17% in 2001.

**Figure 2: Stock of Domestic Government Securities by Instrument**

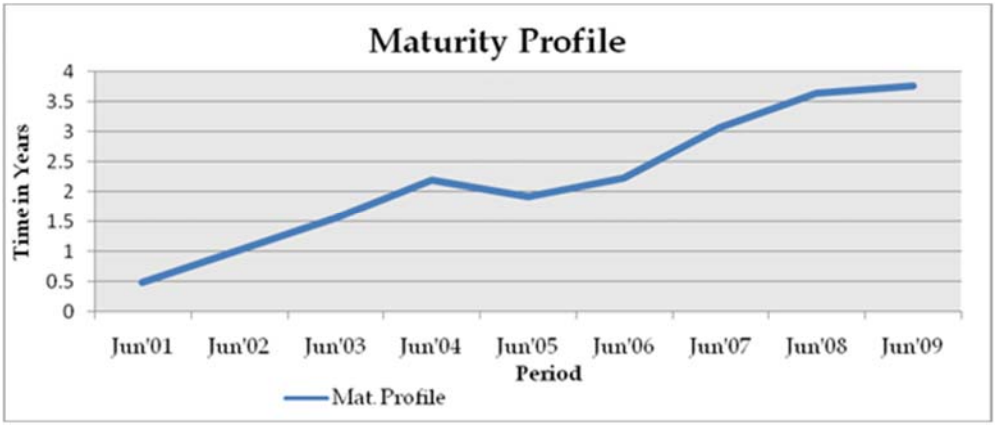

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treasury Bills | 134. | 116. | 87.0 | 78.7 | 62.9 | 71.9 | 94.5 | 94.4 | 76.2 | 119. | 133. | 107. | 161. | 268. | 299. | 390. | 620. |
| Treasury Bonds | 36.8 | 44.5 | 106. | 161. | 188. | 193. | 218. | 272. | 315. | 360. | 513. | 633. | 686. | 733. | 903. | 1,07 | 1,24 |
| Stock of T.Bonds (%) | 19.00 | 17.00 | 46.00 | 63.00 | 71.00 | 69.00 | 66.00 | 71.00 | 79.00 | 73.00 | 79.00 | 85.54 | 80.93 | 73.18 | 75.12 | 73.29 | 66.83 |

*Source: Central Bank of Kenya*

### 2.1.2 Maturity Profile of Bonds

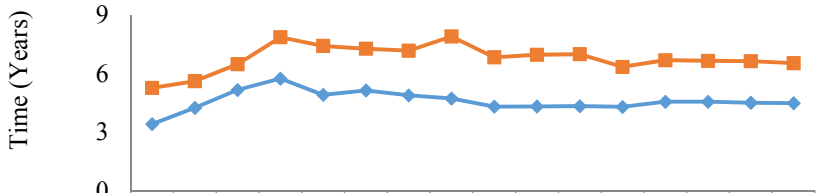
Back in 2001, Treasury bonds accounted for 24% of government domestic debt compared to 76% in Treasury bills. In May 2001, a debt restructuring program was implemented to reduce the pressure on interest rates arising from frequent rollover of maturing securities. The borrowing program concentrated on issuance of large sizes of fixed and floating rate bonds aimed at increasing the proportion of medium to long term bonds and reduce dominance of 91-day Treasury bill. Consequently, by 2009, the domestic debt securities portfolio was reversed with Treasury bonds and bills accounting for 74% and 26% of the debt respectively (Figures 2.2 and 2.3). The second objective of the restructuring program was to develop a reliable yield curve to guide pricing at the primary and secondary markets.

**Figure 3: Average Maturity of Government Securities from 2001 to 2009**




*Source: Central Bank of Kenya*

**Figure 4: Average Maturity of Government Securities from 2010 to 2016**




| | Jun-08 | Jun-09 | Jun-10 | Jun-11 | Jun-12 | Jun-13 | Jun-14 | Jun-15 | Jun-16 | Jul-16 | Aug-16 | Sep-16 | Oct-16 | Nov-16 | Dec-16 | Jan-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Time To Maturity (Years)-All securities | 3.417 | 4.250 | 5.167 | 5.750 | 4.917 | 5.14 | 4.89 | 4.73 | 4.31 | 4.32 | 4.34 | 4.3 | 4.56 | 4.56 | 4.51 | 4.49 |
| Average Time To Maturity (Years)-bonds | 5.27 | 5.62 | 6.49 | 7.87 | 7.42 | 7.28 | 7.18 | 7.91 | 6.84 | 6.97 | 7 | 6.35 | 6.69 | 6.66 | 6.64 | 6.54 |

*Source: Central Bank of Kenya*

At less than 0.5 years in 2001, average maturity of government securities increased to more than 2 years by June 2004, dropped slightly to between 1.5 years and 2 years in June 2005 and continued to rise to between 3.5 years to 4 years by June 2009 (figure 2.2). According to figure 2.3, average maturity of all government securities peaked to 5.75 years by June 2011 but declined steadily to 4.3 years by September 2016, due to unfavorable market conditions such as liquidity tightness that led to increased issuance of short term instruments. Average maturity of bonds alone was highest in 2015 at 7.91 years compared to 7.87 years in 2011, 6.35 years in 2016 and 5.27 years in 2008 when implementation of reforms to lengthen the debt maturity begun to be fast tracked. The medium term objective set out in the 2016 MTDS of the government and as envisaged by the

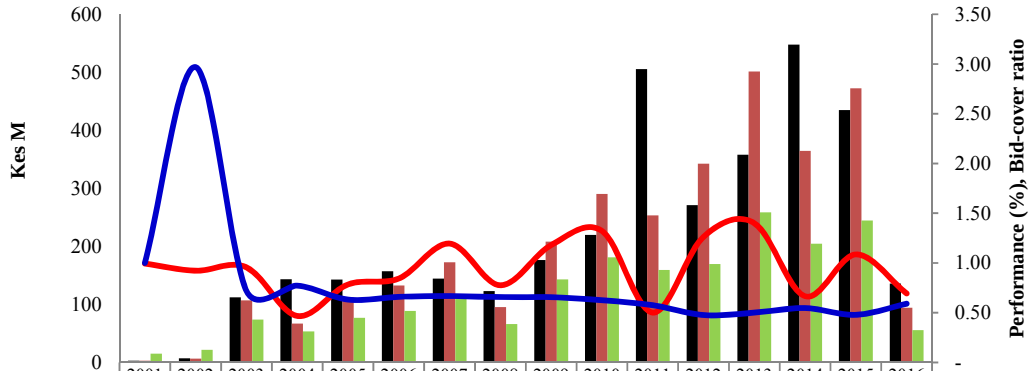
market stakeholder forum[2] has been to achieve a bonds portfolio maturity of 10 years through issuance of large sized long term bonds under the benchmark bonds programme.

### 2.1.3 Auctions of Treasury Bonds

The Central Bank of Kenya, acting as fiscal agent of the government, issues Treasury bonds on a monthly basis, through issuance techniques such as auction and tap sales. Treasury bonds are listed and traded at the NSE and can be pledged as collateral (or for lien) security against credit facilities (loans), and may also be transferred among holders of CDS accounts. Commercial banks also use bonds as collateral for liquidity management through Repurchase Agreements (Repos) and Intraday Liquidity Facility (ILF).

Figure 2.4 shows that auctions of Treasury bonds were generally oversubscribed during the period 2001 and 2016, indicating sustained demand. However, 2011 and 2014 recorded significant undersubscriptions perhaps due to unfavorable market conditions such as liquidity tightness, rising inflation and interest rates.

**Figure 5: Auctions of Treasury Bonds**




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Offer | 3.00 | 7.31 | 112.0 | 143.5 | 143.0 | 157.2 | 144.4 | 123.0 | 176.5 | 219.6 | 505.6 | 271.1 | 358.0 | 547.8 | 435.0 | 136.0 |
| Received (Face Value) | 2.98 | 6.74 | 107.1 | 67.08 | 112.2 | 132.6 | 172.6 | 95.51 | 208.2 | 290.3 | 253.4 | 342.4 | 501.2 | 364.4 | 472.4 | 94.32 |
| Accepted at FV (Ksh M) | 15.30 | 21.61 | 73.99 | 53.33 | 77.06 | 88.77 | 116.7 | 66.24 | 143.2 | 181.1 | 159.2 | 169.5 | 258.5 | 204.6 | 244.6 | 55.69 |
| Perfomance | 0.99 | 0.92 | 0.96 | 0.47 | 0.78 | 0.84 | 1.19 | 0.78 | 1.18 | 1.32 | 0.50 | 1.26 | 1.40 | 0.67 | 1.09 | 0.69 |
| Bid Cover Ratio | 1.00 | 2.97 | 0.72 | 0.77 | 0.63 | 0.66 | 0.67 | 0.66 | 0.66 | 0.63 | 0.58 | 0.48 | 0.50 | 0.55 | 0.48 | 0.59 |

*Source: Central Bank of Kenya*

Table 2.1 shows that the annual average offer size of bonds issued during the period 2001 and 2016 was Kes 217.70 billion while average received and accepted amounts were Kes 201.50bn

[2] This forum was known as Market Leaders Forum (MLF) until 2015 when it was restructured to become the Consultative Forum for Domestic Debt Market (CFDDM) and the Bond Market Stakeholders Forum (BMSF), currently chaired by the Governor, CBK and Deputy Governor, CBK respectively.

and Kes120.61bn respectively. Annual average and median subscription rates and bid to cover ratios during the period was 94% (similar for average and median), 0.78 times and 0.64 times respectively. Annual average and median offer amounts of bonds issued in the post-reform period increased to Kes 308.08bn and Kes 271.12bn compared to Kes 101.50bn (203.52% growth) and Kes 143bn (87.50% growth) during the pre-reform period respectively.

**Table 1: Auctions of Treasury Bonds in the Period 2001 to 2016 (Kes bn)**

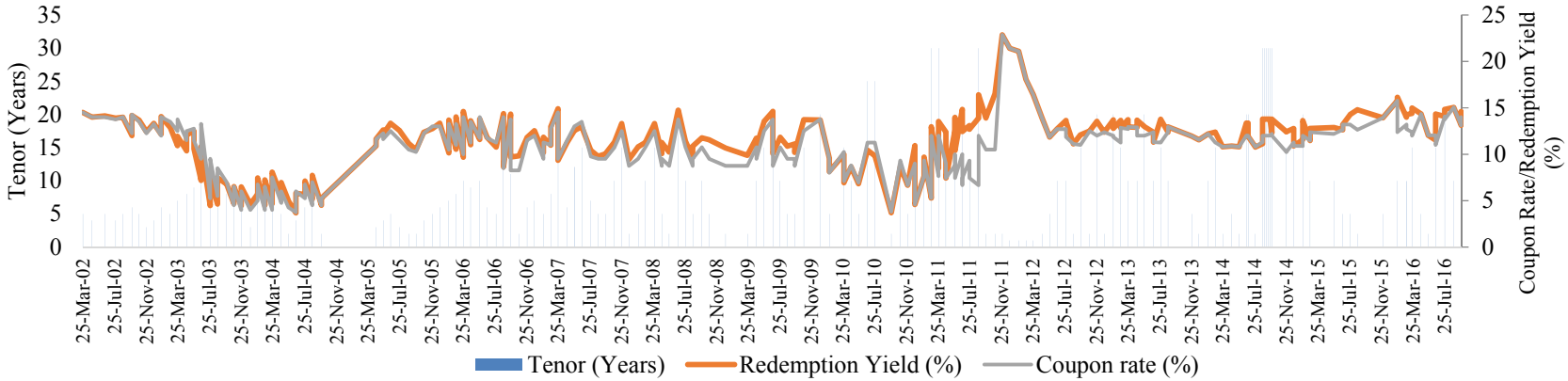
| | Offer | Received (Face Value) | Accepted at FV (Ksh M) | Accepted at cost (Ksh M) | Performance (%) | Bid Cover Ratio (Times) |
|---|---|---|---|---|---|---|
| Average | 217.70 | 201.50 | 120.61 | 115.52 | 0.94 | 0.78 |
| Median | 150.86 | 152.66 | 102.75 | 101.42 | 0.94 | 0.64 |
| Pre-07 Average | 101.50 | 85.92 | 63.83 | 60.82 | 0.88 | 1.06 |
| Post-07 Average | 308.08 | 291.39 | 164.77 | 158.06 | 0.99 | 0.57 |
| Pre-07 Median | 143.00 | 107.13 | 73.99 | 71.00 | 0.92 | 0.72 |
| Post-07 Median | 271.12 | 290.38 | 169.59 | 163.27 | 1.09 | 0.58 |
| Minimum | 3.00 | 2.98 | 15.30 | 2.98 | 0.47 | 0.48 |
| Maximum | 547.82 | 501.28 | 258.58 | 250.99 | 1.40 | 2.97 |

*Source: Central Bank of Kenya*

Annual average amount received and accepted in the post reform period increased to Kes 291.39bn and Kes 164.77bn compared from Kes 85.92bn (139.13% growth) and Kes 63.83bn (158.15% growth) in the pre-reform period respectively. Median amount received and accepted in the post reform period increased to Kes 290.38bn and Kes 169.59bn compared to Kes 107.13bn (171.06% growth) and Kes 73.99bn (129.19% growth) in the pre-reform period respectively.

On the basis of single bond series, the average offer size of bonds during the period 2001-2016 was Kes 12.85 billion while average amounts received and accepted were Kes 11.73bn and Kes 7.32bn respectively. Average and median offer amounts of bonds issued at the primary market in the post-reform period increased to Kes 15.96bn and Kes 15bn (116.08% growth) compared to Kes 7.39bn and Kes 8bn (87.50% growth) during the pre-reform period respectively. Average amount received and accepted in the post reform period increased to Kes 15.21bn and Kes 9.73bn compared from Kes 5.81bn (161.68% growth) and Kes 3.70bn (162.99% growth) in the pre-reform period respectively. Median amount received and accepted in the post reform period increased to Kes 13.11bn and Kes 9.36bn compared to Kes 5.07bn (158.49% growth) and Kes 3.34bn (179.39% growth) in the pre-reform period respectively.

**Figure 6: Kenya Government Bond Yield, Coupon Rate and Tenor**




*Source: Central Bank of Kenya*

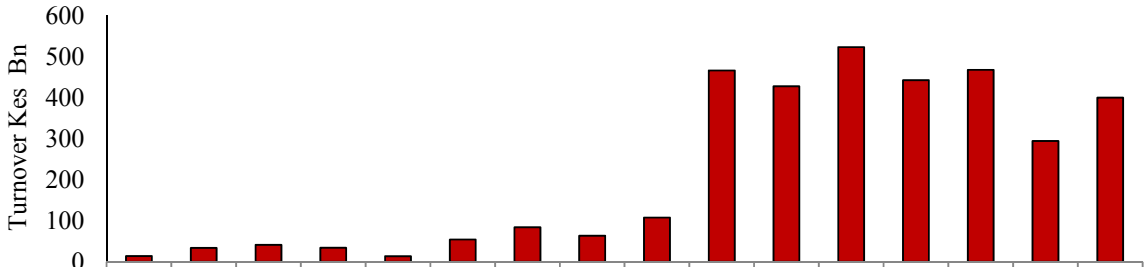
According to Figure 2.5, domestic Government bonds issued during the period 2001-2016 were largely fixed coupon bonds with floating rate bonds (mainly 1-3 years and referenced on the 91-day Treasury bill rate) issued from 1997 to 2002 and discontinued in 2003. Zero coupon bonds, mainly one-year in tenor, were also issued between 2001 and 2008, and withdrawn from 2009 when the 364-day Treasury bill was introduced. There was general stability of interest rates (coupon rate and yield to maturity (WAY)) of bonds issued at the primary market in the period between 2002 and 2016. However, volatility can be observed in 2002, 2003 and 2011. The average tenor of bonds issued during the period under review was 7.7 years while average coupon rate and WAY was 10.914% and 11.582% respectively. Average tenor of bonds issued at the primary market increased to 9.3 years in the period between 2008 and 2016 (post-reform period) compared with 5.3 years (growth of 73.76%) in the period between 2001 and 2007 (pre-reform period) while median tenor remained unchanged at 5 years both in the pre- and post-reform periods. Average coupon rate and WAY in the post reform period increased to 11.426% and 12.487% compared to 10.148% and 10.224% in the pre-reform period respectively. Median coupon rate and WAY in the post reform period increased to 11.934% and 12.531% compared to 11.250% and 10.943% in the pre-reform period respectively.

## 2.2 Secondary Market for Government Bonds

Before 2007, Kenya's government bond market was characterized by many small bonds of similar and/or different maturities scattered along the yield curve. This bond fragmentation phenomenon led to an illiquid secondary market (Figure 2.6), reflected by infrequent trades and wide yield spreads. The net result was an unstable and unreliable yield curve, with most investors pursuing buy-hold rather than buy-trade strategies due to lack of reliable pricing mechanism.

As shown in figure 2.6 and appendix 2, annual bond trading turnover at the Nairobi Securities Exchange (NSE) improved significantly from 2010 to 2016 which was the post-reform period compared to 2001 to 2009, the pre-reform period. During the period under review, trading turnover was at its highest point in 2012 at Kes 522.89bn (an increase by 36.14 times) compared to Kes 14.08bn back in 2001. Annual average turnover during the period 2001 to 2016 was Kes 216.66bn while annual median turnover Kes 95.99bn. Annual average and median turnover in the post reform period (2008-2016) was Kes 354.64bn (803.08% growth) and Kes 427.69bn (growth by 1,153.86%) compared to Kes 39.27bn and Kes 34.11bn in the pre-reform period respectively (appendix 2).

**Figure 7: Trading Turnover of Treasury Bonds (Kes Bn)**




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turnover | 14.08 | 33.63 | 41.13 | 34.11 | 13.63 | 54.16 | 84.14 | 63.21 | 107.85 | 466.07 | 427.69 | 522.89 | 442.40 | 467.40 | 294.32 | 399.90 |

*Source: NSE, CMA*

On month analysis, appendix 1 shows increased monthly trading activity in the post reform period compared to pre-reform period. For instance, turnover in June 2010 shot to Kes 93.38bn compared to Kes 0.14bn in June 2001 and Kes 11.10bn in June 2009, representing an increase by 666 times and 7.41 times respectively.

There was significant improvement in average, median, minimum and maximum turnover levels from 2009 to 2016 compared to 2001 to 2008. The highest average and median annual turnover was Kes 43.57bn in 2012 and Kes 39.24bn in 2014 compared to the lowest levels of Kes 1.14bn in 2005 and 0.90bn in 2001 respectively. Maximum turnover declined significantly to Kes 60.73bn in 2011 from Kes 93.28bn in 2010, partly due to tight liquidity and high interest rates in 2011. The monetary policy was tight as the Central Bank Rate (CBR) was gradually raised from 5.75% in June 2011 to 18% in December 2011 (appendix 3).

Bond trading turnover peaked in the months of March, May and June during the entire period under review, with highest observations during the post reform period from 2008 to 2016. Average turnover for the entire period was Kes 20.21bn, Kes 20.86bn and Kes 24.77bn while average turnover during post reform period was Kes 33.94bn, Kes 34.57bn and Kes 40.48bn in the months of March, May and June (Appendix 4).

## 2.3 Kenya Government Bond Yield Curve

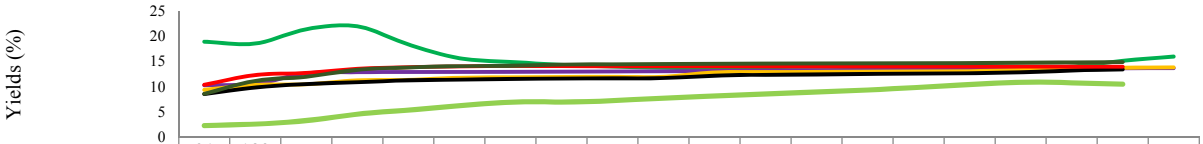
A yield curve (*also term structure of interest rates*) represents the relationship between yield to maturity and time to maturity of bonds of similar asset class and credit quality. It reflects the sentiments of investors and traders on the direction of future interest rates. The shape (slope, level and curvature) of the yield curve is affected by changes in interest rates, supply and demand, maturity, and credit quality of bonds. Before 2007, Kenya's bond market was characterized by many small bonds of the similar and/or different maturities scattered along the yield curve. This bond fragmentation phenomenon led to an illiquid secondary market (Figure 2.6), reflected by infrequent trades and wide yield spreads. This situation led to an unstable and unreliable yield curve, with most investors pursuing buy-hold rather than buy-trade strategies due to lack of a reliable pricing mechanism. Imperative to developing a robust domestic bond market is a reliable yield curve as a pricing tool and the bond index as portfolio valuation tool. Bond market fragmentation discourages the development of the yield curve and bond index.

As at September 2016, there were 38 outstanding benchmark bonds valued at Kes 795bn. This translated to an average of Kes 21bn per outstanding bond. Such an amount of issuance is not adequate to attract the participation of major foreign investors. Invariably, this confirmed that the market was still faced with bond fragmentation and low liquidity per bond series. The problem of

fragmentation of bonds therefore persisted even with the increased issuance of benchmark tenors and reopening of bonds.

The Kenyan yield curve has historically been estimated using the current yields computed on Treasury bonds traded at NSE. It excludes yields on corporate bonds, Treasury infrastructure bonds, floating rate bonds or fixed rate bonds whose traded volume is less than Kes 10 million. Corporate bonds are few both in value and number, mostly restricted to institutional investors due to higher entry threshold of Kes 1mn, implying illiquidity (Chironga, Wambua and Ngugi, 2010).

**Figure 8: Evolution of Kenya Government Bond Yield Curve**




| | 91 days | 182 days | 1 yr | 2yr | 3yr | 4yr | 5yr | 6yr | 7yr | 8yr | 9yr | 10yr | 11yr | 12yr | 13yr | 14yr | 15yr | 20yr | 25yr | 29yr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 YC | 2.313 | 2.631 | 3.283 | 4.586 | 5.405 | 6.223 | 6.980 | 6.987 | 7.223 | 7.769 | 8.172 | 8.577 | 8.989 | 9.361 | 9.914 | 10.41 | 10.92 | 10.77 | 10.51 | |
| 2011 YC | 18.94 | 18.58 | 21.40 | 22.00 | 18.40 | 15.67 | 14.92 | 14.37 | 14.02 | 13.75 | 13.58 | 13.37 | 13.28 | 13.36 | 13.51 | 13.59 | 13.69 | 14.00 | 15.16 | 16.00 |
| 2012 YC | 10.31 | 10.60 | 12.67 | 12.90 | 12.93 | 12.97 | 12.97 | 12.99 | 13.00 | 13.06 | 13.17 | 13.22 | 13.28 | 13.32 | 13.36 | 13.40 | 13.43 | 13.57 | 13.67 | 13.70 |
| 2013 YC | 9.400 | 10.38 | 10.50 | 11.28 | 11.38 | 11.80 | 11.88 | 11.95 | 11.97 | 11.99 | 12.85 | 12.93 | 12.95 | 13.02 | 13.05 | 13.10 | 13.35 | 13.54 | 13.78 | 13.85 |
| 2014 YC | 8.571 | 9.855 | 10.57 | 10.89 | 11.30 | 11.40 | 11.56 | 11.64 | 11.68 | 11.72 | 12.22 | 12.36 | 12.44 | 12.53 | 12.62 | 12.72 | 12.84 | 13.24 | 13.45 | |
| 2015 YC | 10.41 | 12.34 | 12.75 | 13.56 | 13.9 | 14.06 | 14.14 | 14.1 | 14.09 | 14.07 | 14.06 | 14.05 | 14.04 | 14.03 | 14.03 | 14.02 | 14.02 | 14 | 13.99 | |
| 2016 YC | 8.607 | 11.18 | 11.98 | 13.39 | 13.83 | 14.12 | 14.15 | 14.42 | 14.46 | 14.52 | 14.56 | 14.6 | 14.62 | 14.64 | 14.7 | 14.73 | 14.74 | 14.85 | 14.9 | |

*Source: NSE*

Increased issuance of benchmark tenors and reopening of bonds has helped to reduce the bond fragmentation, increased turnover in the secondary market (Figures 2.6, Appendices 1-4), lowered interest rates, firmed up the yield curve (Figure 2.7, Appendices 5-6) and also minimized issuance costs as a result of narrow bond yield spreads in the secondary market (Appendix 6). In addition, there have been enhanced subscriptions in primary market auctions and improved market confidence. With continued implementation of reforms and as the liquidity of bonds at the secondary market continues to improve, it is expected that the levels of coupon rates and WAY at the primary market will decline while more medium-longer tenors of bonds are issued, resulting in lower cost of debt and lower refinancing risk.

# CHAPTER THREE
# LITERATURE REVIEW

## 3.1 Introduction

This chapter reviews both theoretical and empirical work on government bond market efficiency. The determination of the efficiency of the domestic government bond market in Kenya is explained using the Efficient Market Hypothesis (EMH) theory and the Interest Rate Structure theory.

## 3.2 Efficient Market Hypothesis (EMH)

The Efficient Market Hypothesis was developed by Eugene Fama (1970) and states that asset prices fully reflect all available information, that is, shares always trade at their fair value, making it impossible for investors to either buy undervalued stocks or sell at overvalued prices. On a risk-adjusted basis, it is impossible to consistently outperform the overall market based on expert stock selection or market timing because market prices should only react to new information. The only way investors can possibly obtain higher returns is by chance or by buying riskier investments. A study by Fama and French (2012) confirmed the EMH by observing that the distribution of abnormal returns of mutual funds in the USA was very similar to the expected distribution where fund managers had no skill to undertake expert selection analysis.

Fama (1970) identified three forms of the EMH. Firstly, the weak form asserts that prices on traded financial assets already reflect all past publicly available information. Secondly, the semi-strong form is where prices of securities reflect all publicly available information and instantly change to reflect new public information. Share prices adjust very rapidly to new public information and in an unbiased fashion that no excess returns can be earned by trading on that information even with fundamental or technical analyses. Finally, the strong form of the EMH asserts that prices instantly reflect new public information and even hidden private or "insider" information.

Tests on weak EMH have concentrated on random walk analysis and momentum effect where prices of securities are studied over a period of time to establish repeat behavior. The momentum strategy is based on past prices or returns and produces strong evidence against weak-form market

efficiency. These outcomes have been observed in the stock returns of most countries, in industry returns, and in national equity market indices. To test for semi-strong-form efficiency, event analysis is undertaken where there must be reasonable and instantaneous adjustments to previously unknown news. If there are consistent upward or downward adjustments observed after the initial change, it would suggest that investors had interpreted the information in a biased fashion and inefficient manner. Strong-form efficiency test, requires that a market where investors cannot consistently earn excess returns over a long period of time is in existence. This theory supports the hypotheses that there is evidence against EMH in the Kenyan government bond market because the interest rate structure (yield curve) is determined by the level of pricing information on bonds that investors have at points in time.

### 3.3 Interest Rate Structure Theory

On one hand, investors of bonds are exposed to a number of risks such as default or credit risk, interest rate risk, inflation risk, political risk and currency or exchange rate risk. On the other hand, issuers of bonds are exposed to most of these risks with opposite potential impact of risk. The general assessment of all these risk factors by different participants of the market is reflected by the interest rate structure at points in time. The behavior or pattern of interest rates on bonds of different maturities at a given point in time is the term structure of interest rates which is used to explain the links between real economic activity and monetary policy as well as the structure of prices on fixed income securities. Central banks control the short term instruments market mainly through monetary policy while long-term interest rates are determined by firms' investment behavior which represents real economic activity (Malkiel, 1966). In this study, this theory supports the dependent variable - benchmark bond yield, which is related to the general assessment of risk by bond investors as reflected in the interest rate structure at given periods in time and on which the effect of size of bond stock, bond subscription rate and demand (bid-to-cover ratio) and trading turnover was assessed.

### 3.4 Liquidity Preference Theory

Liquidity preference is preference for holding financial wealth in the form of short-term, highly liquid assets rather than long-term illiquid assets, based principally on the fear that long-term assets will lose capital value over time. The liquidity preference theory was advanced by John Maynard

Keynes (1936) as he explained the determination of the interest rate by the supply and demand for money. The demand for money as an asset depends on the interest foregone by not holding bonds (or other less liquid assets). According to Keynes (1936), interest rate is a reward for parting with cash (liquidity) as investors put money in less liquid assets. Interest rate is not a reward for savings. Money is the most liquid asset and therefore any other asset that is convertible into money more quickly and easily is said to be liquid.

There are three motives that determine demand for liquidity. First is the transactions motive where individuals and households prefer to have liquidity to assure basic transactions because income is not constantly available. The level of income therefore determines the amount of liquidity demanded thus the higher the income, the more money demanded for carrying out more spending. Secondly, under the precautionary motive, households prefer liquidity to cater for unexpected social problems that bring unusual costs. As income rises, the amount of money demanded for this purpose also increases. Finally, speculative motive is where households retain liquidity for speculative purposes in the market such as that bond prices will fall. As the interest rate decreases there is demand for more money to hold onto until the interest rate rises. This would drive down the price of an existing bond so that its yield is consistent with the interest rate. The lower the interest rate, the more money is demanded and the higher the interest rate, the less demand for money (Keynes, 1936).

Liquidity is one of the key characteristics of the growth of a bond market that affect yields of bonds. Other major factors are interest-rate expectations, the term premium and credit risk (Vayanos, Dimitri and JiangWang, 2012). This is because, for risk-averse investors to be compensated for possible losses arising from increases in interest rates which increase with bond duration, they demand a risk premium (term premium) for investments in long-term bonds. The spread of longer maturity bond yields compared to shorter maturity bond yields results in a positive term spread regardless of whether the market expects an increasing and decreasing interest rates environment (Wong, Gilley and Gonzalez, 2015). According to Trebbi and Xiao (2016), credit risk refers to the risk of loss arising from failure of counterparty to a contract to perform according to a contractual arrangement. Example is loss due to a default by a borrower. Credit-risk premium is the spread between the yield of a credit-risk free bond and the yield of a bond with similar

characteristics but with credit risk. Globally, credit risk of bonds and issuers of bonds are assigned by rating agencies such as Moody's, Standard & Poor's, and Fitch.

According to Kyle (1985), liquidity has three dimensions. First is *tightness* which refers to a low bid–ask spread which is the cost of turning around a position during a short period. Second, *depth* where a market is said to be deep if the impact on prices of securities is only due to large buy or sell orders. Third, *resilience* which refers to ability of the market prices to reflect fundamental values and where there are shocks, quickly return to fundamental values. Liquidity premium refers to the yield spread between a liquid bond and a similar but less liquid bond. In this study, this theory supports the hypotheses on size of bond portfolio (stock and turnover) and bond demand (subscription rate and bid-to-cover ratio) which reflect liquidity situation in the bond market.

### 3.5 Empirical Literature Review

According to Thupayagale (2015), a few studies have sought to determine existence, magnitude and investment implications of long memory in bond interest rates and yield spreads. Numerous studies that present evidence for and against efficiency in financial markets have concentrated on global equity markets with little research on fixed income markets, mostly limited to developed markets. In Africa, South Africa's local currency 10-year bond has shown evidence of liquidity. On Kenya's 10-year bond yield changes and volatility, the study showed statistical significance of long memory parameters suggesting that bond yield changes and volatility represented an important description of Kenya's bond market liquidity. There was evidence of long memory during the entire sample period as well as the period after reforms. These findings indicated that even with the implementation of market development reforms, Kenya's local currency bond market remained illiquid and inefficient. But, worth noting is the smaller size of post reform period long memory parameters, shedding some light that some good progress had been made and that strengthening of market reforms still needed to be considered as a matter of priority (Thupayagale, 2015).

Cochrane (2014) identified maturity structure of bonds as an important factor for the growth of the domestic bond market. Maturity structure affects bond yields as short term instruments are associated with rollover risk where government has to frequently rollover maturing securities

leading to increases in interest rates for bonds as investors seek better returns. Frequent fluctuations in interest rates discourages investment in long term bonds because it erodes market confidence and compromises the stability of the yield curve. Balancing the maturity of domestic instruments with focus on medium and long term securities helps to minimize refinancing costs and risks associated with short term instruments as well as bonds service costs associated with high interest payments for bonds (Cochrane, 2014). But also ensure that the choice of maturity structure matches the maturity of short to long term capital expenditures of the government.

Bao, Pan and Wang (2011) observed that where the market is ready to take up short, medium and long term instruments, the government is able to attract a diversified investor base but must promote market development initiatives that enhance competition to minimize volatility of market yields resulting in a normal yield curve, thereby lowering bonds service costs associated with long term bonds. The length of maturity of government securities is an indicator of the degree of market development.

Technology impacts on information search costs which again affect market liquidity. Emergence of market makers is facilitated by modern electronic trading platforms. These platforms should be accessible to market participants such as asset managers and other traders to improve market liquidity and resilience. In the trading of corporate bonds, electronic platforms are less used compared with other asset classes. The change of business models by traditional market makers, aside of regulations, to acting as brokers (risk distribution) which is more profitable, from acting as dealers (risk warehousing), which is less profitable, due to more efficient management of the balance sheet changes in technology (Goldman Sachs, 2015). Brokers earn more returns in a low-risk and low-volatility environment as premium for warehouse risk is low.

Economic growth with interest rate volatility showed negative and significant relationship with bond market growth in a study of 41 countries chosen from among developing and developed economies but focusing on emerging Asia by Bhattacharyay (2011). Negative and significant macroeconomic variables were GDP per capita at purchasing power parity, exchange rate volatility, and the fiscal balance. According to Ngugi and Afande (2015), a well-functioning money market enhances the liquidity of the bond market particularly as a precursor to an active

secondary bond market and this is important for promoting market liquidity, efficiency and minimal volatility with diverse risk preference. Another study by Nyongesa (2012) used multivariate OLS model on time series data to determine the factors that influence liquidity in Kenya's secondary bond market. The results showed that significant factors for bond market liquidity included behavior of interest rates such as savings rate and bank lending rate. One of key policy recommendations was to have in place appropriate and prudent fiscal and monetary policies to manage the volatility of interest rates to support government bond market growth.

One of the major reasons for the Asian financial crisis of 1990s, was the dominance of banking finance in financial intermediation, with little market scrutiny as opposed to domestic bond market that would promote greater information disclosure and contribute to better and efficient financial intermediation. Another important feature of the institutional structure that is critical in reducing risks from quick movements in short term capital flows is the existence of a liquid domestic fixed-income market that incorporates suitable risk valuation systems (Flood, Liechty & Piontek, 2015). High interest rate spread discourages bond market liquidity (Vayanos, Dimitri and JiangWang 2012). Among key financial market/sector drivers of bond market development are banking sector interest rate spreads and overhead costs, and factors associated with demand of securities such as tax rate among others (Hu, Pan and Wang, 2012).

Christensen and Gillan (2016) compared off-the-run Treasury bond spread to the corresponding liquidity premium of similar maturity. The difference between yields of off-the-run similar maturity Treasury bonds and on-the-run (most recently issued) Treasury bonds, showed that the on-the-run bonds are most actively traded securities for each maturity segment in the Treasury yield curve. On the run bonds therefore attract positive spreads as a result of low liquidity premiums. This implied that existence of wide yield spreads between liquid on-the-run bonds compared to off-the-run bonds translates to large liquidity premiums in the other segments of the markets such as Treasury Inflation Protected Securities (TIPS) and inflation swap products. They also studied the bid-ask spreads of TIPS and inflation swap contracts to observe the behavior of microstructure frictions that such spreads represent in the variation of liquidity premium.

Among key features of institutional structures that contribute to lower volatility and higher stability in financial systems is the diversification of sources of finance where a well-functioning domestic

bond market introduces great benefits in reducing the impact on corporate finance during periods of scarce credit (Posner and Weyl, 2013). Bao *et al*., (2011) identified certain significant explanatory variables that explain differences in bond spreads across emerging market countries. Among these variables was the liquidity and solvency of the economy measured by variables such as bonds-to-GDP ratio, international reserves-to-GDP ratio, net foreign assets, and country macroeconomic fundamentals such as terms of trade and inflation rate. Bae and Kee-Hong (2012) examined sets of determinants of bond market growth and found that wider banking sector interest rate spread negatively and significantly affected the growth of bond markets. Bhattacharyay (2011) in his study on Asian bond markets established that interest rate spread was a major determinant of bond market development in Asia.

Ngugi and Afande (2015) pointed that encouraging effective banking and financial systems was an important intervention in enhancing capital funding by the corporate sector from the bond market in Kenya. Their study also recommended policies geared towards strengthening the market structure and infrastructure in promoting the growth of both government and corporate bond markets in the domestic market. According to Bao, Pan, and Wang (2011), crisis-time liquidity in bond markets can be predicted from normal-time liquidity. The growth of European sovereign bonds market in terms of liquidity is more driven by business conditions while resilience of liquidity in emerging markets is more driven by external conditions and not by business conditions. Vayanos and Wang (2012) and Duffie, 2012) also observed that funds and institutional investors have increased their holdings of less liquid assets as accommodative monetary policy by the Fed triggered a search for yield. Liquidity risk is encouraged by accommodative monetary policy and search for yield by the asset management industry (Gungor and Sierra 2014). In addition, index investors and increasing use of benchmarks have increased systemic liquidity risk.

Bae and Kee-Hong (2012) in studying determinants of market development used a variable to measure short term uncertainty as a gauge of risk aversion and investor fear. They observed that uncertainty about the future price of bonds was elevated by economic uncertainty leading to higher liquidity premiums to compensate for the uncertainty. In measuring market illiquidity, deviations in Treasury bond prices from a fitted yield curve act as a measure of noise and illiquidity as a result of unavailability of arbitrage capital. The analysis shows that the economy-wide illiquidity measure affects all markets as a priced risk factor across several financial markets. According to

Bhattacharyay (2011), low government financing needs (fiscal balance) negatively and significantly influenced the growth of government bond market while important promoters of bond market growth included exchange rate stability and capital openness. On the contrary, Vayanos, Dimitri and JiangWang (2012) found out that low fiscal burden encourages larger domestic bond markets. Hu, Pan and Wang (2012) found that government budget deficit, among other variables was important for the growth of the government bond market. A country should focus to reduce variability in its primary balance to avert a potential fiscal crisis.

According to Yibin, Phelps, and Stotsky (2013), local currency bond markets in Sub-Saharan Africa (SSA) have been at the nascent stage of growth for a long time. Compared with emerging, developing and advanced economies around the world, market capitalization of both government and corporate bonds as a percentage of GDP in SSA is much lower (estimated at 14.8 percent and 1.8 percent for corporate bonds of GDP in 2010). In 2010, capitalization of corporate bond market to GDP for Canada was 26.5 percent and 98.6 percent for the United States. The African Development Bank has been launching bond programs for Africa to raise funds for infrastructure development in projects such as ports and airports. This confirms the growing importance of bond markets in financing development in SSA.

Yibin, Phelps and Stotsky (2013) found that fiscal balance had a negative relationship with bond market development, while interest rate volatility presented a positive relationship. In Kenya, Nyongesa (2012) studied the determinants of liquidity in secondary bond market and found that the level of public domestic debt significantly and positively affected bond market liquidity. Christensen and Gillan (2016) observed that as a domestic bond market development strategy, emerging market countries should ideally aim to reduce external bonds component and increase domestic bonds because of the risk vulnerabilities (both foreign exchange and interest rate risks) associated with foreign bonds and the fact that, these economies are vulnerable to slowdowns arising from external shocks. Advanced economies have a higher advantage of sharing their risks with external creditors because much of their foreign bonds involve minimal net foreign currency exposure. Liquid domestic bond markets facilitate the risk-based approach to management of government bonds which does not only contribute to enhanced financial stability but also promotes a more successful participation of an emerging market in the global financial landscape. Even

more, liquid domestic bond markets are crucial for better risk management by financial intermediaries. This is a strong point in support of development of a liquid and efficient domestic bond market.

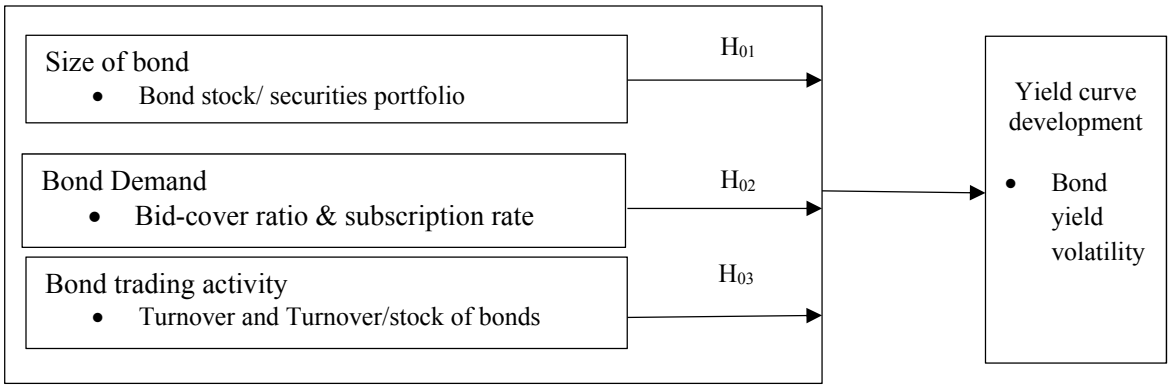
## 3.6 Summary of Empirical Literature Review

The forgoing literature review presents important factors that determine the development of Government bond yield curve as shown in Appendix 7.

## 3.7 Conceptual Framework

Figure 3.1 below presents the conceptual framework of this study.

**Figure 9: Conceptual Framework**




*Source: Author, 2017*

Evidence against weak form EMH hypothesis was to be provided if non-linear behavior and volatility of bond yields are observed where GARCH model was used to simultaneously estimate the statistical properties of yield changes and volatility. This is a time series technique that allows simultaneous modeling of persistence in changes in yields and yield volatility.

# CHAPTER FOUR

# METHODOLOGY

## 4.1 Introduction

This Chapter discusses the methodology that was used in gathering data, analyzing the data and translating the data into meaningful information. The chapter contains sections on the research design, research philosophy, data collection instrument, model specification and data analysis techniques that were used in this study.

## 4.2 Research Philosophy

This study was based on one of the research philosophies known as positivism which aims to mirror scientific method and uses deductive reasoning, empirical evidence and hypothesis testing. The type of data involved in this philosophy is numeric and quantitative, involves larger sample sets and surveys based on scientific methods. Whilst the ontology under this philosophy is that the world is objective and independent of our subjective experience, the epistemology postulates that the world is knowable, and that this knowledge is communicable between agents. The philosophy of positivism is used in this study because observations of variable trends are independent with no human interest; explanations demonstrate causality; generalization was through statistical probability; research progressed through hypotheses and deductions; concepts were operationalized for purpose of measurement and study involved simplification of units of analysis.

## 4.3 Research Design

This study employed descriptive research design. Descriptive design is a systematic empirical inquiry where observations on the variables have already occurred and the researcher does not have direct control on them (Mugenda & Mugenda, 2003). This design was used to determine the relationship between the independent variables and dependent variable through panel multivariate regression analysis. This research design was relevant to this study because of the quantitative nature of variables and involves repeated observations over a period of time (time series) and across sampled elements (different benchmark tenor of bonds).

## 4.4 Target Population

The target population for this study was the portfolio of benchmark tenors of 2-year, 5-year, 10-year, 15-year, 20-year and 25-year constituted in 55 outstanding Treasury bond series that were listed and traded at the NSE and which constituted the yield curve data during the study period.

## 4.5 Sampling Design

Through purposive sampling, a sample of 3 benchmark tenors - 2-year, 5-year and 10-year were selected and studied. The selection of these tenors was informed by availability of data on measurable aspects of the benchmark bond programme during the period 2000 to 2016.

## 4.6 Data Collection

The study exclusively utilized secondary data comprising of historical Treasury bill and bond auctions data (offer sizes, received amount, accepted amount, demand or performance, bid-cover ratios, bond tenors or maturity spectrum, primary market bond yields (low, high, WAY, coupon), bond yield spreads and stock of bonds in the debt portfolio. Data from the secondary market comprised of bond trading turnover at the Nairobi Securities Exchange (NSE), traded bond yields, spreads of yields of different bond maturities and ratio of traded bonds to stock of bonds. These data constituted microstructure elements which are specific to the bond instruments which was the focus of this study. Other variables that influence bond yields and the bond market in the macroeconomic, financial and structural environment were not included in this study.

## 4.7 Data Analysis

In the assessment of causal relationship and testing hypothesis of association, linear regression analysis was used to establish statistical significance of the independent variables (stock of bonds in Government securities, subscription rate at bonds, Bid-Cover Ratio of bonds, bond trading turnover and bond turnover to stock ratio) on the dependent variable (Yield volatility for bond i in time t). The dependent variable was denoted as (BYV i, t). Data analysis and presentation of findings was conducted in E-view 8 which is a powerful statistical tool for data analysis and econometric modeling.

## 4.8 Empirical Model

### 4.8.1 Model I – Analyzing Bond Yield Volatility

Inference analysis aimed to identify significant microstructure variables that influenced bond yield volatility through ordinary Least Squares (OLS) regression. Panel regression analysis was used in line with modeling by Yibin Phelps and Stotsky (2013) who included fixed effects estimation and accounted for both time-variant as well as time invariant effects. Panel models provide more insight than time series and cross section data models because they offer theoretical possibility of isolating effects of specific elements in the sample (Hsiao, 2007). Panel analysis also captures heterogeneity among variables and sample elements.

The model used was developed from Solow's economic growth model, shown below, which considers capital and labour as factors influencing productivity.

Y=F (K, L) …….4.1

Where Y represents Production

K represents Capital and

L represents Labour

This is because Solow's growth model analyses economic growth in long-term (Solow 1956). Modifications for the model yielded the representation shown below;

BYV= f (BS, SR, BCR, BTO, TSR) ……. ….....4.2

Since the variables are time series, a multivariate statistical model was fitted to analyze the variables as shown in equation 4.3:

$$BYV_{i,t} = \beta_o + \beta_1 BS_{i,t} + \beta_2 SR_{i,t} + \beta_3 BCR_{i,t} + \beta_3 BTO_{i,t} + \beta_2 TSR_{i,t} + \varepsilon_{i,t} \quad \text{…..... 4.3}$$

Where:

*BYV* Yield volatility for bond *i* in time *t*

This was denoted as *twoyy, fiveyy and tenyy* to represent two-year yield, five-year yield and ten-year yield respectively.

$\beta_{i,t}$ represents the vector of coefficients of different explanatory variables in bond *i* at time *t*.

*BS* Stock of bonds in Government securities (Treasury bills and bonds)

*SR* Subscription rate at bonds' auctions

*BCR* Bond demand (Bid-Cover Ratio)

*TO* Bond trading turnover

$TSR$ Bond Turnover to Stock Ratio

$\varepsilon_{it}$ Error term which represents the variability in $BYV_{i,t}$ that is not explained by the explanatory variables singly or in sets. $\varepsilon_{it}$ is Gaussian with normal distribution of mean of zero and constant standard deviation

The variables included in this model constitute microstructure elements specific to the bond instruments and performance of the bond market which is the focus of this study. Other variables that influence bond yields and the bond market in the macroeconomic, financial and structural environment have not been included in this study because of the need to focus on the effect of microstructure elements of the government bond market on bond yields.

### 4.8.2 Model II – Analyzing Informational Efficiency of Kenyan Bond Market

To analyze and interpret informational efficiency of the bond market, the efficient market hypothesis (EMH) was used. One of the versions of EMH is the random walk technique (refined by Fama, 1965, 1970) which asserts that for an efficient financial market, currently available information cannot be used to predict future prices or returns. In bond markets, long memory (or long-range dependence) analysis has been used to establish important implications for the efficiency of the market in pricing fixed income securities (Thupayagale, 2015). The long memory technique using the GARCH (*Generalized Auto Regressive Conditional Heteroskedasticity*) model explained below was used to provide evidence against weak form EMH hypothesis if the following observations are made:

a. Non-linear behavior as shown by distinct but non-periodic cyclical patterns and long-term dependence between distant observations of bond yields
b. Fluctuations of bond yields indicate a predictable component; past trends in yield movements can be used to extrapolate future trends

The GARCH model was used to simultaneously estimate the statistical properties of yield changes and volatility. This is a time series technique that allows simultaneous modeling of persistence in changes in yields and their volatility. GARCH modelling was used to capture long memory in the conditional variance of a time series, where non-zero values of the fractional differencing parameter imply dependence between distant observations. This modelling of volatility of bond yields is intended to measure direct and spill-over effects of volatility in bond yields.

# CHAPTER FIVE

# EMPIRICAL RESULTS

This section describes the results obtained from running the models described in Chapter IV involving single variable and multivariate panel ordinary least squares linear regression (OLS) and long memory analysis using the GARCH technique.

## 5.1 Simple Ordinary Least Squares Analysis

Appendix 8, shows the results of simple linear regression where the two-year bond yield *(twoyy)* was the dependent variable representing the yield to maturity of two-year bond during the period 2005 to 2016. Explanatory variables were DLBS, DLSR, DLBCR, DLTO and DLTSR representing the first difference of the log of stock of bonds, auction subscription rate, bid cover ratio, bond trading turnover and ratio of turnover to stock of bonds respectively. For the two-year bond yield (*twoyy*), the subscription rate of bonds at the primary market was significant at 1% with a positive influence on two-year bond yield (model 2). Variables that showed positive but insignificant influence on the two-year bond yield were stock of bonds and bid-to-cover ratio (representing demand for bonds at the primary market) while trading turnover and ratio of turnover to stock were negative and insignificant.

Appendix 9, shows the results of simple linear regression where the dependent variable was the yield to maturity of five-year bond *(fiveyy)* during the period 2005 to 2016, with explanatory variables represented as DLBS, DLSR, DLBCR, DLTO and DLTSR. Subscription rate of bonds had a negative influence on five-year bond yield and was significant at 10% (model 2). The bid cover ratio was significant at 5% level with positive influence on five-year yield (model 3). Variables that showed negative and insignificant influence on the five-year bond yield were stock of bonds, turnover and ratio of turnover to stock. The Durbin Watson statistic was higher than 1.7 across models 1 to 5 indicating little or no serial (auto) correlation in the explanatory variable.

In the ten-year bond yield estimation, Appendix 10 shows that bid cover ratio was positive and significant at 1% while turnover and ratio of turnover to stock were both negative and significant

at 10% (models 4 & 5 respectively). Bond stock and subscription rate were insignificant with positive and negative relationship respectively. These results indicate that compared to the two and five-year yield scenarios above, demand for bonds at the primary market was important and had a positive relationship with the ten-year bond yield. On the other hand, bond trading activity at the NSE had a significant and negative relationship with the ten year yield as reflected in the universe relationship between price and yield of a bond – trading activity increases when bond yields decline and vice versa. This confirmed the hypotheses that demand of bonds at the primary market and level of trading in the secondary market affects the direction and volatility of yields of bonds.

## 5.2 Multiple Ordinary Least Squares Analysis

According to Appendix 11, the multivariate OLS analysis of the influence of explanatory variables on the two-year yield shows that bond subscription rate was positive and significant at 1% level when all variables were included (model 1). In model 2, with the exception of bond stock (size of bonds issued) in the estimation, subscription rate was negative and significant at 1% level. Bid cover ratio was positive and significant at 1% in both model 4 and 5 where turnover and ratio of turnover to stock were excluded. These results confirmed the hypotheses that bond demand measured by subscription rate and bid cover ratios at the primary market have positive influence on bond yields.

Appendix 12, shows the results of the multiple OLS for the five-year yield scenario. In the full model containing all variables (model 1), the subscription rate was negative and significant at 5% while bid cover ratio was positive and significant at 1%. In model 2, excluding the stock of bonds, subscription rate was negative and significant at 5% while bid cover ratio was positive and significant at 1%. When bond stock and subscription rate were excluded in model 3, bid cover ratio became positive and significant at 5% level, and when turnover to stock ratio was excluded in model 4, subscription rate became negative and significant at 5% while bid cover ratio was positive and significant at 1%. Model 5, excludes turnover and ratio of turnover to stock of bonds, where subscription rate was negative and significant at 5% while bid cover ratio was positive and significant at 1%. In model 6 which includes bond stock and subscription rate only, subscription rate was negative at a significance level of 10%.

The multivariate OLS results of the ten-year bond yield in appendix 13 showed that bid cover ratio was positive and significant at 1% in models 1 to 5 (1- containing all explanatory variables, 2 - excluding stock of bonds, 3- excluding bond stock and subscription rates, 4- excluding turnover to stock ratio, 5 – excluding turnover and ratio of turnover to stock ratio). Model 6, which includes bond stock and subscription rate only showed that the latter was negative and significant at 10%.

In line with the findings of this study, Bhattacharyay (2011) and Bae, Kee-Hong (2012) found that the Government needs to promote a proper macroeconomic, financial and structural environment to achieve liquidity and efficiency of local government bond markets, which encourages market liquidity through fair pricing of bonds informed by among other factors market fundamentals; high demand-supply and competition for securities, high number of local and foreign investors, diversified investors and securities, low return volatility, large market size, market depth with high cross-border integration, modern electronic trading platforms, many intermediaries, and pro-growth legal and regulatory framework.

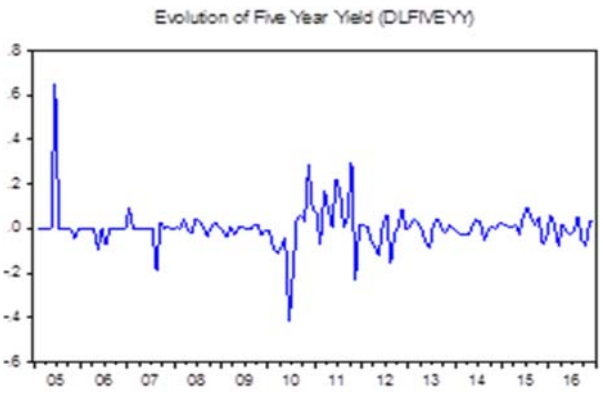
## 5.3 Analysis of the Volatility of Benchmark Bond Yield Curve

Figures 5.1-5.3, show the relative yield change of the 2-, 5- and 10-year benchmark yield (represented as *twoyy, fiveyy, tenyy* respectively) centered around mean of zero with periods of large volatility following periods of relative calmness during the pre- and post- reform period of bond market development in Kenya. This represents the relative percentage change of returns which is the focus of attention for investors, portfolio and risk managers as well as policy makers. Uncertainty is partly caused by changes by economic fundamentals, but these can only explain a moderate portion of the observed financial market volatility. Time series models are used to adequately measure volatility beyond that caused by fundamentals, including forecasting. As shown in figures 5.1-5.3, volatility of 2-, 5- and 10- year benchmark bond yields was higher in the pre-reform period from 2005 to 2007 compared to post-reform period from 2008-2016.

**Figure 10: Evolution of 2-year yield (Pre- and Post-Reform Period)**

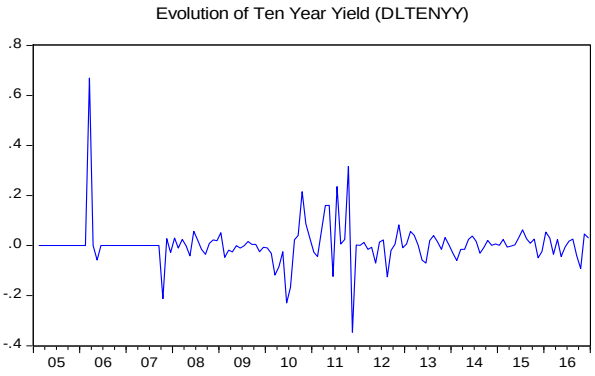

*Source: Research findings*

**Figure 11: Evolution of 5-year yield (Pre- and Post-Reform Period)**



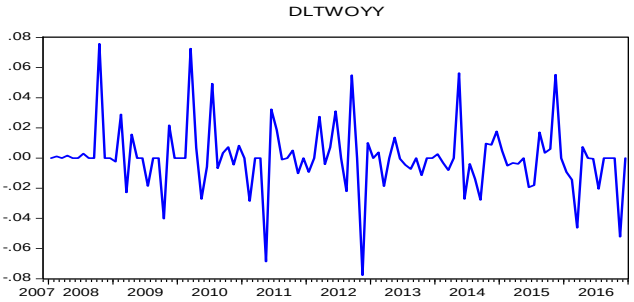

*Source: Research findings*

**Figure 12: Evolution of 10-year yield (Pre- and Post-Reform Period)**



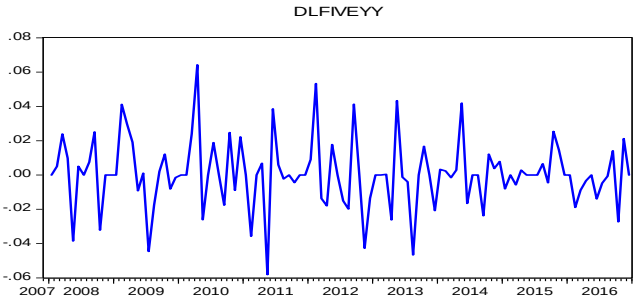

*Source: Research findings*

**Figure 13: 2-year yield (Post reform period)**



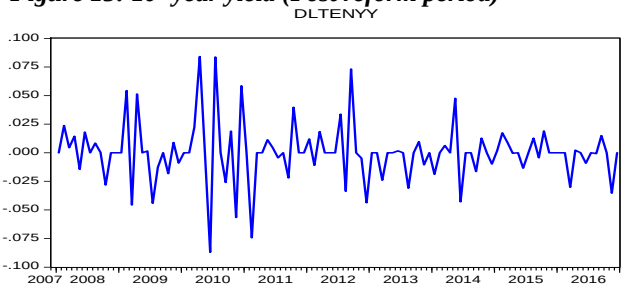

*Source: Research findings*

**Figure 14: 5-year yield (Post reform period)**




*Source: Research findings*

***Figure 15: 10 -year yield (Post reform period)***




*Source: Research findings*

We use the first difference of the log of 2-, 5- and 10- year benchmark yields to achieve stationary series and minimize trend components - deterministic and/or stochastic trend or combination of both. Non-stationary series contain a unit root where the variables may have a time variant mean and/or non-constant variance. Econometric analysis using non-stationery series leads to high likelihood of spurious regression results – depicted by significant t-statistic with high explanatory power even when the regressors are statistically unrelated to the explained variable.

### 5.3.1 Heteroskedasticity and Auto (Serial) Correlation Analysis

Bond holders are interested in the volatility of returns during the period they hold the bonds as well as in future. This then requires looking at risk in terms of *conditional volatility* where expected future volatility of returns is informed by new information available today. Autocorrelation refers to a situation where the error terms or the residuals in a regression model are interdependent over time. Heteroskedasticity means that the variance of the error terms is not constant but varies over time. The Auto Regressive Conditional Heteroskedasticity (ARCH) and Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) type models is used to perform modeling of volatility of bond returns and determine whether Kenya's bond market is weak efficient or not.

To provide proof that the residuals are not serially correlated, the D-W statistic should be >=2. If it is too low, it raises suspicion that the residuals could be serially correlated. Table 5.1 shows that when we run regressions for DLTWOYY C, DLFIVEYY C and DLTENYY C, we find that the residuals for the 2-year yield could be serially correlated because the D-W statistic is too low (1.451 compared to 2.00). This is an indication of presence of autocorrelation referring to the fact that future bond yields could be determined by information about past bond yields, which provides evidence against the null hypothesis that there is no serial correlation (supports the idea that short end of the bond market is weak efficient). The D-W statistic of 1.751 for the 5-year yield may be indicative of weak serial correlation while 2.054 for the 10-year yield does not point to presence of autocorrelation.

**Table 2: Residual Serial Correlation**

| | 2-year yield (Twoyy) | 5-year yield (Fiveyy) | Ten-year yield (Tenyy) |
|---|---|---|---|
| Durbin-Watson (D-W) statistic | 1.451 | 1.751 | 2.054 |

*Source: Research findings*

To further prove the presence of autocorrelation or remove autocorrelation of the residuals, we incorporate Auto Regressive (AR) lags in the basic specification.

### 5.3.2 The GARCH Process - Modeling Conditional Volatility

The most popular form of conditional volatility model is the GARCH (1, 1) which is especially used for modeling volatility with very persistent shocks. Table 5.2 and figures 5.7-5.9 presents the results of GARCH (1,1) for 2-, 5- and 10-year benchmark yield, with ARCH-M specification of None, Standard deviation and Log(Var). We make the following observations about the GARCH (1, 1) models in Table 5.2:

- All coefficients are significant with the inverted roots of the AR polynomial within the unit circle while the Durbin-Watson statistic indicates absence of serial correlation especially for the specification of the ARCH-M under "none".
- The system is covariance stationary as the coefficient to the autoregressive parameter of the mean equation is 0.850, which is <1.
- Under the "none" ARCH-M specification, the sum of conditional variance parameters is 1.652 in the 2-year bond yield scenario, which is >1, implying that GARCH (1, 1) process for $\varepsilon_t$ is weakly stationary and depicts the high volatility persistency inherent in bond yield movements. Similarly, there is high volatility persistency inherent in the 5-year bond yield as the sum of conditional variance parameters is 0.958 almost equal to 1. However, the sum of conditional variance parameters for the 10-year yield is 0.161 and does not depict volatility persistency.
- There is strong evidence of volatility clustering as RESID (-1) ^2 is significantly different from zero. The availability of new information increases conditional volatility by a magnitude of 1.44.
- There is presence of a GARCH term and autoregressive persistence of conditional volatility as GARCH (-1) parameter is significantly different from zero.

**Table 3: GARCH (1, 1) for 2-year, 5-year and 10-year bond yields**

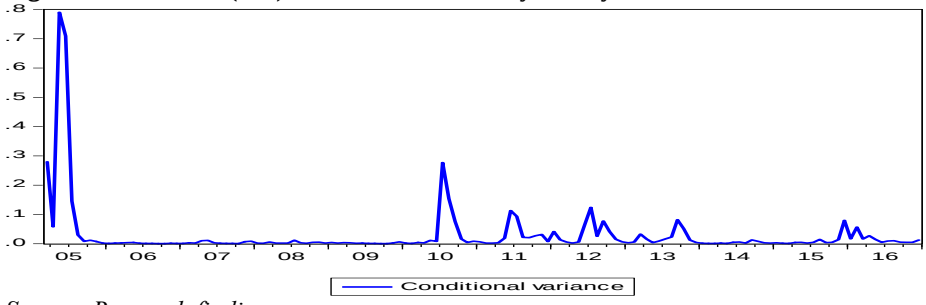
| Variable | ARCH-M Specification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | None | | | Std. Deviation | | | Log (Var) | | |
| | 2-YY | 5-YY | 10-YY | 2-YY | 5-YY | 10-YY | 2-YY | 5-YY | 10-YY |
| @SQRT (GARCH) | | | | 0.287* | 0.225 | | | | |
| GARCH | | | | | | | | | |
| LOG (ARCH) | | | | | | | 0.01** | 0.010 | -2.493 |
| C | -0.030 | 0.001 | 0.005 | -0.015** | -0.012 | | 0.063** | 0.062 | -11.972 |
| AR(1) | 0.850* | -0.051 | 0.115 | -0.173 | -0.061 | | 0.025 | -0.054 | 0.077 |
| Variance Equation | | | | | | | | | |
| C | 0.000** | 0.000 | 0.007 | 0.000** | 0.000 | | 0.000** | 0.000 | -0.372 |
| RESID(-1)^2 | 1.448* | 0.197 | 0.216 | 1.114* | 0.207 | | 1.086* | 0.217 | 2.499 |
| GARCH(-1) | 0.204** | 0.761* | -0.055 | 0.283* | 0.753* | | 0.306* | 0.746* | -1.403 |
| Adjusted R-squared | 0.862 | 0.724 | 0.727 | 0.851 | 0.821 | | 0.711 | 0.815 | |
| S.E. of regression | 0.120 | 0.095 | 0.090 | 0.110 | 0.095 | | 0.106 | 0.094 | 28.925 |
| Sum squared resid | 2.033 | 1.257 | 1.128 | 1.672 | 1.244 | | 1.573 | 1.237 | |
| Durbin-Watson stat | 2.746 | 1.647 | 2.276 | 1.517 | 1.695 | | 1.521 | 1.687 | 0.004 |
| Inverted AR Roots | 0.85 | -0.05 | 0.11 | -0.02 | -0.06 | | 0.02 | -0.05 | 0.08 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

*Source: Research findings*

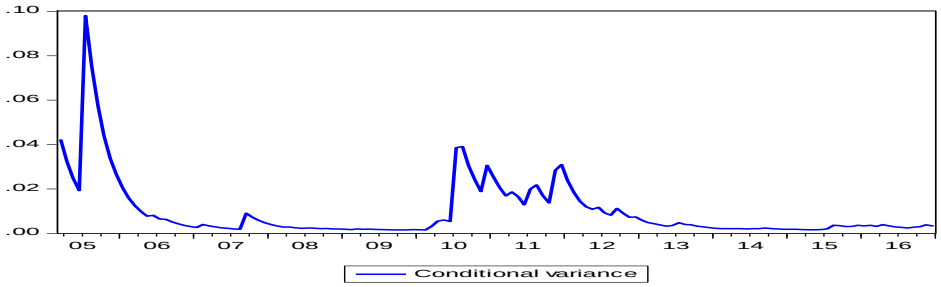
The results in Table 5.2 and Figures 5.7-5.9 indicate that volatility persistency is highest in the 2-year benchmark bond yield, followed by the 5-year bond yield with the 10- year yield depicting the lowest volatility persistency. In addition, the coefficient for volatility clustering is significant at 1% level for the 2-year yield indicating that availability of new information increases conditional volatility. These outcomes provide evidence that the 2-year benchmark yield is weak form efficient and that the medium-long term bond market could have started to move to semi-strong efficiency, supported by the fact that, there is less volatility persistency and insignificant volatility clustering on the 5-year and 10-year benchmark yields.

**Figure 16: GARCH (1, 1) Conditional Volatility for 2-year Bond Yield**



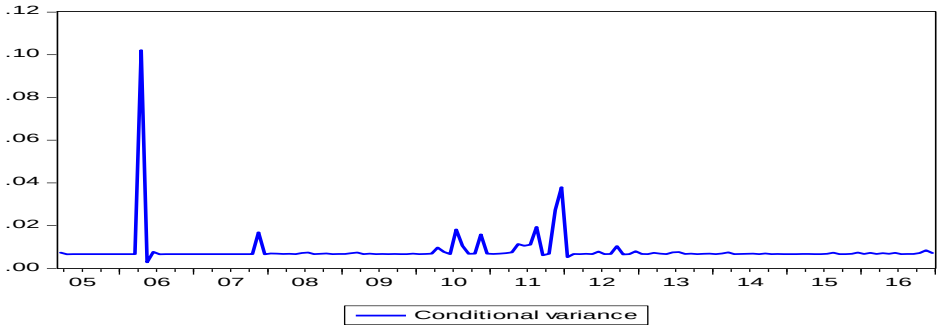

*Source: Research findings*

**Figure 17: GARCH (1, 1) Conditional Volatility for 5-year Bond Yield**




*Source: Research findings*

**Figure 18: GARCH (1, 1) Conditional Volatility for 10-year Bond Yield**




*Source: Research findings*

Thupayagale (2015) studied Kenya's 10-year bond yield changes and volatility and through statistical significance of long memory parameters, showed that bond yield changes and volatility represented an important description of Kenya's bond market liquidity. During the entire sample period as well as the period after reforms, there was evidence of long memory, indicating that even with the implementation of market development reforms, Kenya's local currency bond market remained illiquid and inefficient. However, the smaller size of post reform period long memory parameters indicated that some good progress had been made and that market reforms being undertaken needed to be strengthened as a matter of priority.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusion and Recommendations for Policy and Further Research

Under the simple OLS, compared to the two and five-year yield scenarios, demand for bonds at the primary market is important and has a positive relationship with the five-year bond yield. On the other hand, bond trading activity at the NSE has a significant and negative relationship with the ten year yield as reflected in the universe relationship between price and yield of a bond – trading activity increases when bond yields are declining and vice versa. This confirms the hypotheses that demand of bonds at the primary market and level of trading in the secondary market affects the direction and volatility of yields of bonds. The multivariate OLS results of the two, five and ten-year bond yields show that demand for bonds as measured by subscription rate and bid to cover ratios at the primary market were significant determinants of the level and direction of two and five-year bond yields confirming the hypotheses that bond demand at the primary market influences bond yields at the secondary market.

In analyzing volatility of the benchmark yield curve, this study assessed Heteroskedasticity and Auto (Serial) Correlation of the 2-year, 5-year and 10-year bond yields as well as conditional volatility through GARCH modeling. The results indicated that volatility persistency is highest in the 2-year benchmark bond yield, followed by the 5-year bond yield with the 10- year yield depicting the lowest volatility persistency. In addition, the coefficient for volatility clustering is significant at 1% level for the 2-year yield indicating that availability of new information increases conditional volatility. These outcomes provide some evidence about the 2-year benchmark yield being weak form efficient and the possibility of the medium-long term bond market starting to move towards semi-strong efficiency, supported by the fact that, there is less volatility persistency and insignificant volatility clustering on the 5-year and 10-year benchmark yields. This is a strong indicator of the need to continue supporting the benchmark bond programme.

Little work has been published in this area for Kenya; this paper provides evidence that the benchmark bond programme has had positive impact on the development of the yield curve in

Kenya. The results provide recommendations for Kenya and the larger MEFMI region on future policies for increasing the efficiency of the bond market through market reforms. Specifically:

i. Initiatives[3] to increase demand of bonds at the primary market and level of trading in the secondary market which affect the direction and volatility of yields of bonds should be encouraged and enhanced. This has implication on the cost of government borrowing and level of returns of bonds for the investors as well as bond demand at the primary market influencing bond yields at the secondary market.

ii. The significant and negative relationship of bond trading turnover with the ten-year yield is an indication that the bond market in Kenya may have begun to confer benchmark status to the ten-year benchmark tenor. The negative relationship reflects the universal relationship between price and yield of a bond – trading activity increases when bond yields decline and vice versa.

iii. Enhance the implementation of the benchmark bond programme as part of reforms for achieving market efficiency. This is supported by the findings showing gains already being achieved from the programme as weak-form market efficiency is demonstrated by the 2-year benchmark yield while the 5-year and 10- year benchmark yields indicate movement towards semi-strong market efficiency. The key issues on the journey towards an efficient yield curve in Kenya involve enhanced support of the benchmark bond programme and development of a liquid secondary market. Government should maintain large benchmarks in bonds across maturities, in order to promote market liquidity (Crown Agents Report, 2009).

Further research on this area would involve undertaking full testing of the application of the model as well as critically testing downside risks on inferences in this study that may not be backed by other studies or policy guidelines. Further work may also involve scrutinizing the individual relationships among the most important variables used incorporating qualitative factors in the analysis and also including macroeconomic, financial and structural variables, in order to concretize policy prescriptions.

[3] Such initiatives include innovative instrument/investor diversification to suit different classes of investors, automation of trading platforms to enhance turnover, structured government issuance strategies (MTDS, borrowing programme, issuance calendar, benchmark bond programme, market consultations, primary dealing and market making), instruments/facilities to promote money market growth (Repo instruments etc.), investor education programs, among others.

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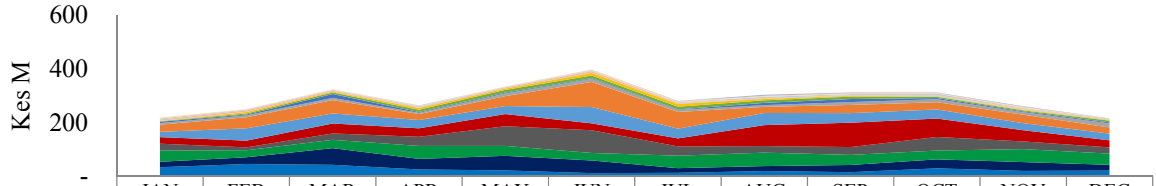
# APPENDICES

## Appendix 1: Government Bonds Trading Turnover




| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 0.15 | 0.02 | 0.18 | 1.24 | 0.22 | 0.14 | 1.10 | 4.48 | 1.98 | 1.71 | 2.17 | 0.70 |
| 2002 | 3.48 | 1.92 | 2.11 | 2.69 | 1.56 | 3.01 | 3.97 | 3.34 | 3.97 | 2.55 | 3.73 | 1.30 |
| 2003 | 3.80 | 3.18 | 2.83 | 2.72 | 2.15 | 2.77 | 2.42 | 5.32 | 3.55 | 6.54 | 3.03 | 2.82 |
| 2004 | 4.58 | 4.99 | 3.62 | 2.14 | 3.18 | 5.34 | 2.40 | 0.84 | 1.44 | 2.25 | 2.12 | 1.21 |
| 2005 | 1.02 | 0.64 | 0.13 | 1.01 | 0.79 | 1.30 | 1.46 | 1.78 | 1.28 | 1.52 | 1.23 | 1.48 |
| 2006 | 0.85 | 5.33 | 3.20 | 6.36 | 4.79 | 9.19 | 10.11 | 5.29 | 2.86 | 1.62 | 2.80 | 1.76 |
| 2007 | 1.65 | 4.45 | 5.73 | 8.51 | 9.90 | 10.32 | 10.14 | 9.78 | 9.50 | 4.22 | 3.46 | 6.47 |
| 2008 | 4.87 | 3.18 | 14.29 | 3.07 | 3.04 | 2.45 | 1.89 | 8.42 | 10.99 | 4.32 | 3.12 | 3.58 |
| 2009 | 5.65 | 6.86 | 8.45 | 4.53 | 10.48 | 11.10 | 7.54 | 6.14 | 10.67 | 11.71 | 9.43 | 15.28 |
| 2010 | 27.28 | 41.06 | 49.05 | 22.38 | 36.73 | 93.38 | 62.23 | 22.87 | 30.65 | 26.31 | 31.56 | 22.57 |
| 2011 | 19.67 | 46.19 | 37.94 | 31.01 | 30.03 | 60.73 | 35.93 | 45.10 | 35.81 | 34.13 | 26.28 | 24.87 |
| 2012 | 24.31 | 24.89 | 36.87 | 31.07 | 45.08 | 25.94 | 29.98 | 77.95 | 90.24 | 68.22 | 41.99 | 26.34 |
| 2013 | 25.52 | 10.39 | 23.81 | 34.31 | 73.27 | 84.20 | 34.56 | 24.45 | 29.19 | 50.84 | 28.24 | 23.61 |
| 2014 | 41.82 | 26.42 | 31.04 | 47.77 | 36.67 | 28.02 | 46.17 | 50.07 | 37.31 | 32.78 | 48.16 | 41.17 |
| 2016 | 20.25 | 25.20 | 61.65 | 39.71 | 54.42 | 46.98 | 17.82 | 18.64 | 27.00 | 33.49 | 33.00 | 21.75 |
| 2015 | 33.21 | 45.03 | 42.40 | 24.94 | 21.42 | 11.53 | 12.28 | 18.96 | 14.90 | 29.12 | 19.71 | 20.82 |

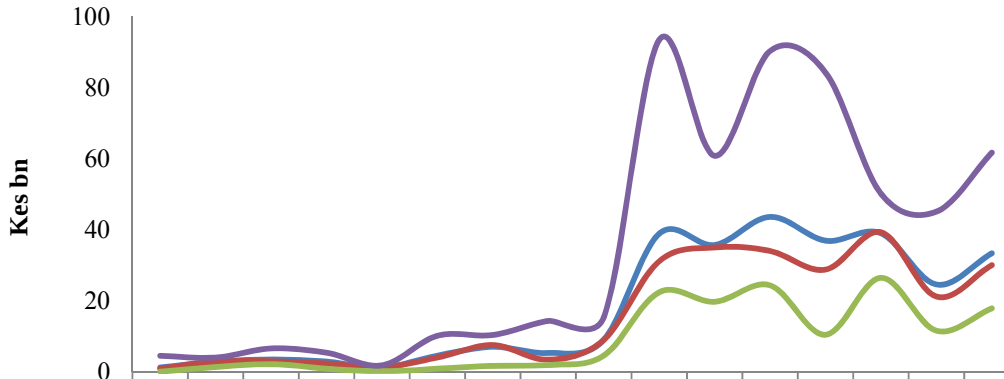
*Source: NSE, CMA*

## Appendix 2: Descriptive Statistics on Treasury Bonds Turnover (Kes bn)

| Annual Average | Annual Median | Pre-reform Annual Average Turnover | Post-reform Annual Average Turnover | Pre-reform Annual Median Turnover | Post-reform Annual Median Turnover |
|---|---|---|---|---|---|
| 216.66 | 95.99 | 39.27 | 354.64 | 34.11 | 427.69 |

*Source: Source: Research findings*

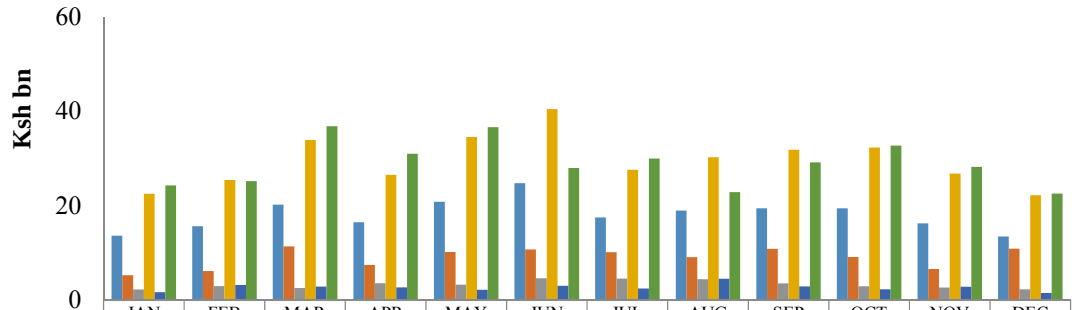
## Appendix 3: Treasury Bonds Turnover (Descriptive Statistics)




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 1.17 | 2.80 | 3.43 | 2.84 | 1.14 | 4.51 | 7.01 | 5.27 | 8.99 | 38.84 | 35.64 | 43.57 | 36.87 | 38.95 | 24.53 | 33.33 |
| Median | 0.90 | 2.85 | 2.93 | 2.33 | 1.26 | 3.99 | 7.49 | 3.38 | 8.94 | 31.10 | 34.97 | 33.97 | 28.72 | 39.24 | 21.12 | 30.00 |
| Min | 0.02 | 1.30 | 2.15 | 0.84 | 0.13 | 0.85 | 1.65 | 1.89 | 4.53 | 22.38 | 19.67 | 24.31 | 10.39 | 26.42 | 11.53 | 17.82 |
| Max | 4.48 | 3.97 | 6.54 | 5.34 | 1.78 | 10.11 | 10.32 | 14.29 | 15.28 | 93.38 | 60.73 | 90.24 | 84.20 | 50.07 | 45.03 | 61.65 |

*Source: Research findings*

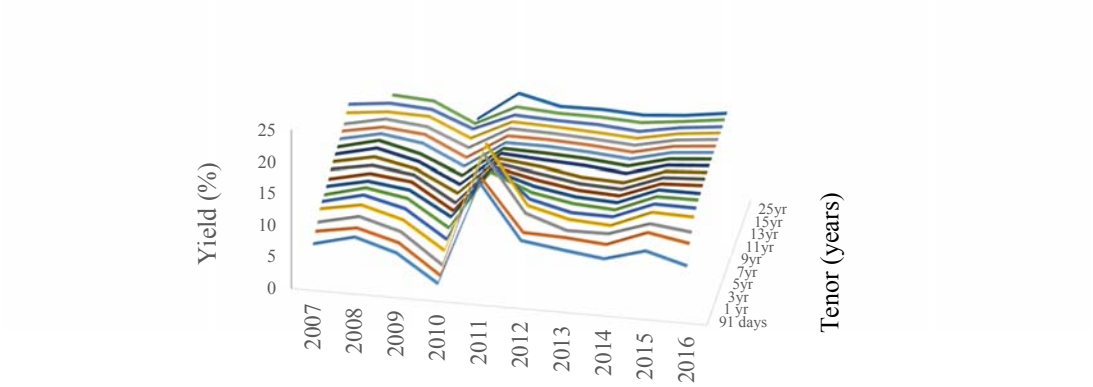
## Appendix 4: Bonds Turnover in the Period 2001-2016 (Descriptive Statistics)




| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 13.63 | 15.61 | 20.21 | 16.47 | 20.86 | 24.77 | 17.50 | 18.96 | 19.46 | 19.46 | 16.25 | 13.48 |
| median | 5.26 | 6.10 | 11.37 | 7.44 | 10.19 | 10.71 | 10.13 | 9.10 | 10.83 | 9.13 | 6.58 | 10.88 |
| Ave. Pre-reform | 2.22 | 2.93 | 2.54 | 3.52 | 3.22 | 4.58 | 4.52 | 4.41 | 3.51 | 2.92 | 2.65 | 2.25 |
| Ave. Post-reform | 22.51 | 25.47 | 33.94 | 26.53 | 34.57 | 40.48 | 27.60 | 30.29 | 31.86 | 32.32 | 26.83 | 22.22 |
| Median pre-reform | 1.65 | 3.18 | 2.83 | 2.69 | 2.15 | 3.01 | 2.42 | 4.48 | 2.86 | 2.25 | 2.80 | 1.48 |
| Median Post-reform | 24.31 | 25.20 | 36.87 | 31.01 | 36.67 | 28.02 | 29.98 | 22.87 | 29.19 | 32.78 | 28.24 | 22.57 |

*Source: Research findings*

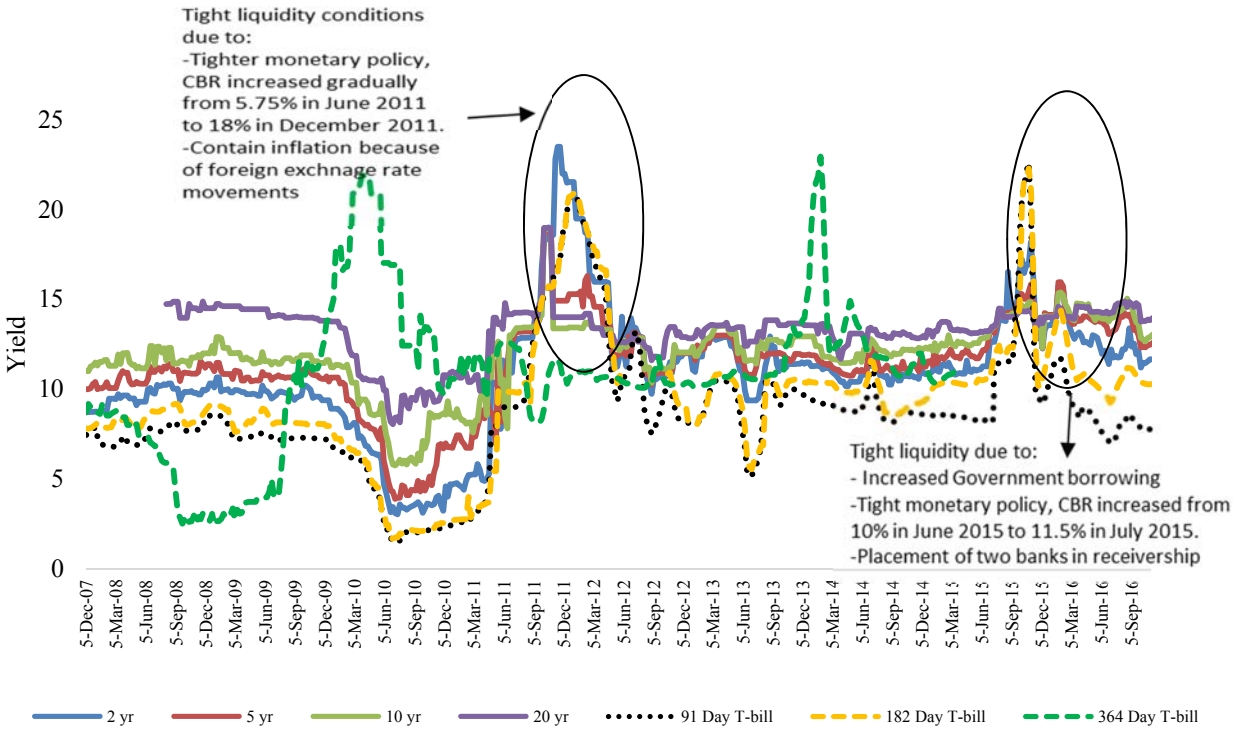
## Appendix 5: Evolution of Kenya Government Bond Yield Curve




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| 91 days | 6.892 | 8.557 | 6.612 | 2.313 | 18.948 | 10.318 | 9.400 | 8.571 | 10.406 | 8.607 |
| 182 days | 7.889 | 9.007 | 7.245 | 2.631 | 18.576 | 10.602 | 10.383 | 9.855 | 12.336 | 11.182 |
| 1 yr | 8.35 | 9.835 | 8.008 | 3.283 | 21.408 | 12.674 | 10.500 | 10.575 | 12.747 | 11.982 |
| 2yr | 9.465 | 10.659 | 8.903 | 4.586 | 22.000 | 12.900 | 11.282 | 10.890 | 13.5623 | 13.3881 |
| 3yr | 9.65 | 11.26 | 9.684 | 5.405 | 18.400 | 12.939 | 11.385 | 11.303 | 13.8978 | 13.8274 |
| 4yr | 9.712 | 11.406 | 10.309 | 6.223 | 15.672 | 12.971 | 11.800 | 11.408 | 14.0566 | 14.119 |
| 5yr | 10.055 | 11.463 | 10.643 | 6.980 | 14.923 | 12.978 | 11.888 | 11.568 | 14.1435 | 14.1531 |
| 6yr | 10.2 | 11.655 | 10.933 | 6.987 | 14.376 | 12.993 | 11.950 | 11.645 | 14.1039 | 14.423 |
| 7yr | 10.75 | 11.931 | 11.032 | 7.223 | 14.022 | 13.000 | 11.979 | 11.686 | 14.0888 | 14.455 |
| 8yr | 10.95 | 12.28 | 10.951 | 7.769 | 13.755 | 13.064 | 11.995 | 11.726 | 14.0702 | 14.515 |
| 9yr | 11.15 | 12.682 | 11.166 | 8.172 | 13.586 | 13.177 | 12.850 | 12.220 | 14.0593 | 14.5592 |
| 10yr | 11.3 | 12.9 | 11.350 | 8.577 | 13.373 | 13.225 | 12.936 | 12.367 | 14.0468 | 14.6002 |
| 11yr | 11.55 | 12.947 | 12.027 | 8.989 | 13.289 | 13.289 | 12.959 | 12.446 | 14.0383 | 14.6222 |
| 12yr | 11.7876 | 13.013 | 12.415 | 9.361 | 13.362 | 13.323 | 13.026 | 12.536 | 14.03 | 14.6438 |
| 13yr | 11.929 | 13.284 | 12.654 | 9.914 | 13.518 | 13.361 | 13.050 | 12.625 | 14.025 | 14.7011 |
| 14yr | 12.695 | 13.43 | 13.272 | 10.418 | 13.599 | 13.400 | 13.100 | 12.728 | 14.0194 | 14.7307 |
| 15yr | 13.095 | 13.83 | 13.446 | 10.923 | 13.694 | 13.433 | 13.352 | 12.845 | 14.015 | 14.7393 |
| 20yr | | 14.152 | 13.767 | 10.776 | 14.000 | 13.579 | 13.548 | 13.243 | 13.9993 | 14.8518 |
| 25yr | | | | 10.518 | 15.167 | 13.672 | 13.781 | 13.450 | 13.99 | 14.9 |
| 29yr | | | | | 16.000 | 13.700 | 13.850 | | | |

*Source: NSE, CMA*

**Appendix 6: Benchmark Bonds Yields and T-bill Rates**




*Source: Research findings*

## Appendix 7: Summary of Empirical Literature Review

| Author(s) | Title (Focus of study) | Findings | | Research gaps | Focus of this study |
|---|---|---|---|---|---|
| | | Positive and significant variables | Negative and significant variables | | |
| Bhattacharyay (2011) | Bond Market Development in Asia: An Empirical Analysis of Major Determinants | Low inflation, stable exchange rates, low and stable interest rates, large and developed banking sector, pension sector reforms, importance of institutional investors fiscal balance with high deficits, risk based approach to public debt management, diversified and deep investor base | Low government financing needs, wider bank interest rate spread, interest rate volatility, GDP per capita at purchasing power parity, exchange rate volatility, economic uncertainty, and fiscal balance | Study analyzed both government and corporate bond markets in Asia, hence did not concentrate or focus deeply on either market<br><br>Study used ordinary regression for empirical analysis | This study focuses on the development of the government bond yield curve in Kenya and provide more specific recommendations for this particular segment of the bond market<br><br>This study combines more rigorous panel OLS analysis and long memory technique using the GARCH (Generalized Auto Regressive Conditional Heteroskedasticity) model |
| Bae and Kee-Hong (2012) | Bond Market Liquidity in Asia – Theory and Empirical Evidence | Economic development, structure of the economy, strong investment environment, enhanced transparency and regulation, firm investor protection, large size of the banking sector, and regional approach to bond market development | Wide bank interest rate spread, volatility of exchange rate and interest rates, future uncertainty | Study focused on bond market liquidity at secondary market in Asia<br><br>Study used ordinary regression for empirical analysis | This study focuses on the development of the government bond yield curve in Kenya<br><br>This study combines more rigorous panel OLS analysis and long memory technique using the GARCH (Generalized Auto Regressive Conditional Heteroskedasticity) model |
| Yibin, Phelps and Stotsky (2013) | Bond Markets in Africa | interest rate volatility, English legal systems based on civil law, strong regulatory framework | exchange rate variations, capital openness | Study analyzed both government and corporate bond markets in SSA, hence did not concentrate on either market deeply<br><br>Study also used a wide range of variables | This study focuses more on the domestic government bond market yield curve in Kenya<br><br>This study focuses on a few variables to increase analytical rigor for more firm results |

| | | | | | |
|---|---|---|---|---|---|
| Flood, Liechty, and Piontek, (2015) | System-wide Commonalities in Bond Market Liquidity | Low country risk, positive investment environment and large size of the market, mix of local and foreign investors, strong legal and regulatory framework. | High country risk<br><br>Negative investment environment and small size of the market, economic uncertainty. | Study concentrated on financial market variables only and focused on bond market liquidity, a different measure of bond market growth | This study includes financial and structural variables but focuses on size (growth) of the domestic government bond market in SSA |
| Thupayagale (2015) | Fixed Income Market Efficiency: Evidence from Kenya's 10-Year Local Currency Bond | Kenya's local currency bond market remains inefficient despite implementation of financial market reforms.<br><br>Evidence of long memory in volatility of bond yield changes | | Study focused on the 10-year bond yield only whereas other bond tenors have been issued in Kenya<br><br>Study analyzed long memory of bond yields using ARFIMA-FIGARCH model | This study broadens the analysis to 2-year, 5-year and 10-year bond yields in Kenya<br><br>This study also uses panel OLS because it involves more than one variables |
| Nyongesa (2012 | Factors that influence liquidity in Kenya's secondary bond market | behavior of interest rates such as savings rate and bank lending rate | Undeveloped financial system, high country risk | Study focused on bond liquidity at secondary market in Kenya. Liquidity is a measure of bond market growth. | This study focuses on government bond yield analysis in Kenya |
| Ngugi and Afande (2015) | Raising Finance in the Kenyan Bond Market (A Case of Listed Companies on the Nairobi Stock Exchange) | Sound and prudent macroeconomic and fiscal and debt management policies, credible and stable macroeconomic environment, diversified investor base | Volatile interest rates and exchange rates, insecure settlement and custodial infrastructure, ineffective information disclosure systems | Study focused on corporate bond market in Kenya and used descriptive statistics in the analysis of data | This study focuses on government bond markets and use more rigorous analytical models |

**Appendix 8: Univariate Ordinary Least Squares (OLS) Model Results for Two Year Yield (twoyy)**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| DLBS | 0.071<br>(0.566) | | | | |
| DLSR | | 0.043*<br>(0.015) | | | |
| DLBCR | | | 0.011<br>(0.016) | | |
| DLTO | | | | -0.009<br>(0.016) | |
| DLTSR | | | | | -0.009<br>(0.016) |
| C | 0.006<br>(0.009) | 0.005<br>(0.009) | 0.006<br>(0.009) | 0.006<br>(0.009) | 0.006<br>(0.009) |
| Adj. R-squared | 0.784 | 0.848 | 0.754 | 0.875 | 0.836 |
| S.E. of Regression | 0.011 | 0.004 | 0.007 | 0.016 | 0.017 |
| Sum squared residual | 0.597 | 0.526 | 0.609 | 0.610 | 0.610 |
| F-statistic | 121.530 | 158.152 | 176.431 | 185.308 | 192.307 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson stat | 1.852 | 1.939 | 1.955 | 1.931 | 2.031 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

*Source: Research findings*

**Appendix 9: Univariate Ordinary Least Squares (OLS) Model Results for Five Year Yield (fiveyy)**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| DLBS | -0.494 | | | | |
| | (0.497) | | | | |
| DLSR | | -0.025*** | | | |
| | | (0.013) | | | |
| DLBCR | | | 0.033** | | |
| | | | (0.014) | | |
| DLTO | | | | -0.009 | |
| | | | | (0.014) | |
| DLTSR | | | | | -0.009 |
| | | | | | (0.014) |
| C | 0.005 | 0.005 | 0.004 | 0.005 | 0.005 |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Adj. R-squared | 0.789 | 0.817 | 0.790 | 0.804 | 0.817 |
| S.E. of Regression | 0.093 | 0.093 | 0.032 | 0.094 | 0.094 |
| Sum squared residual | 0.228 | 0.207 | 0.092 | 0.233 | 0.233 |
| F-statistic | 156.988 | 163.449 | 171.189 | 178.442 | 198.435 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson stat | 1.843 | 1.912 | 1.839 | 1.863 | 1.897 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

*Source: Research findings*

**Appendix 10: Univariate Ordinary Least Squares (OLS) Model Results for Ten Year Yield (tenyy)**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| DLBS | 0.081<br>(0.472) | | | | |
| DLSR | | -0.009<br>(0.013) | | | |
| DLBCR | | | 0.050*<br>(0.013) | | |
| DLTO | | | | -0.023***<br>(0.013) | |
| DLTSR | | | | | -0.022***<br>(0.013) |
| C | 0.004<br>(0.007) | 0.005<br>(0.007) | 0.004<br>(0.007) | 0.005<br>(0.007) | 0.004<br>(0.007) |
| Adj. R-squared | 0.837 | 0.788 | 0.809 | 0.813 | 0.814 |
| S.E. of Regression | 0.089 | 0.088 | 0.084 | 0.088 | 0.088 |
| Sum squared residual | 0.107 | 0.103 | 0.000 | 0.084 | 0.085 |
| F-statistic | 198.029 | 185.455 | 179.018 | 204.932 | 211.807 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson stat | 2.053 | 2.047 | 2.051 | 1.994 | 1.993 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

*Source: Research findings*

**Appendix 11: Multivariate Ordinary Least Squares (OLS) Model Results for Two Year Yield (twoyy)**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| DLBS | -0.897<br>(0.586) | | | 0.167<br>(0.460) | 0.297<br>(0.452) | 0.061<br>(0.473) |
| DLSR | 0.043*<br>(0.016) | -0.043*<br>(0.016) | | -0.017<br>(0.012) | -0.019<br>(0.012) | -0.009<br>(0.013) |
| DLBCR | 0.006<br>(0.017) | 0.003<br>(0.016) | 0.012<br>(0.017) | 0.053*<br>(0.013) | 0.055*<br>(0.013) | |
| DLTO | 0.044<br>(0.561) | 0.208<br>(0.554) | 0.088<br>(0.565) | -0.018<br>(0.013) | | |
| DLTSR | -0.033<br>(0.561) | -0.202<br>(0.553) | -0.079<br>(0.564) | | | |
| C | -0.004<br>(0.012) | 0.002<br>(0.012) | 0.005<br>(0.012) | 0.005<br>(0.007) | 0.004<br>(0.007) | 0.004<br>(0.0107) |
| Adj. R-squared | 0.839 | 0.824 | 0.816 | 0.791 | 0.795 | 0.811 |
| N | 143 | 143 | 143 | 143 | 143 | |
| S.E. of Regression | 0.105 | 0.105 | 0.107 | 0.084 | 0.084 | 0.089 |
| Sum squared residual | 0.497 | 0.523 | 0.605 | 0.968 | 0.981 | 0.103 |
| F-statistic | 202.139 | 212.068 | 210.264 | 214.940 | 215.944 | 210.234 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson stat | 1.720 | 1.823 | 1.833 | 1.978 | 2.026 | 2.046 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

1 contains all explanatory variables
2 excludes DBLS
3 excludes DLBS and DLSR
4 excludes DLTSR
5 excludes DLTSR & DLTO
6 excludes DLTSR, DLTO & DLBCR

*Source: Research findings*

**Appendix 12: Multivariate Ordinary Least Squares (OLS) Model Results for Five Year Yield (fiveyy)**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| DLBS | -0.4629<br>(2.1657) | | | -0.0498<br>(0.4887) | -0.0561<br>(0.4868) | -0.1958<br>(0.4961) |
| DLSR | -0.0321**<br>(0.0136) | -0.0323**<br>(0.0136) | | -0.0323**<br>(0.0136) | -0.0327**<br>(0.0135) | -0.0254***<br>(0.0135) |
| DLBCR | 0.0398*<br>(0.0143) | 0.0396*<br>(0.0143) | 0.0330**<br>(0.0142) | 0.0395*<br>(0.0142) | 0.0399*<br>(0.0142) | |
| DLTO | 0.4127<br>(2.1242) | -0.0310<br>(0.4790) | 0.0592<br>(0.4854) | -0.0047<br>(0.0138) | | |
| DLTSR | -0.4153<br>(2.1205) | 0.0262<br>(0.4785) | 0.0668<br>(0.4848) | | | |
| C | -0.0058<br>(0.0101) | 0.0055<br>(0.0100) | 0.0036<br>(0.0102) | 0.0058<br>(0.0101) | 0.0058<br>(0.0101) | 0.0077<br>(0.0103) |
| Adj. R-squared | 0.745 | 0.815 | 0.818 | 0.786 | 0.758 | 0.811 |
| N | 143 | 143 | 143 | 143 | 143 | 143 |
| S.E. of Regression | 0.0912 | 0.0909 | 0.0924 | 0.0909 | 0.0906 | 0.0928 |
| Sum squared residual | 0.1395 | 0.1398 | 0.1864 | 0.1398 | 0.1407 | 0.2057 |
| F-statistic | 202.335 | 212.928 | 201.957 | 210.930 | 203.892 | 201.792 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson stat | 1.6903 | 1.6900 | 1.7479 | 1.6909 | 1.6845 | 1.7219 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

1 contains all explanatory variables
2 excludes DBLS
3 excludes DLBS and DLSR
4 excludes DLTSR
5 excludes DLTSR & DLTO
6 excludes DLTSR, DLTO & DLBCR

*Source: Research findings*

## Appendix 13: Multivariate Ordinary Least Squares (OLS) Model Results for Ten Year Yield (tenyy)

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| DLBS | 0.2575<br>(0.4697) | | | 0.167<br>(0.460) | 0.297<br>(0.452) | -0.1958<br>(0.4961) |
| DLSR | -0.0182<br>(0.0125) | -0.0182<br>(0.0125) | | -0.017-<br>(0.012) | -0.019<br>(0.012) | -0.0254***<br>(0.0135) |
| DLBCR | 0.0519*<br>(0.0133) | 0.0510* 0.0131 | 0.0473*<br>(0.0129) | 0.053*<br>(0.013) | 0.055*<br>(0.013) | |
| DLTO | -0.4564<br>(0.4498) | -0.4093<br>(0.4404) | -0.3583<br>(0.4408) | -0.018<br>(0.013) | | |
| DLTSR | 0.4391<br>(0.4499) | 0.3905<br>(0.4400) | 0.3379<br>(0.4403) | | | |
| C | 0.0108<br>(0.0093) | 0.0102<br>(0.0092) | 0.0091<br>(0.0092) | 0.005<br>(0.007) | 0.004<br>(0.007) | 0.0077<br>(0.0103) |
| Adj. R-squared | 0.799 | 0.804 | 0.797 | 0.801 | 0.793 | 0.811 |
| N | 143 | | | | | |
| S.E. of Regression | 0.0838 | 0.0836 | 0.0839 | 0.084 | 0.084 | 0.0928 |
| Sum squared residual | 0.9615 | 0.9636 | 0.9785 | 0.968 | 0.981 | 0.2057 |
| F-statistic | 194.141 | 195.127 | 186.075 | 204.940 | 195.944 | 201.792 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson stat | 2.0052 | 2.0070 | 2.0226 | 1.978 | 2.026 | 1.8219 |

*, **, *** indicates significance levels at 1%, 5% and 10% respectively

1 contains all explanatory variables
2 excludes DBLS
3 excludes DLBS and DLSR
4 excludes DLTSR
5 excludes DLTSR & DLTO
6 excludes DLTSR, DLTO & DLBCR

*Source: Research findings*