PREDICTABILITY OF ECONOMIC GROWTH USING THE YIELD SPREAD IN KENYA (2006-2015)

BY

MOHAMED OSMAN ADAN

X50/80224/2012

RESEARCH STUDY SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTERS OF ARTS ECONOMICS OF THE UNIVERSITY OF NAIROBI

August 2015

DECLARATION

This is my original work and to the best of my knowledge it has not been presented for the award a degree in other university

MOHAMED OSMAN ADAN

SIGNATURE……………………   DATE……………………

This paper has been submitted for the award of the degree of Masters of Arts in Economics with our approval as university supervisors

DR. BETHUEL KINYANJUI KINUTHIA

SIGNATURE…………………… DATE……………………………

DR. PETER MURIU

SIGNATURE……………   DATE…………………………… .

DEDICATION

I dedicate this paper to my HoyoFatumaMaalimAbdi Ismail for her love, care and enormous sacrifices (my Allah reward with Paradise).

MjombaMohamudMaalim Abdi Ismail for his support, motivation and inspiration.

To my beautiful wife and lovely daughter (Munirah Mohamed)

And to cousins; Hamza and Luqman so that this paper serves them as an encouragement to work hard and excel in school

ACKNOWLEDGEMENT

Contents

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey Fuller test
ATS	Automated trading system
CAPM	Capital Asset Pricing Model
CBK	Central Bank of Kenya
CBR	Central Bank Rate
CDS	Credit Default Swap
CMA	Capital Markets Authority
IRA	Insurance Regulatory Authority
IRF	Impulse Response Function
EH	Expectation Hypothesis
GDP	Gross Domestic Product
NSE	Nairobi Securities Exchange
RBA	Retirement Benefit Authority
SASRA	Sacco Societies Regulatory Authority
OLS	Ordinary Least Square
VAR	Vector Auto regression
KPSS	Kwiatkowski-Phillips-Schmidt-Shin

ABSTRACT

Thisobjective of research study was to establish the relationship between economic growth and yield spread (the difference between the three month Treasury bill and the ten year Treasury bond). There exists enormous literature not just on the potency of the yield spread to predict economic activity but its leading indicator property too. However, this paper is motivated by the lack of comparative evidence from emerging markets and developing countries.

Numerous studies have established the findings that an upward sloping yield curve is indicative of an increased levels of economic activity in the future whereas flat or inverted yield curve means that there will be slowdown in the level of economic activity. This study used a VAR model which satisfied stability test as well as absence of autcorrelation of the residuals. The study established that the yield spread is statistically significant in explaining economic growth. Growth too was found to statistically significant to explain the yield spread.

There after the study forecasted economic growth in Kenya and found out the economy is projected to grow at 5.8 and 5.9 for the third and fourth quarters of 2015 respectively and 6.0 and 6.1 for the first and second quarters of 2016 respectively. In addition, the study found out the identified structural break in the central bank rates (Monetary policy) had significant effect on the economic growth in Kenya.

The findings of the study are consistent with those of the literature review and to that extent corroborates the findings the yield spread is capable of offering foresight in to the direction the economy is expected to take.

INTRODUCTION

1.1 Background

Predicting economic growth is important to enable firms make decisions affecting their productive capacity given the level future economic activity. It's also important to enable statebudgetary authorities to predict future surplus or deficit and for the central banks in choosing proper current monetary policy in the current period.The yield spread[1] has attracted considerable attention from researchers and financial analyst as a tool for predicting the future economic growth as well as expected recessions (Mohapi & Botha, 2013).

Upward sloping yield curve (positive spread) is associated with positive liquidity premium (economic optimism) whereas a flat and an inverted yield curve (where short maturity bonds have higher interest rates than the long maturity bonds) is associated with slowdown in the level of economic activity i.e. recession (Estrella A. , 2005)

The reason for the focus on the co-movement of the yield spread and business cycle is premised on the thinking that financial market participants have expectations about future price levels and the prices of securities traded in the financial markets have inbuilt information about future economic outlook. Thisis because people price securities close to their fundamental value (Stock & Wartson, 2003). Therefore, there is considerable information about future economic events built into such prices.

Bonds have different characteristics such as; maturity length, credit quality and tax characteristic. These features in turn determine the level of interest rates such bonds bear. Sovereign bonds of a given country have the same characteristic save for maturity. Some of the economic theories explaining the difference between the yields of bonds of different maturities are the liquidity premium theory and the expectation hypothesis. On the term premium, participant in the bond market will ask for a premium above the prevailing short-term rates to cushion them against risks

---

[1]Difference between the yields of bonds of different maturities but equal credit quality.

associated with time(Estrella & Mishkin, 1998). The expectation hypothesis states that the long-term rates are made up of the averages of short-term rates expected in the future. These short-term rates are usually set by monetary authorities/central banks who are guided by macro prudential and surveillance polices that are consistent with the targeted economic and inflationary environment. In this regard, the yield spread is a product of expected future economic growth and inflation (Estrella & Mishkin, 1998)

US data1953 ó1987 demonstrated that the yield curve contained information about the future(Harvey, 1989). Thereafter, the author corroborated the initial findings in subsequent studies on the US (Harvey, 1989&93). The author then extended the scope of the study to Germany (Harvey, 1991a), France (Harvey 1991b) and other G-7 countries (Harvey 1991c). In 1997, Harvey did a comparison of the data from US and Canada. In all these studies, the authorøs findings were that the yield spread has in-built information to forecast economic growth or recession.

Despite numerous empirical studies that verified the potency of the yield spread to predict GDP[2], literature emanating from emerging economies and especially those of Sub-Sahara Africa are scarce. Some of the notable studies on the topic in the Sub-Sahara Africa are those of(Khomo & Aziakpono, 2007), (Richard & Keeton, 2011)and(Mohapi & Botha, 2013). All these studies found out the ability of the yield spread to predict economic growth. The scarcity of studies on the topic in this regioncan be attributed to underdeveloped financial markets in these economies(Mohapi & Botha, 2013).

According to the second summit of the Africa Debt Capital Market[3]; Bond market in Africa witnessed some progress though marginal. Africa accounts for only 2% of global bond turnover however, 96% of this is attributable to South Africa. This observation is consistent with the fact

---

[2] Harvey (1988), Estrella, A&Hardvouelis (1991), Estrella and Mishkin (1997), Bonser-Neal and Morley (1997), Stock and Watson (2003) , Bordo and Haubrich (2008)

[3]http://ic-events.net/wordpress/wpcontent/uploads/2014/12/ADCM_BrochureFinal_lowres.pdf (Date Visited 3.10.2015)

that all cited studies on the topic in Sub-Sahara Africa were done in South Africa. The tardy development of the markets in the region can be attributed to lack of institutional and operating infrastructure, narrow investor base, limited secondary market and high borrowing cost, among others (Mohapi & Botha, 2013).

This paper will focus on Kenya[4] and will offer an update as to the ability of the yield spread to forecast economic growth. Regarding concerns raised above on essentiality of developed bond market to make a sensible study, according to the Financial Stability report[5] (2013),there is vibrancy in the market and numerous competitive investors such as commercial banks, cooperative societies, Insurance companies, pension firms, and individuals.

The sequence of the remaining parts of this chapter of the paper is; an over view of Kenya's economic growth, Kenya's bond market, problem statement, objective, scope and justification of the study. The Literature review; theoretical and empirical literature, will be dealt with in the second chapter. The methodology will come last to specify; variables, econometric test and model

1.2 Overview of Kenya's economic growth

The country's economic growth objective is guided by thelong-term development blue print; vision 2030. This plan aims to make the country a globally competitive and prosperous state. The vision has three pillars; Economic, social and political.

The economy's main drivers are transport, manufacturing, telecommunication, mining and quarrying, electricity generating sectorswholesale and retail trade. Of late, sectors like Agriculture and forestry and fishing have experienced muted growth. Tourism which has been a critical part of the economy has been hit by insecurity and the Ebola crisis of West Africa. The weakening Shilling is also expected to erode some of the expected gains for 2015. Despite all these challenges, the economy is predicted to grow at 6.00% in 2015, 6.6 in 2016 and 6.5 in

---

[4]Kenya has the most liquid and vibrant capital market in the region

[5]Joint report by the CBK, CMA, IRA, RBA SASRA

2017[6]. Generally the economic growth trend of Kenya has been susceptibility to election related violence[7] (2002, 2007/8, and 2012/13).

1.2 Kenya's Treasury bills and Bonds

The bond market is liquid and continues to deepen. There is a 15% withholding tax on treasury bills and treasury bonds of less than 10-year tenor and a 10% withholding tax on Treasury bonds of over 10year. Infrastructure bonds are tax exempt. Since 2002, the long-term bonds have dominated the market. This is consistent with the country's increased demand for infrastructural development that calls for a higher maturity financing.

Table 1: composition of government securities

YEAR	Treasury Bills (%)	Treasury Bonds (%)	Kenya Long-Term Stock (%)
2000	78.45	21.18	0.37
2001	72.35	24.4	3.25
2002	45.01	54.57	0.42
2003	32.77	66.94	0.29
2004	24.02	74.67	1.31
2005	27.12	72.59	0.29
2006	30.22	69.54	0.24
2007	25.76	74.09	0.15
2008	19.49	80.36	0.15
2009	24.81	75.07	0.12
2010	20.69	79.31	Redeemed fully
2011	14.46	85.54	Redeemed fully
2012	19.07	80.93	Redeemed fully

---

[6]http://www.worldbank.org/en/publication/global-economic-prospects/regional-outlooks/Global-Economic-Prospects-June-2015-Sub-Saharan-Africa-analysis#2(Date Visited 3.10.2015)

[7]http://databank.worldbank.org/data//reports.aspx?source=2&country=KEN&series=&period=# (Date Visited 3.10.2015)

2013	26.82	73.18	Redeemed fully

Kenya made its debut in the Eurobond market in June 2014. It issued USD 1.5 Billion 10-year bond, and a 5-year issue worth USD500 million. The country also utilized the same tenors for USD500 Million and USD250 Million respectively on December 2014 hence, bringing the total debt outstanding in the year 2024 to USD2billion and in the year 2019 to USD750million.

On credit rating, the major rating agencies have Kenyaøs long-term foreign currency debt rating at B+/B1, with stable outlooks. Fitch Ratings affirmed its rating on 23 January 2015, while standard and pooroøs (November 2014) and Moodyøs (March 2014) also affirmed their respective ratings in the most recent assessments. Supportive factors for Kenyaøs current ratings include economic diversification, a large and growing debt market, robust growth rates and satisfactory monetary flexibility. Constraints on the ratings include weak GDP per capita, weak social and governance indicators, high government debt and vulnerability to balance of payments pressures. Kenyan Eurobonds attract interest from global institutional investors (*Source: Barclays Bank; Barclays Research)*.

There have been some landmark achievements in the markets. In 2008, the Central bank of Kenya floated the longest dated paper of 20 years to maturity and a debut 30 year saving in 2011 to augment the vision 2030 objectives of facilitating saving.

In 2007, the central bank embarked on bond benchmarking program which was meant to address the issue of bond fragmentation, improve on the liquidity of the bond market at the secondary market as well as firm up the yield spread.The central bank together with the Nairobi stock Exchange ensured the automation of the trading in the bonds market. This infrastructure has led to enhanced efficiency levels as well as boosted the confidence in the secondary market by reducing the length of the settlement process. The reduction of the minimum investment to participate in treasury auctions as well as the introduction of Treasury direct mobile platform have also attracted small investors to the market who can invest as low as KES 3,000.

The NSE standard yield curve adoption is one such milestone and of specific importance as far as this study is concerned.

Figure 1: Trend - Quarterly GDP and Spread (2006-2014)
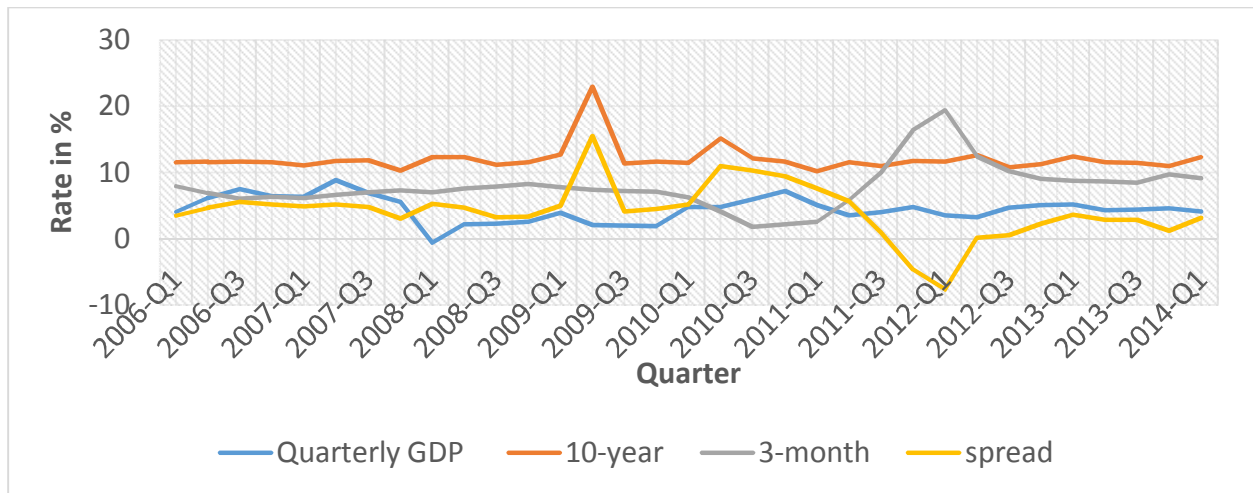
The trend in figure one relates to the period of the first quarter of 2006 to the first quarter of 2014. Generally, there is co-movement between the yield spread and growth. An interesting point to note is that there was an inversion in the yield curve starting at the last quarter of 2007 and first quarter of 2008 (quarter 8 and 9). This coincides with reduction in GDP following the 2007/8 post-election violence. There after the yield spread displays a positive trend which again is consistent with the witnessed recovery.

Another point is where in late 2011 to the second quarter of 2012, there was reduction in GDP during this time too. In fact, during this time, the economy was faced with sky rocketing foreign exchange rate coupled with electioneering mode and uncertainty about the return of what was seen in 2007/8.

1.3 Statement of the problem

With growing concern for growth and visible effort for economic growth and development by the country; as evident from economic blue prints (vision 2030), the need for proper parameters to gauge the direction of the economy is needed more than ever before. Kenya witnessed tremendous financial inclusion over the past decades. In the latest dramatic action to increase financial inclusivity, the government reduced the minimum investment to participate in treasury auctions in addition to the introduction of the Treasury direct platform which has attracted small investors to the bond market. These recent developments have reduced agentsø detachment from the market thereby enhancing the link between their actions and the market outcomes. In

addition, at an era where there is seemingly re-energised effort to peg regime change on the performance of the economy (evident from political parties manifestos), simple and reliable tool for assessing the direction and the state of the economy is needed. The yield spread's potency has been a consistent finding of several empirical studies in both the developed and developing nations on the ability of the yield spread to predict GDP[8].

The availability of data and simplicity of methodology makes it possible for the Central Banks to help inform policy makers what is going to happen in the future in terms of economic growth. Prediction of economic growth will go a long way in planning and decision making for both investors and policy makers.

Consistent with the aforementioned need for growth prediction model, this study investigates whether the yield spread, as a macroeconomic tool, can be used to predict economic growth. In addition, this paper is informed by the scarcity of comparative evidence from emerging markets on the role of the yield spread as a predictor of growth. In this regard, the paper derives its drive fromthe fact that õthe universality (of this issue) is unresolvedö(Stock & Wartson, 2003)

1.4 Research Questions
In view of the outlined statement of problem, the study seeks to provide answers to the following questions:

1. What is the relationship between the yield spread and economic growth?
2. What does the yield spread predict Kenyan economic growth rate to be?

---

[8]Chen (1991), Estrella and Hardouvelis (1991), Estrella and Mishkin (1997), Devis and Fagan (1997), Aziakapono and Khomo (2007), Keeton and Richard (2011) and Mohapi and Botha (2013)

1.5 Objectives of the study

The primary objective of the study seeks to establish whether the yield spread has in-built information capable of predicting economic growth. In specific terms the study seeks;

1. To establish the direction of causality of yield spread and economic growth.
2. To Predict Kenya's economic growth rate.

1.6 Scope and Justification of the study

The focus of this paper is to establish whether there is causal relation between the yield spread and economic growth in Kenya. To achieve this, Kenya's quarterly GDP rates and yield spread on government bonds. The study choice of government bond yields is motivated by first convenience; with respect to availability of data. Secondly, pricing of these instruments is not subject much credit risk premium. Thirdly, other instruments (such as commercial papers and equities) have their pricing basis formed from the prices of risk free government bond. The study's definition of yield spread is the difference between the yield on three month Treasury bill and ten-year Treasury bond. The use of this definition is motivated partly the finding of past studies[9] and the fact that in Kenya the three-month and the ten-year maturity bond is the shortest and longest maturities which are also actively traded and had longest presence in the secondary market. The paper will employ time series analysis for the period 2000 – 2014.

The study is important first in contributing to the existing literature on the topic and specifically in providing a comparative evidence from sub-Sahara Africa. If it's established that the yield spread has the capability to predict economic growth, it will offer policy makers an alternative to explore in forecasting economic growth which is essential as aforementioned in enhancing choice of monetary policy stance as well as budgetary process. If the yield spread is found impotent to predict growth, then that will open another line of academic debate as to why the yield spread is capable of predicting economic growth in some countries and not in others.

9Moneta (2003), Estrella (2005), Mohapi and Botha (2013), Keeton and Richard (2011)

CHAPTER TWO

LITERATURE REVIEW

There is extensive literature on the relationship between financial variables (interest rates, dividend yields, stock returns and exchange rates), economic growth and inflation. However, much of this literatures are devoted to the leading indicator property of the yield spread,(Stock & Wartson, 2003).

This chapter will dwell on the theoretical literature, empirical literature and an overview of the literature review.

2.1THEORETICAL LITERATURE

2.2 The term structure of interest rates.

There are several theories explaining the difference between the yields of different maturities. There is the expectation hypothesis which states that yields are based on the market participantsø expectation about the future rates. The fundamental assumptions under this hypothesis are that the bond of different maturities are perfect substitutes, investors are risk neutral and the shape of the yield spread is dictated by investors expectation of future interest rates and inflation. To explain the assertion of the hypothesis, if an investor buys a one-year bond, holds it and invests the proceeds in another one-year bond the following year, s/he will have equal proceeds as an investor who bought a two-year bond(Mishkin, 2007).

There is also the segmented Market theory that assumes that the financial market is segmented, differentiable and distinct. According to this theory the interest rate on each bond with distinct maturity is determined by the market forces of demand and supply distinct to it. According to this theory investors have different investment preferences determined influenced by their liquidity, claims and obligation facing them. In this regard, some investors will prefer to hold bonds of short maturity while others will prefer those of longer maturity(Mishkin, 2007). Hence Investors and borrowers will only care about a given section of the general market and interest rates of each section of the market will be independently determined by the number of borrowers and investors it attracts(John, Jonathan, & Stephen, 1985).

A third theory (The liquidity Premium Theory) postulates that the long term interest rates equal to the average of the short term interest rates occurring during its lifespan plus a premium to account for the demand and supply condition of the long term interest rates. The fundamental assumption of the liquidity premium theory is that bonds of different maturities are substitutes but not perfect substitutes. This is to say that expected yield on one bond influences the yield on another of a different maturity. This makes investors to prefer one maturity length over another in which case they will prefer those of relatively shorter maturity. And if they are to hold one of relatively longer length of maturity, they will demand a premium(Mishkin, 2007).

A similar view to the liquidity premium theory is the Preferred Habitat Theory. According to this hypothesis, Investors have preferences for bond of one maturity (preferred habitat) and will only buy another whose maturity is not preferred if they can give a higher expected return(John, Jonathan, & Stephen, 1985).

2.3 Yield spread and economic activity

There is no straight forward theoretical linkage connecting the yield spread and economic growth(Wheelock & Whohar, 2009). These sentiments have also been echoed in other studies (Dotsey, 1998) and (Estrella A. , 2005). That said, there are two main economic explanations on the linkage between the yield spread and the levels of economic activity;

The first explanation is the linkage between yield spread and macroeconomic activity, that is, through consumption and investment.From the expectation hypothesis, the market participantsø expectation about future interest rates informs the pricing of bonds hence theprevailing yield spread. In addition, as established in the theory of consumption smoothening, people prefer to maintain a steady standard of living instead of high consumption during high levels of income and low consumption when income is low. In this regard, if a person expects a recession, s/he will sell short term financial instruments and buy long term securities to ensure steady income in the future. As a result, the yield on short term securities will raise will those of longer maturities will fall thereby causing an inverted yield curve which is usually associated with a slowdown in the level of economic activity (Wheelock & Whohar, 2009).

The second explanation on the linkage between the yield spread and economic activity comes through the monetary policy.This is attributed to the apparent ability of the yield spreads

foresight to the actions of monetary authorities. If the central bank undertakes contractionary monetary policy, the short term rates will temporarily increase and market participants will expect future short term rates to be lower than current level. Now; as postulated in the expectation hypothesis theory, the long-term rates will go up less than the short-term rates thereby causing an inverted yield spread, which is associated with slowdown of economic activity(Lorenzo & Eric, 2015). The Keynesian IS-LM model provides a more elaborate and graphical illustration of this argument since tightening of the monetary policy shifts the LM spread to the left increasing the short rates hence, reducing the spread and productivity(Wheelock & Whohar, 2009).

2.4 EMPIRICAL LITERATURE

Empirical literature on the topic spans from the work of Mitchell and Burn (1913) although the work of (Kessel, 1965)is the first elaborate study on the co-movement of the yield spread and business cycle(Chen, 1991). The need to make decisions on the basis of expectations about the future economic conditions has made the topic relevant to this day. A plethora of research says that that the yield spread (the difference between the rates on the long term treasury bonds and short maturity treasury bills) contains information on future economic activity which is independent of information contained in other macroeconomic variables. Quite a number of these empirical studies verify the ability of the yield spread to predict GDP[10]. Another portion of the literature focused on probit models to establish whether the yield spread generates reliable probabilities on future recessions[11].

Much as the above studies attest to the potency of the yield spread to predict growth, (Schock, 2015)is of the view that the leading indicator property of the yield spread has vanished. According to the author, since the financial crisis and its aftermath, due to sovereign default, the long term rates are strongly distorted by credit risk.The author came up with a way of adjusting

---

[10] Harvey (1988), Estrella and Hardvouelis (1991), Estrella and Mishkin (1997), Bonser-Neal and Morley (1997), Stock and Watson (2003) , Bordo and Haubrich (2008)

[11] Estrella and Hardvouelis (1991), Estrella and Mishkin (1997), Chauvet and Potter (2001), Wright (2006),

the credit risk is by accounting for credit default swap. CDS is assumed to be equivalent to the risk premium of long-term government debt. The long term rate in the credit risk-adjusted yield spread is computed by reducing long-term rate by the CDS factor. He asserts that the accuracy of predicting growth and recessions using the yield spread is high, provided that biases associated with Euro zone sovereign default risk are considered.

In addition to the above adjustment, a new measure of credit risk known as GZ spread can be used as an alternative to enhance accuracy of the yield spreads ability to predict growth (Gilchrist & Zakrajsek, 2012). GZ was defined as the difference between the interest rate on securities perceived to carry default risk premium and government debt instrument (German bunds) with equal maturities. This additional variable leads to significant improvement in the fit of in-sample growth projections both in the US and countries in the Euro Zone(Gilchrist & Zakrajsek, 2012).

This new perspective emanates from the fact that despite the continuous high level yield spread in the Euro region, growth has been sparse. This anomaly is explained as contamination by default risk(Gilchrist & Zakrajsek, 2012). Prior to the financial crisis, studies (mostly done in Europe and America) assumed all government securities don't carry default risk premium.

The predictive ability of the yield curve has of late been questioned(Arif & Firdous, 2014). , In their study, they found out that on using conventional OLS and quantile regression, the yield curve did not demonstrated possession of any in-built information to predict economic growth. However, on using wavelets regression, the yield curve displayed some potency in predicting economic activity. The use of Supervised Factor Model has also been seen to improve the yield spreads ability to forecast unemployment, disposable income, industrial production and less for inflation(Lorenzo & Eric, 2015).

The empirical literature on the topic is enormous and inexhaustible. In addition, the findings of the studies have majorly corroborated each other. Table 2shows additional empirical literature.

Table2: Summary of empirical studies on the predictive ability of the yield spread on economic activity

STUDY	COUNTRY	DEPENDENT VARIABLE	FINDINGS
Dotsey (1998)	US; 1955-97	GDP growth	Spread has marginal predictive power upto 6 quarters a head
Jardet (2004)	U.S; (1957-2001	monthly industrial production and employment	Spread forecasts output growth well at one year horizon
Lorenzo & Eric, (2015).	US data	unemployment, disposable income, industrial production and inflation	The use of Supervised Factor Model has also been seen to improve the yield spreads ability to forecast unemployment, disposable income, industrial production and less for inflation
Arif&Firdous, 2014	India	GDP growth	With OLS and quantile regression, Spread has no predictive power, on using wavelets regression, the spread indicated ability to predict GDP growth
DøAgostino, Giannone, and Surico (2006)	U.S.	monthly personal income, industrial production, unemployment rate and employment	Spread has predictive ability but there occurred a general decline in the forecasting accuracy
(Stock &Wartson, 2003)	Germany, France, Italy, UK,	Quarterly GDP growth rate	Some asset prices have predictive power but results vary across time

	US, Japan and Cananda		and countries

2.5 Yield spread versus other indicators

The yield spread tends to perform better than other leading economic indicators including traditional leading indicators and their components and other variables with potential predictive power(Estrella A. , 2005). Indicators such as interest rates and stock prices may have similar performance with the yield spread sometimes but none seem superior to the yield spread in predicting economic activity levels. (Dueker, 1997)and (Dotsey, 1998)compared the yield spread with some other leading economic indicators of recession and their conclusion corroborated the findings of (Estrella A. , 2005)as above. Estrella & Miskin (1998), compared the term structure of interest as predictor of economic downturns with a large number of alternative indicators and found out to be the best particularly for a period of around one year.

(Stock & Wartson, 2003), examined a large number of indicators of economic recessions and found that all of the indicators lacked ideal properties but even with this limitation the term structure õcomes closestö in predicting output growth.

In the emerging markets and particularly Sub-Sahara Africa, studies on the yield spread ability to forecast economic growth is scarce and the few available emanate from South Africa. (Khomo & Aziakpono, 2007)examined the yield spread predictive power from 1980 to 2004 in South Africa and found out that it successfully predicted the four economic down turns that occurred during the period. However according to this study it falsely predicted a down turn in 2002/03.

Even though there was no economic down turn in South Africa during 2002/03, there was significant reduction in the level of economic activity in South Africa(Richard & Keeton, 2011). According to them, growth in GDP observably declined with one quarter of negative growth (Q4 2002). Manufacturing output had two quarters of negative growth (Q4 2002 and Q1 2003). Therefore, whereas a recession in its actual characteristic never occurred, a major economic slowdown did occur. In this regards, usefulness of the yield spread as a forecasting tool of future economic activity level/direction of movement of the economy cannot be understated(Richard &

Keeton, 2011). In addition, in as much as there is a lot of empirical evidence on the yield spread, most of them were done in developed countries with evidence of the same from emerging markets being from only South Africa(Khomo & Aziakpono, 2007). The scarcity of studies on the topic in this regioncan be attributed to underdeveloped financial markets in these economies(Mohapi & Botha, 2013).

2.6OVERVIEW OF LITERATURE REVIEW

At this juncture itøs worth noting that the quest into verifying the leading indicator property of the yield spread has attracted much attention from academician across the globe. A lot of variations in methodology have been provided since the work of Mitchell and Burn of 1913. The global dynamics have shaped the methodology employed in assessing its forecasting ability across time. To be specific, the after month of the global financial crisis and the birth of defaults in several sovereign bonds is one such turning point as far as yield curves ability to predict economic activity is concerned(Schock, 2015). There have been varied approaches in assessing the potency of the yield spread to predict economic activity. Whereas substantial literature used annualised GDP (annual and quarterly), there has been use of Industrial production, Unemployment, Non-agricultural unemployment, manufacturing and trade sales, disposable income, Consumption and Investment as proxies for economic activity. In either way, as evident from literature, there was concurrence on the consistent of the yield spreads predictive ability.

In addition to consensus, even after use of different proxy variables, there has been use of additional different variables such as monetary policy, lagged and current oil prices and GDP levels. Even then, the empirical literature review witnessed consistency in the affirmation of the in-built information in the yield spread that can be harnessed to predict economic growth.

Moreover, whereas the yield spread forecasting ability proved consistency in the developed world, the gap on whether it can post the same results for developing countries with their peculiar phenomenon is the key drive of this paper. At the time of this paper, I am not aware of any other study on the predictive ability of the yield spreads in the Kenya.

CHAPTER THREE

METHODOLOGY

This chapter will outline the conceptual framework and empirical model which the study willemploy

3.1 Theoretical framework

The term structure of interest rates as discussed in the theoretical literature is the starting point in building the link between economic growth and the yield spread. From the liquidity premium theory (a combination of the expectation hypothesis and the segmented market theory), we can get the linkage between the long term and short term interest rates;

$$ = \frac{(\qquad \cdots\ldots\ldots \qquad)}{} + \qquad \ldots\ldots\ldots\ldots\ldots\text{ (1)} $$

Where   is the interest rate on a bond of maturity n at time t, is the expected interest rate on a one period bond for period t+j , based on information available at time t , and   is the Liquidity (or term) premium for the n-period bond at time t. This specification nests the Expectations hypothesis of the term structure (EHTS) (corresponding to the first term on theright hand side of equation 1), and the liquidity premium theory (corresponding to the secondterm).

From the expectation hypothesis, if an investor expects a recession in the future, s/he will invest in long term securities. That is from the preferred habitat theory, the investorøs preferred investment horizon will be long term. In this regard, the investor will demand for a premium to forgo the preferred maturity term which in this case is long term in order to buy a short term security.

In other word, consumers who rationally forecast economic slowdown (following credible tightening of liquidity) in the future will increase their current savings in order to boost future income. This will push up the short term rates which will deprive the economy of sufficient spending levels thereby causing a slow down

From simple National income identity;

GDP = C+I+G;

Interest rate impact on GDP through consumption and investment

From Figure 2, it can be explained that people form expectations about future interest rates which forms the basis of bond prices.These expectations affectpeopleøsinvestment and consumption/saving decisions, which in turn have direct impact on gross domestic product as shown in the national income identity

Figure 2: Co-movement between Economic activity and yields on bonds
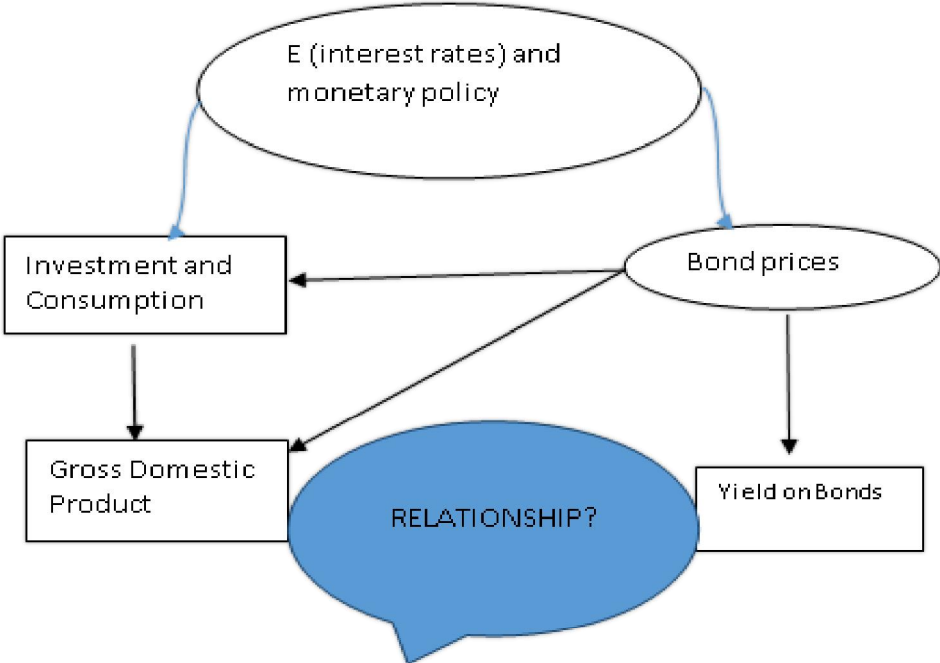
Source: Authors own conceptual framework formulation

3.3 Data

The paper is focused on testing the casual relationship between the yield spread and the economic growth as well as predicts growth using the yield spread. The data necessary to curry out the study are the quarterly GDP growth rate and the yield spread. The definition yield spread in this paper is the difference between the three-month Treasury bill and the ten-year Treasury bond. The paper will use the CBK rate as indicator of monetary policy. This spread was found to have the best forecasting capability in predicting economic growth as compared to other spreads (Estrella A. , 2005). These Data is available at the Kenya National Bureau of statistics, Central Bank of Kenya, Nairobi Securities Exchange and the National Treasury.

3.2 Econometric Model

The predictive content of the yield spread is found to improve upon inclusion of other explanatory variables (Estrella A. , 2005). However, there is no consensus on the fact that including of other explanatory variables may improve the yield spreads ability to forecast economic activity (Stock & Wartson, 2003).

Owing to the explanations on the linkage between yields spread and economic growth given in the theoretical literature, this paper will test the significance of the yield spread in explaining economic activity considering the impact of monetary policy. There has been wide use of OLS and VAR models (in the cited literature) owing to their simplicity. The paper will in this regard adopt a VAR model (Giuseppe & Domenico , 2010),while considering the argument of the suitability of using additional variable that is, monetary policy(Estrella A. , 2005).

In this regard, the model this paper will employ is;

$$= \quad + \quad + \quad + \quad + \quad .... \textbf{(ii)}$$

$$= \quad + \quad + \quad + \quad + \quad .... \textbf{(iii)}$$

$$= \quad + \quad + \quad + \quad + \quad ……………… \textbf{(iv)}$$

Where;

is GDP growth rate (quarterly) at period t and   is GDP growth rate lagged K periods

is the spread at period t (10yr ó 3month) and   is spread lagged K periods

is a measure of monetary policy (CBK rates, M3 growth)   is CBR/M3 growth lagged K periods

And   are the error term

By taking the current growth, Spread and the Central bank rate on one side of the equations, we will have a reduced VAR model in matrix form of;

$$AY_t = B_0 + B_1 Y_{t-1} + U_t \quad …………………… \textbf{(v)}$$

Before estimation, the paper will test for the paper will begin with determining the optimal lag length by employing the information criteria and thereafter proceed with testing for stationarity using Kwiatkowski-Phillips-Schmidt-Shintest (KPSS) as well as modified Dickey fuller test for comparison. If there will be diverging results between the two tests, the study will conduct structural break test to establish whether the revelation of non-stationarity by modified Dickey Fuller test is as a result of structural breaks. After stationary test, Johansen Cointegrationtest will be conducted.

After estimation, the paper will undertake innovation accounting to evaluate the influence of exogenous shocks on the variables of the VAR model. This will be achieved by use of Impulse response function and Variance Decomposition. IRF is used to determine the reaction of the variables in the system to unit change in the innovations (shocks). In other words, it measures the instantaneous impact of a temporary shock on the other variables. Variance Decomposition is used to tell the proportion of the movement in sequence due to its own shocks versus shocks due to other variables.

3.3 Expectation of the study

Flowing from the theoretical framework is the thought that market participantsø expectations about the future macroeconomic environment affect GDP consumption and investment and through the bond market. In this regard, the paper expects to find out the yield spread being able to forecast economic growth.

CHAPTER FOUR

4.0 EMPIRICAL ESTIMATION

This chapter outlines the results and interpretations from tests conducted before estimation (stationarity test, Johansen Cointegration test, determination of optimal lag and structural break test). Thereafter, the chapter will provide the result and interpretations of the estimation and post estimation test (stability test, robustness of the model, Impulse response function and variance decomposition)

4.1 Descriptive data analysis

From Table 3, we conclude that there are a total of 37 observations for the period covered by the study. Looking at the mean value we find that the mean quarterly growth rate for the period under review is 4.22 percent. The interest rate spread between the long term 10 year bond and the 91 treasury bill rate averages at 3.93 percent for quarter two 2006 and quarter two 2015. In terms of measures of dispersion as indicated by the standard deviation of the variance, interest rate spread has the highest deviation of the mean of 3.91 percent followed by central banking rate at 3.04 percent and quarterly GDP at 1.77 percent. Interest rate spread and central banking rate are both positive skewed meaning that they are skewed to the right with the quarterly GDP being skewed to the left.

In terms of distribution, the quarterly GDP growth and M3 havedistribution which are close to normal distribution as evidenced by the kurtosis of 2.76 and 0.6 which is close to a value of 3.0 for a normally distributed variable. As for the spread and Central Bank Rate, both of them are non ó normally distributed with fat tails since their kurtosis values are greater than 3.0.However having normal distribution in terms of the variables is not mandatory to draw inferences about the data.

Table 3: Descriptive statistics

	GROWTH	**SPREAD**	**CBR**	**M3**
Mean	4.2162	3.9730	8.8108	4.097
Variance	3.1186	15.3048	9.2132	2.363
Std. Dev	1.7660	3.9121	3.0353	1.537
Minimum	0.0000	-7.0000	5.0000	0.223
Maximum	8.0000	16.0000	18.0000	7.078
Skewness	-0.1800	0.2265	1.8443	-0.6269
Kurtosis	2.7619	5.4746	5.9988	0.69022

Source: Authors computation

4.2 Graphical analysis

A trend analysis of the data was conducted to establish the movement of the various variables over time and to analyse the cause of movement of the variables

From Figure 3, the spread and the CBR move in opposite direction over time. As at the first quarter of 2009, the spread is at its peak while CBR rate is coming down. The same is again replicated at the last quarter of 2010. Another point to note is at the first quarter of 2012 where the spread is at its lowest and the CBR is at its highest.This is consistent with economic theory. Increased CBR means liquidity tightening which drives up the lower end of the yield curve (increased short rates). As explained in the expectation hypothesis, during contractionary monetary policy, the short rates rise faster than the long rates hence decline in the spread. The reverse (quantitative easing) is also true.

Growth rate moves in the same direction as the spread however, the direction of movement between growth and CBR is seemingly opposite especially at the two ends of the graph. From the second quarter of 2012, as CBR reduces GDP moves upward.

Figure 3: Trend movement of quarterly rate s of GDP growth, CBR and the spread
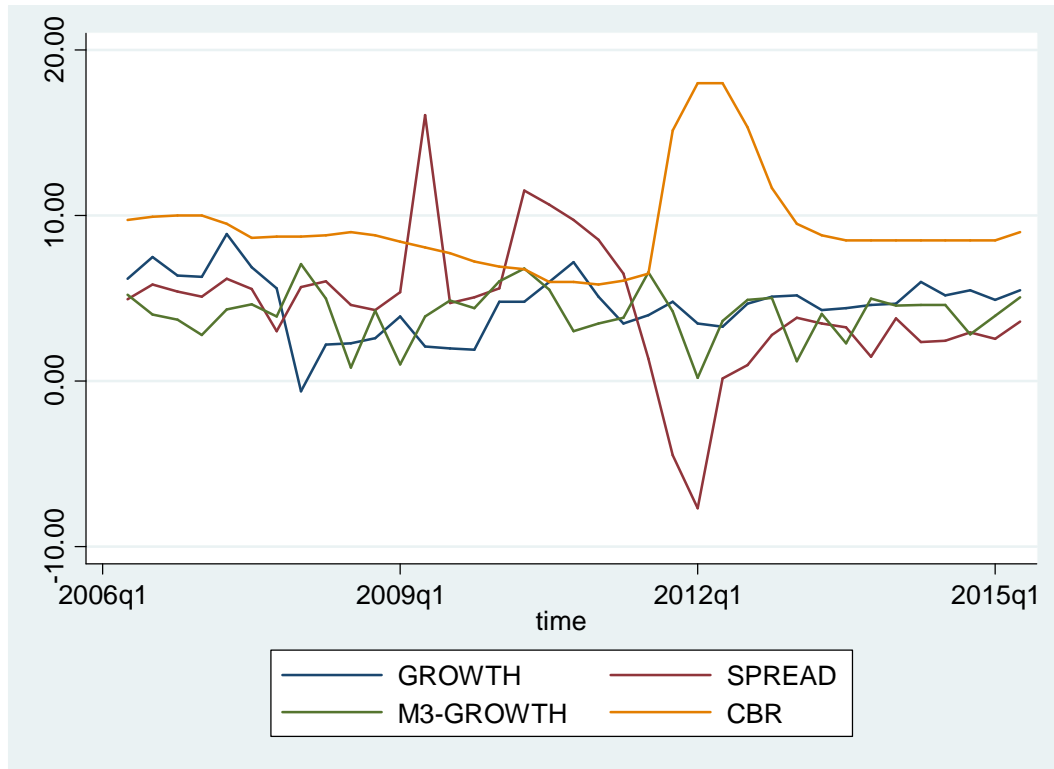
Source: Authors own computation (stata13)

4.3 Optimal lag

Before estimation the study undertook the determination of the optimal lag with the aim of avoiding heteroscedasticity and autocorrelation problems manifesting in the model. Having many lags will consume the degree of freedom as well as lead the problem of multicollinearity. Putting few lags will also lead to specification errors. The study run optimal lag test to get a lag that does not sacrifices the precision of the model in terms of accuracy.

Table 4: Selection-order criteria

	selection-order criteria			Number of obs	=	33				

Sample: 2007q2 - 2015q2

	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-292.612				753.748	17.9765	18.0375	18.1579
1	-257.845	69.534	16	0	243.956*	16.8391*	17.1443*	17.7461*
2	-247.894	19.902	16	0.225	369.013	17.2057	17.755	18.8382
3	-239.421	16.946	16	0.389	658.84	17.6619	18.4553	20.02
4	-224.374	30.093*	16	0.018	902.06	17.7197	18.7572	20.8034

Source: Authors own computation (stata13)

Form the results in table 1, all the optimal lag selection criteria FPE, AIC, HQIC and SBIC all select lag of one as the optimal lag.

4.4 Unit root test

The study conducted unit root test to establish the status of the underlying time series. This was necessary to avoid generation of spurious results and inferences from the estimation. The study started with the modified Dickey fuller test with null hypothesis of non-stationarity. The results of this test; as tabulated in table 5, indicated presence of unit root.

Thereafter, the study used Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Use of KPSS was motivated by the fact that classical statistics is biased towards accepting the null hypothesis of unit root (Kwartkwoski, Schmidt, & Shin, 1992).KPSS tests for a null hypothesis of trend stationary. Results of the KPSStest (as shown in table 5) revealed that the all the model variables were stationary.

At this point it was necessary to test for structural breaks. This necessity stems from the fact that the Dickey fuller test tends to reveal non-stationarity due to presence of structural break. If structural breaks are found to be present the next thing will be to generate dummy variables to enhance the accuracy of estimation. On conducting the structural break test, it was found out that the variables all had structural breaks during periods indicated in table 4.

Table 5: KPSS, Modified Dickey Fuller test and structural breaks result

VARIABLES	DFGLS (Lags1)	KPSS (lag order 1)	STRUCTURAL BREAK
Growth	-2.513	.166***	2007q3, 2009q3
Spread	-2.463	.111***	2011q2, 2012q3
CBR	-2.942	.113***	2011q3
M3 Growth	-3.844***	.0404***	-

Source: Author¢s own computation (stata13)

Note *** means 1% significance level

At level, we fail to reject the null hypothesis for the modified Dickey fuller test (dfgls) hence, presence of unit root. However on conducting Kwiatkowski-Phillips-Schmidt-Shin test, we again fail to reject the null hypothesis of hence the variables are stationary. At this juncture, the structural break test affirmed presence of structural break which then concludes our test for unit root by corroborating the findings of KPSS test. Dummy variables were also generated to enhance validity of statistical inferences.

4.5 OLS estimation

The study conducted OLS regression for all the three equations to establish whether it can offer relationships between the variables in model. The results tabulated are as shown in table 8 (Complete estimation results are shown in the annexes). According to the OLS regression, only the one period lag of growth is statistically significant in explain economic growth. The spread and the monetary policy (central bank rate) are not statistically significant in explaining the current rate of economic growth.

The spread was regressed on the one period lags of economic growth, central bank rate and the spread. From the results in table, the one period lag of the central bank rate as well as that of economic growth do not significantly explain the yield spread. However, the one period lag of the spread was is significant in explaining the current spread.

Monetary policy was regressed on its own one period lag and those of economic growth and the spread. The resultsare as shown in Table 8 and as is observable, the central bank rate is explained by its own one period lag as well as the one period lag of the spread

Table 8: OLS estimation results

	OLS Equations p>|t|				
VARIABLES	**Growth**	**Spread**	**CBR**	**[95%**	**Conf. Interval]**
Growth$_{t-1}$	0	0.721	0	0.2878375	0.7845888
Spread$_{t-1}$	0.554	0.005	0.002	-0.473913	-0.1129915
CBR$_{t-1}$	0.644	0.874	0.781	-0.322342	0.2441968

Source: Author¢s computation

4.6 Johansen Cointegration test

Having affirmed that the variables in the model were all stationary, the next step is to ascertain whether there existsa long run relationship. If the residuals of the estimated long run relationship are stationary, then the dependent and independent variables are said to be cointegrating. If then Cointegration is established (existence of long run equilibrium relationship), the Ordinary Least Squares estimations are said to be invalid since there will be need to correct the residuals used in the estimation process.

Table 9: Johansen Cointegration result

	Johansen	tests	for cointegration			5%
Trend:	constant	Number	of obs=35			
Sample:	2006q4	-	2015q2	Lags	2	
					Trace	Critica'
maximum						
	rank	parms	LL	eigenvalue	Statistic	value
	0	12	-218.90682	.	34.8154	29.68
	1	17	-210.4663	0.38265	17.9343	15.41
	2	20	-204.51615	0.28824	6.0341	3.76
	3	21	-201.49912	0.15836		
					max	5% Critical
maximum						
	rank	Parms	LL	eigenvalue	statistic	value
	0	12	-218.90682	.	16.8811	20.97
	1	17	-210.4663	0.38265	11.9003	14.07
	2	20	-204.51615	0.28824	6.0341	3.76
	3	21	-201.49912	0.15836		

Source: Authors own computation (stata13).

The trace statistic and the maximum statistic in table 9 show that there is Cointegration between the variables.

4.7 VAR model estimationresults

The results from the VAR estimation; as presented in table 10, indicate that the current GDP growth rate is explained by the one period lag of economic growth and the one lag period of the spread. However, monetary policy (central bank rate) is insignificant in explaining economic growth. The spread on the other hand is explained by the one period lag of economic growth, the one period lag of spread and the one period lag of the central bank rate. Finally the monetary policy (central bank rate) is explained by both its own one period lag as well as the one period lag of the spread. The estimation results, in terms of relationship, vary from those report for Ordinary Least Squares (OLS).According to the results from the VAR estimation, there is cross causality between economic growth and the yield spread. There is also cross causality between the yield spread and the central bank rates. However, the spread causes the central bank whereas the central bank rates do not explain the variations in the spread and economic growth. In this

regard, the spread does cause economic growth it significantly explains the changes in central bank rates too. At this juncture, we can affirm that the yield spread does offer foresight with respect to economic growth and that it bears in-built information that can be utilised to predict the direction of the economy.

Table 10: VAR estimation results

Vector autoregression

Sample: 2006q3 - 2015q2				No. of obs	36	
Log likelihood = -194.723				AIC	11.98461	
FPE = 32.65586				HQIC	1230701	
Det(Sigma_ml) = 10.01728				SBIC	1290833	

Equation	Parms	RMSE	R-sq	chi2	P>chi2
GROWTH	7	1.36351	0.5527	44.48725	0
SPREAD	7	2.82502	0.6042	54.96436	0
CBR	7	1.46205	0.7991	143.1501	0

		Coef.	Std. Err.	Z	P>|z|	[95%	Conf. Interval]
GROWTH							
	GROWTH						
	L1.	0.30158	0.1533278	1.97	0.049	0.001063	0.602097
	SPREAD L1.	0.16082	0.077962	2.06	0.039	0.008017	0.313622
	CBR L1.	-0.02707	0.1274179	-0.21	0.832	-0.2768	0.222665
	DUgrowth	-0.92048	0.5552414	-1.66	0.097	-2.00873	0.167778
	DUspread	-0.06049	0.7195261	-0.08	0.933	-1.47074	1.349751
	DUcbr	-1.82592	0.8291357	-2.2	0.028	-3.45099	-0.20084
	_cons	3.865157	1.792438	2.16	0.031	0.352044	7.378271
SPREAD							
	GROWTH						
	L1.	0.936252	0.3176749	2.95	0.003	0.31362	1.558883
	SPREAD L1.	0.338477	0.1615269	2.1	0.036	0.02189	0.655064
	CBR L1.	0.650815	0.263993	2.47	0.014	0.133398	1.168232
	DUgrowth	-1.45528	1.150386	-1.27	0.206	-3.71	0.799436
	DUspread	-5.96732	1.490763	-4	0	-8.88916	-3.04548
	DUcbr	6.574263	1.717859	3.83	0	3.207321	9.941205
	_cons	-8.55108	3.713693	-2.3	0.021	-15.8298	-1.27238
CBR							
	GROWTH						
	L1.	-0.00789	0.1644077	-0.05	0.962	-0.33012	0.314344
	SPREAD L1.	-0.298	0.0835958	-3.56	0	-0.46185	-0.13416
	CBR L1.	0.439665	0.1366255	3.22	0.001	0.171884	0.707446
	DUgrowth	0.672377	0.5953647	1.13	0.259	-0.49452	1.83927
	DUspread	1.766071	0.7715211	2.29	0.022	0.253917	3.278224
	DUcbr	-0.07588	0.8890514	-0.09	0.932	-1.81839	1.666624
	_cons	5.949052	1.921965	3.1	0.002	2.182071	9.716033

í .

Itøs also worth noting that the structural break in the central bank rate had statistically significant impact on economic growth. The structural breaks occur in the central bank rates on the third quarter of 2011. This coincides with the exchange rate crisis that occurred in 2011. During this time, the central bank monetary policy committee increased rapidly the central bank rate to stability the then nose diving shilling that went to its all-time low in a decade.

The study also tested for the stability of the VAR model and autocorrelation of the residuals. On stability the study found out that all the eigenvalues lie inside the unit circle hence the model satisfices stability condition. To test for autocorrelation in the residuals of VAR models Lagrange multiplier (LM) test was run and the results as shown demonstrated that there is no autocorrelation of the residuals.

Table 11: Stability condition and Lagrange multiplier test

Eigenvalue stability condition			
Eigenvalue			Modulus
0.462633	+	.264026i	0.532671
0.462633	-	.264026i	0.532671
0.154456			0.154456
All the eigenvalue lie inside the unit circle			
VAR satisfies stability condition			
Lagrange Multiplier test			
lag	chi2	df	Prob>chi2
1	15.1375	9	0.08723
H0: no autocorrelation at lag order			

Having established that the VAR model satisfices the stability condition and having found that there is no autocorrelation in the residuals, the study has no evidence to contradict the validity of the VAR model.

4.8Robustness test

To test on the robustness of the model, the study employed an alternative proxy for monetary policy which is the growth of money supply. The findings were that unlike the central bank rate, the growth in money supply is statistically significant in explaining economic growth. However, with use of money supply as proxy of monetary policy, the significance of the spread in predicting economic growth is eroded. In addition, the spread predictability by economic growth and monetary policy is also lost. Finally the R^2 for all the VAR equations is significantly reduced upon using the money supply growth rate as proxy of monetary policy. The result for the alternative model is as table12. In this regard, use of the central bank rate is much superior compared to use of the money supply growth.

Table 12: VAR result (Money supply growth as proxy for Monetary Policy)

Vector autoregression								
Sample: 2006q3 - 2015q2				No. of obs = 36				
Log likelihood = -211.6951				AIC	12.92751			
FPE = 83.84096				HQIC	13.24991			
Det(Sigma_ml) = 25.71845				SBIC	13.85123			
Equation	Parms	RMSE	R-sq	chi2	P>chi2			
GROWTH	7	1.32872	0.5753	48.75815	0			
SPREAD	7	3.27841	0.467	31.54413	0			
M3GROWTH	7	1.65745	0.075	2.918131	0.819			
_____								
		Coef.	Std.Err.	z	P>|z|	[95%	Conf.Interval]	
_____								
GROWTH	|							
	GROWTH L1	0.4393061	0.1209434	3.63	0	0.2022614	0.6763509	
	SPREAD L1	-0.0027385	0.0560328	-0.05	0.961	-0.1125608	0.1070837	
	M3GROWTH L1	0.2299786	0.1374511	1.67	0.094	-0.0394205	0.4993778	
	DUspread	-0.8013469	0.5418124	-1.48	0.139	-1.86328	0.2605859	
	DUgrowth	-0.4928217	0.5444684	-0.91	0.365	-1.55996	0.5743168	
	DUm3growth	-2.093603	0.7979503	-2.62	0.009	-3.657556	-0.5296488	
	_cons	2.213858	0.927914	2.39	0.017	0.3951795	4.032536	
_____								
SPREAD	|							
	GROWTH L1	0.0901327	0.2984098	0.3	0.763	-0.4947398	0.6750052	

SPREAD L1	0.5589184	0.1382526	4.04	0	0.2879484	0.8298885
M3GROWTH L1	-0.4349785	0.33914	-1.28	0.2	-1.099681	0.2297237
DUspread	-2.632289	1.336841	-1.97	0.049	-5.25245	-0.0121282
DUgrowth	0.0515451	1.343395	0.04	0.969	-2.58146	2.68455
DUm3growth	0.1933345	1.968823	0.1	0.922	-3.665488	4.052157
_cons	3.824416	2.289489	1.67	0.095	-0.6629011	8.311732

M3GROWTH						
GROWTH L1	-0.0386655	0.1508653	-0.26	0.798	-0.334356	0.257025
SPREAD L1	0.1029966	0.0698955	1.47	0.141	-0.0339961	0.2399893
M3GROWTH L1	-0.0371681	0.171457	-0.22	0.828	-0.3732176	0.2988814
DUspread	0.0097005	0.6758588	0.01	0.989	-1.314958	1.334359
DUgrowth	-0.7177712	0.6791719	-1.06	0.291	-2.048924	0.6133813
DUm3growth	0.6628954	0.9953661	0.67	0.505	-1.287986	2.613777
_cons	4.100915	1.157483	3.54	0	1.832289	6.369541

Source: Author's own computation (stata13)

What does the model forecast?
Having established the relationship between the variables, stability of the model and having found that the residuals of the model are not autocorrelated, which validate the model, the question is what does the model forecast.

On economic growth, as shown in figure 5, the model predicts a growth rate of 5.8 in the third quarter of 2015 and 5.9 in the fourth quarter. The growth rate is forecasted to be 6.0 in the first quarter of 2016 and 6.1in the second quarter.In this regard, the study projects enhanced levels of economic activity.

With respect to the spread between the three month Treasury bill and the ten year Treasury bond, the forecast are 3.677 and 3.899 for the third and fourth quarter of 2015. The first and second quarters of 2016 are predicted to have spread of 4.01 and 4.05 respectively.In other words we expect to have long rates being higher than the short rates (an upward sloping yield curve) which again is consistent with the forecast for higher economic growth levels.

The projections for the central bank rate are 8.78 and 8.67 for the third and fourth quarters of 2015. The forecasted central bank rates for the first and second quarters of 2016 are 8.55 and 8.46 respectively. In general terms, the central bank rates are expected to fall. This means that we expect to have a more liquid economy. The forecast for all the three variables in the model are shown in figure5.

Figure 4: Forecast graph for economic growth, the yield spread and central bank rate in Kenya
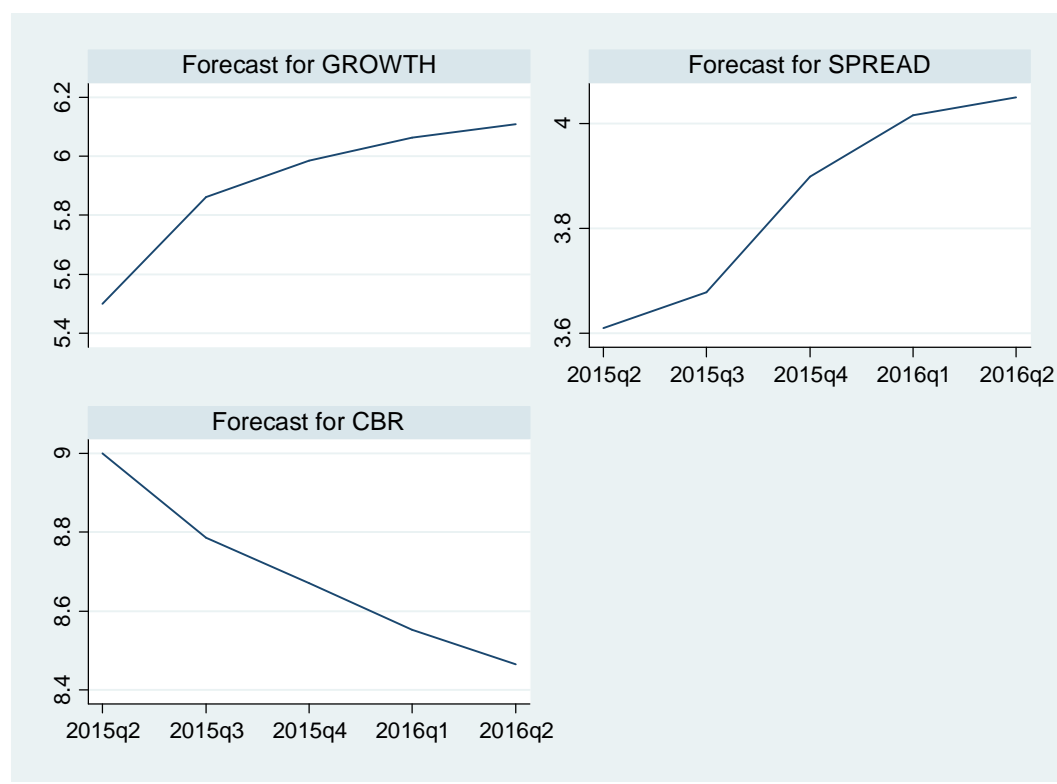
Source: Authors computation (stata13)

4.9 Impulse Response Function

The study has established that the residuals in the model are uncorrelated. This is important because itøs only when the residuals are contemporaneously uncorrelated that they can be interpreted as shocks. In figure 4, the diagonal panels show the effect of shock from each variable on their future values. In all cases, the shock decays out quickly.

A one standard deviation shock to central bank rate is just 1%, a corresponding shock to growth is just over 1% whereas a corresponding shock to spread is slightly over 2%.

The of-diagonal panels show the effect of one variable on the other. We can see that a one standard deviation (about 1%) on growth reduces the central bank rate by slightly over the 0%

and the effect decays dies out by the fourth quarter. Similarly a one standard deviation shock on growth (around 1%) increases the spread by over 1% before the effect dies out by around the fifth quarter. A one standard deviation (about 2%) shock on the spread has the effect of raising the central bank rate by over 1% and the impact persist up to nearly the eighth quarter, it also has the impact of marginally increasing growth by 0.5%. A one standard deviation shock on the central bank rate has no observable impact on economic growth rate. However, it has the impact of increasing the spread marginally by 0.5%.

Figure 5: Impulse response function
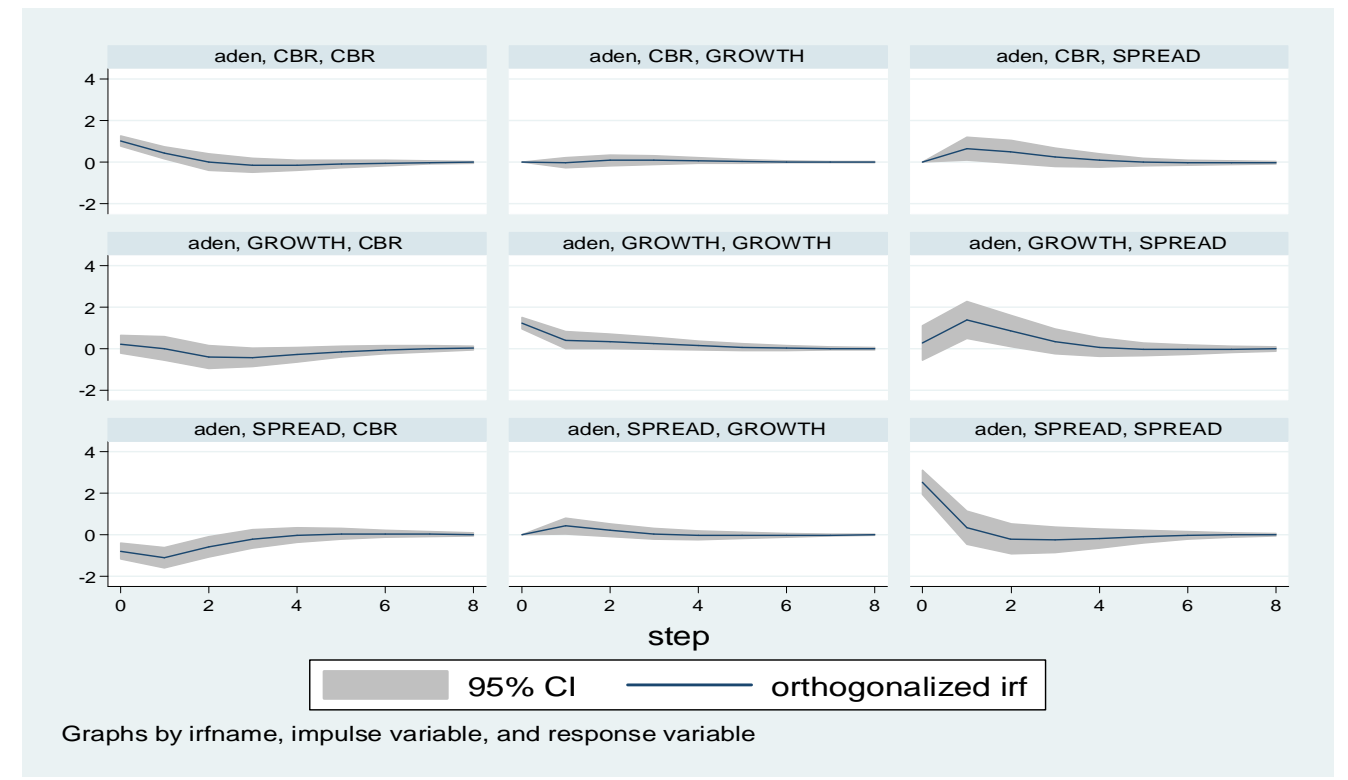
Source: Authors computation (stata13)

4.10 Variance decomposition
The output of the forecasting error decomposition is shown in table 13. According to the results, a shock in the first quarter to growth has more impact than the second. The impact of the shock decreases with time. The impact of shock on growth to spread is intermittent gradually decreasing over time. Conversely shock on growth in the first period has lesser impact than the successive quarters. In other words the shock on growth has increasing impact on the central bank rate over time.

On the other hand the impact of shock on the spread on growth in the first quarter has a lesser impact than those in the subsequent periods like second, third et cetera. In other word, the impact

32

is increasing over time. The impact of shock on Spread to itself is a decreasing one over time while the impact on central bank rate is increasing then decreasing over time.

Finally, shock on the central bank rate has the effect of marginally increasing economic growth over time whereas the effect on the spread is increasing impact over time. The effect of the shock on the central bank rate (itself) is intermittent but generally decreasing impact.

Table 13: Forecast error Variance Decomposition

	(1)	(1)	(1)	(2)	(2)	(2)	(3)	(3)	(3)
step	fevd	Lower	Upper	fevd	Lower	Upper	fevd	Lower	Upper
	0	0	0	0	0	0	0	0	0	0
|1	1	1	1	0.011265	-0.0573	0.079825	0.026913	-0.07738	0.131206
|2	0.900884	0.727192	1.07458	0.221525	-0.01241	0.455459	0.014804	-0.04434	0.07395
|3	0.883057	0.686701	1.07941	0.272006	0.018856	0.525156	0.059139	-0.06556	0.18384
|4	0.880923	0.685233	1.07661	0.277064	0.020238	0.53389	0.104247	-0.08738	0.295873
|5	0.87951	0.685887	1.07313	0.276388	0.019561	0.533216	0.123313	-0.08758	0.334204
|6	0.878592	0.685299	1.07189	0.276281	0.019714	0.532847	0.127976	-0.0858	0.341748
|7	0.878243	0.684736	1.07175	0.276446	0.019877	0.533015	0.128533	-0.08499	0.342056
|8	0.878161	0.68451	1.07181	0.276543	0.01991	0.533177	0.128518	-0.08485	0.341887

	(4)	(4)	(4)	(5)	(5)	(5)	(6)	(6)	(6)
step	fevd	Lower	Upper	fevd	Lower	Upper	fevd	Lower	Upper
	0	0	0	0	0	0	0	0	0	0
|1	0	0	0	0.988735	0.920175	1.0573	0.362007	0.113521	0.610493
|2	0.098699	-0.073139	0.270537	0.728318	0.463533	0.993104	0.584284	0.356635	0.811932
|3	0.112827	-0.081931	0.307585	0.658318	0.365207	0.951429	0.596509	0.367549	0.825469
|4	0.109792	-0.083655	0.303239	0.648849	0.352511	0.945187	0.568117	0.329015	0.807219
|5	0.108616	-0.080063	0.297296	0.649088	0.353906	0.94427	0.55295	0.311707	0.794193
|6	0.108799	-0.077635	0.295233	0.649251	0.354296	0.944206	0.548988	0.308034	0.789942
|7	0.109033	-0.076925	0.294991	0.649089	0.353781	0.944398	0.548557	0.307817	0.789297
|8	0.109111	-0.076862	0.295085	0.648976	0.353426	0.944525	0.548617	0.307921	0.789313

	(7)	(7)	(7)	(8)	(8)	(8)	(9)	(9)	(9)
step	fevd	Lower	Upper	fevd	Lower	Upper	fevd	Lower	Upper
	0	0	0	0	0	0	0	0	0	0
|1	0	0	0	0	0	0	0.61108	0.362106	0.860055
|2	0.000418	-0.007315	0.008151	0.050157	-0.0259	0.126212	0.400913	0.178995	0.62283
|3	0.004116	-0.012556	0.020788	0.069676	-0.03529	0.174643	0.344351	0.136122	0.552581
|4	0.009285	-0.026488	0.045059	0.074087	-0.03715	0.185326	0.327635	0.126275	0.528996
|5	0.011873	-0.032065	0.055812	0.074524	-0.03649	0.185534	0.323738	0.12445	0.523025
|6	0.012609	-0.033377	0.058595	0.074468	-0.03613	0.185064	0.323036	0.124148	0.521924

| |7 | 0.012724 | -0.033447 | 0.058894 | 0.074464 | -0.03622 | 0.185146 | 0.32291 | 0.124007 | 0.521813 |
| |8 | 0.012728 | -0.033405 | 0.058861 | 0.074481 | -0.03634 | 0.185299 | 0.322865 | 0.12391 | 0.521821 |

Source: Author's computation (stata13)

95% lower and upper bounds reported

(1) irfname = mohaa, impulse = GROWTH, and response =GROWTH

(2) irfname = mohaa, impulse = GROWTH, and response = SPREAD

(3) irfname = mohaa, impulse = GROWTH, and response = CBR

(4) irfname = mohaa, impulse = SPREAD, and response = GROWTH

(5) irfname = mohaa, impulse = SPREAD, and response = SPREAD

(6) irfname = mohaa, impulse = SPREAD, and response = CBR

(7) irfname = mohaa, impulse = CBR, and response = GROWTH

(8) irfname = mohaa, impulse = CBR, and response = SPREAD

(9) irfname = mohaa, impulse = CBR, and response = CBR

4.11 Discussion of results

The study established the relationships between the yield spread, economic growth and monetary policy. There after it forecasted both economic growth, the spread and offered projection of the monetary policy stance. These findings are consistent with those of other studies cited in the literature review.

The question then is could we have expected a different result and why? Actually there can be chances of getting different results than those of the study. The variation of the yield spread in its predictive power across time and countries is a fact. And the reasons are first, the regulation of financial markets is different across time and nations. This difference generates distortions which cause interest rates not to reflect financial market participantsøexpectations about the future economic growth path. (Stock & Wartson, 2003). In Kenya, since the liberalization policy by the government, there has been less interference in the financial markets by the government and by extension.

Secondly, unlike developed nations (where most studies confirmed the ability of the spread to predict growth) the spread is usually distorted by the monetary authoritiesøpursuit to fix exchange rate turbulence. The exchange rate instability are in most cases than not the result of foreign market dynamics. This makes the spread not to have any relation with the domestic economy but rather the bear semblance with the movement of foreign economies (Bernard & Gerlach, 1998). Following the 1971/72 balance of payment crisis, Kenya pursued fixed exchange rate regime up until 1990s when the country adopted floating exchange rate regime. This has

stopped the distortions on the spreadøs ability to offer foresight in to the direction of the economy.Thirdly, there is the view that, vibrant and unstable inflation rates erode the predictive power of the spread. In this regard, stability of inflation is a necessary condition for the spread to offer insight into future economic direction. In developing countries, inflation has remained a challenge. Kenya has relatively stable inflation as compared to most of the sub-Saharan economies.

The outcome of the study corroborates the findings of past studies and especially the consistency of the yield spread to predict economic growth across countries. The universality of the yield spread role in predicting economic growth; though not conclusively established owing to the limited scope of the study in terms of number of developing economies that have been tested, has been established.

CHAPTER FIVE

SUMMARY CONCLUSION AND POLICY RECOMMENDATION

This chapter will provide the summary, conclusion and policy recommendation of the study as well as the limitation and proposed areas of further research.

5.1 Summary of the study

The study objective was to examine whether there is relationship between the spread and economic growth. The study used a system of equations to establish the relationship between the two. The motivation was to see whether the spread can offer insight into the direction the economy would take in the future. The study employed quarterly data on GDP from the KNBS whereas data on the ten-year bond and the three month Treasury bill as well as the Central bank rate (proxy for monetary policy) were obtained from the central bank of Kenya.

Diagnostic tests were conducted by first of all determining the optimal lag which was found out to be one by use of information criterion technique. There after the study set to find out the status of data with respective to Thereafter stationarity (data found to be stationary) and Cointegration (variables found out to bear long term relationship)

Estimation was done and results revealed an output that is in consensus with the expectation of the study that, the spread contained information about economic growth. The stability of the model was tested using the Eigenvalue stability condition in addition to conducting Lagrange-multiplier to test for autocorrelation of the residuals. The study undertook robustness tests by trying to use an alternative for the monetary policy proxy (replacing the central bank rate with the growth in money supply). The findings under this were the growth in money supply did not enhance the correlation coefficient (R^2)in addition to it not being explained by economic growth and the spread.

5.2 conclusion

The study confirmed that the yield spread was statistically significant in explaining economic growth. In addition the study found out the economic growth was statistically significant in

explaining the changes in spread. This is consistent with the expectation of the study that the yield spread contains information that can be harnessed to predict economic growth rate.

While there are several reason to expect a different result owing to the peculiar nature of developing countries with respect to financial regulation regime, fixed exchange rates as well as skyrocketing inflation (Kenya shares with the rest of sub-Saharan economies), the study indirectly attests to Kenya's success story in as far as the financial regulation, inflation, exchange rate stabilization as well as sovereign monetary policy are concerned.

5.3 Policy Recommendation and academic debate

Predictability of the economy on the basis of parameters that can offer accurate foresight is very crucial. This necessity was part of the motivation to undertake this study however, upon analysis of the available data, the spread was found to bear information capable of explaining variation in GDP growth levels. In this regard, the study recommends the monitoring of the yield curve and it inclusion in the leading list of indicators of economic growth. An upward sloping yield curve (large spread) is associated with economic growth whereas a flat or inverted yield curve (negative or decreasing spread) is associated with slowdown in economic growth.

The recent increase of treasury bills rate following the floating of several treasury bills by the government in its pursuit to mob out liquidity from the market so as to stabilize the shilling as well as tackle inflation, the short end of the yield curve drove upwards thereby leading to an inverted yield curve[12]. This alarming shape comes at a time when there is big public debate on the performance of the economy. On the basis of the analysed data, the shape of the current yield curve can be construed as an indication that there will be slow down in the level of economic activity.

In this regard, the extent that the shape of the yield spread is found to be indicative of future economic conditions, it's fundamental to be sensitive to the shape of the yield curve. This is owing to the fact that an inverted yield curve can cause panic in the economy and therefore cause irreparable damage to the economy.

---

[12]https://www.standardmedia.co.ke/mobile/?articleID=2000180716&story_title=jubilee-blunders-that-sent-interest-rates-into-the-sky (20.10.2015)

The line of academic debate this study wish to bring forth is why the spread cannot predict growth in Kenya and whether addressing the underlying reasons for variation of the yield spreads ability to predict economic growth has can be of public good.

Vibrant and unstable inflation rate is one of the reasons why the spread is found not to offer foresight as to the direction the economy will take. According to May 2015 KNBS report, Kenya had the highest inflation rates in the country of 7.03%. The associated consequences of inflation such as increased cost of borrowing, uncompetitive export prices as well as business uncertainty have been a set back to the realization of economic growth. In view of this, the study recommends the undertaking of policies geared towards combating inflation.

In addition, there are numerous financial regulatory authorities in the country which make the environment to have overlaps. These authorities include the central bank of Kenya, Capital markets authority, Insurance regulatory authority, Retirement benefit authority, Saccos and cooperative societiesøregulatory board among others. This in turn causes weak supervisory and enforcement of regulations which causes uncertainty in investors. This study recommends policy to consolidate the various authorities.

5.4 Limitations of the study

The study was constrained by unavailability of data. During the research process, the study could only obtain data on Central bank rate for only 37 quarters which slightly above the sample size recommended for time series.

5.5 Proposed areas for further research

To assess the predictive ability of the spread, the study proposes first the decomposition of the yield spread components into expectation and term premium effect and investigate whether either of the two have any foresight capability. Secondly, industrial production moves in the same direction as GDP growth hence, if data on monthly industrial production can be obtained, the limitation of the study can be resolved since the central bank rate and the spread are all in monthly data. A study on this then can be undertaken to ascertain the finding of this study. The study also propose a comprehensive study for EAC member states to provide regional comparative evidence on the role of the yield spread in predicting economic growth.

REFERENCES

Arif, B., & Firdous, A. S. (2014, December 10). *In Search of Leading Indicator Property of Yield Spread forIndia: An Approach Based on Quantile and Wavelet Regression.* (R. Boucekkine, Ed.) Retrieved 10 3, 2015, from Hindawi Publishing Corporation: http://dx.doi.org/10.1155/2015/308567

Bernard, H., & Gerlach, S. (1998). Does the term structure predict recession? The international evidence. (pp. 188-92). London: Centre for Economic Policy Research.

Chauvet, M., & Potter, S. (2002). Predicting Recession: evidence from the yield curve in the presence of Structural breaks. *Economic Letters, 77*, 245-253.

Chen, N. F. (1991). Financial investment and the macroeconomy. *Journal of Finance, 46*, 529-554.

Chinn, M. D., & Kucko, K. J. (2010). The predictive power of yield curve across countries and time. *NBR working paper*, No. 16398.

Christensen, J. H., Jose, A. L., & Rudebusch, G. D. (2012). Extracting Deflation Probability Forecasts from Treasury Yields. *International Journal of Central Banking*, 21-60.

D'Agostino, A., Domenico, G., & Surico, P. (2006, April 1). *"(Un)predictability and Macroeconomic Stability.* Retrieved September 17.09.2015, 2015, from European Central Bank: www.ecb.int/pub/pdf/scpwps/ecbwp605.pdf

Davis, E. P., & Fagan, G. (1997). Are Financial spreads useful indicators of future inflation and output growth. *Journal of Applied Econometrics, 12*, 701-714.

Dotsey, M. (1998). The predictive content of the interest rate term spread for future economic growth. *Economic review, 3rd Quarter*, 31-51.

Dueker, J. (1997). Strengthening the case for the yield spread as a predictor of US recession. *Economic Review*, 41-55.

Estrella, A. (2005, 10 1). *The yield curve as a leading indicator property.* Retrieved 10 3, 2015, from Federal Reserve bank of New york: www.ny.frb.org/research/capital_markets/ycfaq.pd

Estrella, A., & Hardouvelis, G. A. (1991). The term Structure as a predictor of economic activity. *Journal of Fianance, 46*, 555-576.

Estrella, A., & Mishkin, F. (1998, February). Predicting U.S. Recessions: Financial variables as leading indicators. *Review of Economics and Statistics, 80*, 45-61.

Estrella, A., & Miskin, F. S. (1998). Predicting US Recessions: Financial Variables as leading indicators. *Review of Economics and Statistics, 80(1)*, 45-61.

Gilchrist, S., & Zakrajsek, E. (2012). Credit spread and Business cycle fluctuations. *AM Econ Rev*, 1692-1720. Retrieved from https://dx.doi.org/10.1257/aer.102.4.1692

Giuseppe , C., & Domenico , S. (2010, June 28). *The yield curve and the prediction on the business cycle: a VAR analysis for the European Union.* Department of Law and Economics. Munich: Munich Personal RePEc Archive. Retrieved october 3, 2015, from http://mpra.ub.uni-muenchen.de/21795/

Harvey, C. R. (1988). The Real term structure and Consumption growth. *The Journal of Financial Economics, Vol 22*, 305-33.

Harvey, C. R. (1989). Forecasting of Economic growth from the bond and stock market. *Financial Analysts' Journal*, 38-45.

Harvey, C. R. (1991). Interest rate based forecast of Geman economic growth. *WeltwirtschaftlichesArchiv, 127(4)*, 701-18.

Harvey, C. R. (1991(3)). Les tauxd'interetet lacroissance'economique en France. *Analyse financiere*, 32, 97-103.

Haubrich, J. G., & Dombrosky, A. M. (1996). Predicting growth using the yield spread. *Economic Review*, 21, 26-35.

Jardet, C. (2004). Why did the term structure of interest rates lose its predictive power. *Economic modelling*, XI, 509-24.

John, C. C., Jonathan, E. I., & Stephen, A. R. (1985). Theory of the term structure of Interest rates. *Econometrica, 53*, 358-407.

Kessel, R. A. (1965). The cyclical behaviour of the term structure of interest rates. *National Bureau of Economic Research* , Occassional Paper 91.

Khomo, M., & Aziakpono, M. (2007). Forecasting Recession in South Africa: A comparison of the yield spread and other Economic Indicators. *South African Journal of Economics, 75(2)*, 194-212.

Kwartkwoski, P. C., Schmidt, P., & Shin, Y. (1992). Testing the null of stationarity against the alternative of a unit root: How sure are we that the economic time series has a unit root. *Journal of econometrics, 54*, 159-178.

Lorenzo, B., & Eric, H. (2015). The Forecasting Power of the Yield Curve, a Supervised Factor Model Approach. *Centre of Research in Economic Analysis of Time Series*, 31.

Mishkin, S. F. (2007). *The Economics of Money, banking and Financial Markets.* Boston: Pearson Addison Wesley.

Mohapi, T. A., & Botha, I. (2013). The expalanatory power of the yield in predicting recessions in South Africa. *International Business and economics research Journal*, 12-6.

Nyberg, H. (2010). Dynamic probit models and financial variables in recession forecasting. *Journal of Forecasting*, IV, 215-230.

Richard, C., & Keeton, G. (2011). The south African yield curve as a predictor of economic down turns: An update. *African Review of Economics and Finance, Vol 2*, 22-5.

Schock, M. (2015, 01 15). *Predicting Economic activity via Euro-zone yield spread: Impact of credit risk.* (H. E. (HEP), Ed.) Retrieved 10 3, 2015, from EconPapers: http://diskussionspapiere.wiwi.uni-hannover.de/pdf_bib/dp-542.pdf

Stock, J. H., & Wartson, M. W. (2003). Forecasting ooutput and Inflation; the role of Asset prices. *Journal of Economic Literature, Vol. XLI (September 2003)*, 788-829.

Wheelock, D. C., & Whohar, E. M. (2009). Can the Term Spread Predict Output Growth and Recessions? A Survey of the Literature. *Review, 91 (5, part1)*, 419-40.

Wright, J. H. (2006). The yield spread and predicting recession. *Finance and economics discussion series*, *Vol3,* 1-19.

ANNEXES

Annex 1: Data

YEAR	time	QUARTER	GROWTH	SPREAD	CBR	M3-GROWTH
2006	1	30/6/06	6.20	4.96	9.75	5.226123596
2006	2	30/9/06	7.50	5.84	9.92	4.03358204
2006	3	31/12/06	6.40	5.41	10.00	3.716444496
2007	4	30/3/07	6.30	5.11	10.00	2.804263375
2007	5	30/6/07	8.90	6.18	9.50	4.338951949
2007	6	30/9/07	6.90	5.58	8.67	4.629756432
2007	7	31/12/07	5.60	3.04	8.75	3.907041851
2008	8	30/3/08	-0.60	5.68	8.75	7.077926584
2008	9	30/6/08	2.20	6.05	8.83	5.009190285
2008	10	30/9/08	2.30	4.62	9.00	0.833325799
2008	11	31/12/08	2.60	4.30	8.83	4.268166939
2009	12	30/3/09	3.90	5.37	8.42	1.001379214
2009	13	30/6/09	2.10	16.09	8.08	3.930120174
2009	14	30/9/09	2.00	4.71	7.75	4.875685044
2009	15	31/12/09	1.90	5.08	7.25	4.398959437
2010	16	30/3/10	4.80	5.61	6.92	6.031768751
2010	17	30/6/10	4.80	11.50	6.75	6.804791638
2010	18	30/9/10	6.00	10.68	6.00	5.52455035
2010	19	31/12/10	7.20	9.73	6.00	3.029582088
2011	20	30/3/11	5.10	8.54	5.83	3.476780861
2011	21	30/6/11	3.50	6.51	6.08	3.842429987
2011	22	30/9/11	4.00	1.36	6.50	6.558976076
2011	23	31/12/11	4.80	-4.45	15.17	4.240688896
2012	24	30/3/12	3.50	-7.68	18.00	0.223727017
2012	25	30/6/12	3.30	0.18	18.00	3.649849613
2012	26	30/9/12	4.70	0.98	15.33	4.904751179
2012	27	31/12/12	5.10	2.81	11.67	5.042539297
2013	28	30/3/13	5.20	3.83	9.50	1.202492041
2013	29	30/6/13	4.30	3.50	8.83	4.070446538
2013	30	30/9/13	4.40	3.25	8.50	2.29502785
2013	31	31/12/13	4.60	1.48	8.50	4.998584776
2014	32	30/3/14	4.70	3.78	8.50	4.56940925
2014	33	30/6/14	6.00	2.37	8.50	4.623752466
2014	34	30/9/14	5.20	2.46	8.50	4.608168999
2014	35	31/12/14	5.50	2.94	8.50	2.837798802
2015	36	30/3/15	4.90	2.57	8.50	3.954017553
2015	37	30/6/15	5.50	3.61	9.00	5.053197472

Annes 2: OLS estimations

Table 8: OLS estimation of central bank rates

Source	SS	Df	MS	Number of obs	=	36
				F(3, 32)	=	32.89
Model	232.9398	3	77.6465974	Prob> F	=	0
Residual	75.54555	32	2.36079835	R-squared	=	0.7551
				Adj R-squared	=	0.7321
Total	308.4853	35	8.81386684	Root MSE	=	1.5365
CBR	Coef.	Std. Err.	t	P>|t|	[95%	Conf. Interval]
CBRlag1	0.536213	0.121936	4.4	0	0.2878375	0.7845888
SPREADlag1	-0.29345	0.088594	-3.31	0.002	-0.473913	-0.1129915
GROWTHlag1	-0.03907	0.139067	-0.28	0.781	-0.322342	0.2441968
_cons	5.76067	1.599001	3.6	0.001	2.503611	9.017729

Source: Authors own computation (stata13)

Table 7: OLS estimation of the spread

Source	SS	Df	MS	Number of obs =		36
				F(3, 32)	=	6.42
Model	219.6359	3	73.21197	Prob> F	=	0.0016
Residual	365.1678	32	11.41149	R-squared	=	0.3756
				Adj R-squared	=	0.317
Total	584.8037	35	16.70868	Root MSE	=	3.3781
SPREAD	Coef.	Std. Err.	T	P>|t|	[95%	Conf. Interval]
CBRlag1	-0.04296	0.268086	-0.16	0.874	-0.58903	0.5031161
SPREADlag1	0.586948	0.194781	3.01	0.005	0.190191	0.9837042
GROWTHlag1	0.110286	0.305749	0.36	0.721	-0.5125	0.7330758
_cons	1.688189	3.515528	0.48	0.634	-5.47271	8.849086

Source: Authors own computation (stata13)

Table 6: OLS estimation of economic growth rate

Source	SS	Df	MS	Number of obs =	36	
				F(3, 32)	6.65	
Model	46.31093	3	15.4369755	Prob> F	0.0013	
Residual	74.23213	32	2.31975403	R-squared	0.3842	
				Adj R-squared	0.3265	
Total	120.5431	35	3.4440873	Root MSE	1.5231	
GROWTH	Coef.	Std. Err.	T	P>|t|	[95%	Conf. Interval]
GROWTHlag1	0.609414	0.137852	4.42	0	0.328618	0.8902106
SPREADlag1	0.052473	0.087821	0.6	0.554	-0.12641	0.2313582
CBRlag1	0.056354	0.120872	0.47	0.644	-0.18985	0.302561
_cons	1.024058	1.58504	0.65	0.523	-2.20456	4.252679

Source: Authors own computation (stata13)