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**Impact of Quantitative Easing in the US on Kenya's Bond Market
Between 2009 and 2014**

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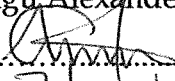
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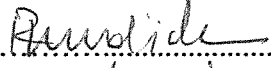
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This Research Project has been submitted for examination with my approval as the Supervisor.

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Abstract

This paper examines the impact of quantitative easing (QE) by the Federal Reserve (Fed) which started in November 2008 on Kenya's bond market. In the wake of the global financial crisis, the Federal Reserve used several rounds of QE to get the economy back on track. In this, the Fed started growing its balance sheet by purchasing government bonds and mortgage-backed securities using central bank money with the aim of injecting money into the economy and boost nominal spending. Over the period from November 2008, the Fed purchased 3.5 trillion dollars of assets, significantly increasing its balance sheet. This paper attempts to assess the impact of these large scale asset purchases (LSAPs) on Kenya's treasury bills yields. This is motivated by empirical evidence indicating that QE purchases reduced long-term US government bond yields. This paper therefore undertakes to find the impact on developing countries' bond markets, specifically Kenya. US money supply and Kenya 182 day treasury bills are the variables of choice for this study. Increase in US money supply is taken to indicate the Fed's LSAPs. Using time series analysis, we conduct vector auto regression and co-integration tests to establish the presence of a relationship and therefore assess the impact. The results indicated the presence of a long term relationship between Federal Reserve's LSAPS and Kenya treasury bills.

Key words: Quantitative easing, Treasury bills rates, Money supply, Time series

Table of Contents

DECLARATION	ii
Abstract.....	iii
1. INTRODUCTION	6
1.1 Background Information	6
1.2 Statement of the Research Problem.....	8
1.3 Overall Research Objective.....	9
1.4 Research Question.....	9
1.5 Scope of the research.....	9
1.6 Justification of the study.....	10
2. LITERATURE REVIEW.....	11
2.1 Introduction	11
2.2 Theoretical Literature	11
2.3 Empirical Literature	15
2.4 Literature Gap.....	18
2.5 Conceptual Framework	19
2.6 Research Hypothesis	20
3. RESEARCH METHODOLOGY	21
3.1 Research design.....	21
3.2 Sources of data	21
3.3 Methodology	21
3.4 Univariate time series analysis	21
3.5 Multivariate time series analysis	23
3.6 Vector Autoregressive Models.....	24
3.7 Granger causality test	24
3.8 Impulse responses and variance decomposition.....	25
4. FINDINGS OF THE STUDY	26
4.1 Section I: Univariate Characteristics.....	26
4.1.1 Unit root test	26
4.2 Section II: Multivariate Characteristics.....	30
4.2.2 VAR analysis.....	32
5. CONCLUSIONS AND RECOMMENDATIONS	35
5.1 Conclusions	35

5.2 Recommendations	36
5.2.1 Policy Recommendations	36
5.2.2 Further Research	36
REFERENCES.....	38

1. INTRODUCTION

1.1 Background Information

The sharp deterioration of the global financial crisis in late 2008 led to the increased risk of a severe downturn in economies all over the world. In many countries, the fiscal and monetary authorities responded with a variety of conventional and less conventional measures aimed at mitigating the effects on financial stability and the real economy. Central banks around the world introduced a variety of measures aimed at stabilizing financial conditions and supporting aggregate demand (Klyuev, de Imus, and Srinivasan 2009). One of the common conventional measures applied was the reduction of interest rates. This led to the interest rates in most developed economies such as the US and the UK nearing the zero lower bound (ZLB). With interest rates bound unable to go beyond zero and economies facing deflationary pressures, central banks had to employ unconventional monetary policies to mop up in the aftermath of the crisis and stimulate the economy.

One of the most common unconventional measures employed was the program of asset purchases financed by the issuance of central bank reserves. This policy of asset purchases has come to be known as quantitative easing (QE). In general terms, QE is normally defined as a policy that expands the central bank's balance sheet, in order to increase the level of central bank money (in particular, bank reserves) in the economy (see Bernanke and Reinhart 2004). QE can also be defined as all policies carried out by central banks involving changes in the composition and/or size of their balance sheet aimed at, in a situation close to the zero lower bound (ZLB), easing liquidity and credit conditions with the final goal of stimulating the economic system.

There exist therefore a variety of different unconventional measures that fall under the label of QE, such as purchases of treasuries, purchases of private securities, and direct loans to banks, companies and households. By purchasing financial assets from the private sector and boosting the amount of money in the economy, nominal spending would increase. The expected effect would thus be an increase in economic activity and mitigation of the deflationary pressure of the financial crisis.

The phrase was first applied to Japan as it dealt with the bursting of a real estate bubble and the deflationary pressures that followed in the 1990s (see, Ugai 2007 and Shiratsuka 2009). The phrase

‘Quantitative Easing’ was introduced to signal a shift in focus towards targeting quantity variables. With interest rates at their Zero Lower Bound (ZLB), the Bank of Japan aimed at purchasing government securities from the banking sector and thereby boosting the level of cash reserves the banks held in the system.

The hope was that by targeting a high enough level of reserves, eventually this would spill over into lending into the broader economy, helping drive asset prices up and thus removing deflationary forces. The central banks of the US, the Euro area and the UK have all followed Japan in adopting policies that have led to substantial increases in their balance sheets, although there are significant differences both amongst themselves and with Japan in terms of how they have implemented QE and other unconventional policies.

In the US, when the Lehman Brothers collapsed, the Fed engaged in dramatic cuts of the policy rate, and the ZLB was virtually reached in December 2008. The U.S. Federal Reserve pursued the unconventional policy of purchasing large quantities of financial market securities. These included Treasury securities, agency securities, and agency mortgage-backed securities (MBS). The objective of this unconventional policy was to reduce long-term interest rates in order to spur economic activity (Dudley 2010). This measure was accompanied by a huge expansion of the Fed’s portfolio assets. The assets jumped by over \$1,000 billion in a few weeks. The Fed started a much more comprehensive program to provide liquidity and reduce risk premia along the term structure and across a variety of different assets.

Given improved conditions in financial markets, many of the programs introduced at the onset of the crisis were suppressed by the end of 2009 or throughout 2010. A second stage of QE, called by practitioners QE2, took place from October 2010 until June 2011, mainly consisting of purchases of medium- and long-term treasury securities. In September 2012, Bernanke announced that the Fed will purchase additional agency mortgage backed securities at a pace of \$40 billion per month, and will extend the average maturity of its holdings of securities. These actions were expected to increase the Fed’s holdings of longer-term securities by about \$85 billion each month until the end of the year.

An important feature of quantitative easing and unprecedentedly low U.S. interest rates is that it led to large short-term capital inflows to a number of emerging markets, which in turn led several to impose capital controls, such as Brazil, Indonesia, South Korea, and others (Ahmed and Zlate, 2013). Quantitative easing led the U.S. dollar to be the funding currency in large-scale carry trade

activity with Emerging Markets as the target currencies. The Fed started slowing down its quantitative easing program by reducing the amount it pumped into the economy each year. This process culminated on December 18, 2013, when the Fed decided to taper its quantitative easing policy by \$10 billion per month, to \$75 billion. This was accompanied by the Fed's chair announcement that it would soon begin to taper its interest rates.

The concern with tapering is the flipside: potentially disruptive large-scale capital outflows from Emerging Markets as carry trade activity is unwound in expectation of tapering and hints at future interest rate increases. Large capital outflows could create disruptions in financial markets, and eventually real economic activity, in Emerging Markets. Private capital flows to emerging markets are benefiting from an overall supportive global environment, in particular improved global outlook and strong projected growth in Africa.

While the monetary policy of the Federal Reserve Bank has been shifting from quantitative easing to a tightening mode, the European Central Bank and the Bank of Japan are expected to undertake further monetary easing. Hence private capital flows to Africa's emerging and frontier markets are expected to be higher than at the beginning of 2014. Nevertheless, risks of sudden stops or even reversals remain. Surprises in the timing, speed and size of the Fed quantitative easing (QE) tapering constitute some of the downside risks.

Through channels such as global liquidity and global portfolio rebalancing, the QE has impacted developing and emerging market economies. As previously predicted, the implementation of QE has brought about increased capital flows to the region, including portfolio flows. In some countries, it has led to appreciation of local currencies, which weakened their export competitiveness. This occurs because such a country's goods become expensive thus its trade partners opt to trade with other countries.

1.2 Statement of the Research Problem

There has been notable development with regard to Quantitative Easing over the past decade. However, majority of the focus has been laid on its effects on the countries whose Central Banks implement it. These countries include the USA, UK and Japan. However, very little has been published on the effect of QE on developing economies. This poses a problem where developing economies' policy makers cannot set policies in time to prevent any possible negative spillover effects of QE on their economies. Thus policymakers are left to have to react to QE effects after they have occurred which most times could be too late. This study attempts to contribute to the

quantitative easing literature by seeking to establish whether there is a relationship between developed economies' monetary policy and developing economies' bond markets.

More specifically, this study seeks to establish whether the Fed's QE, program on the onset of the financial crisis, had an effect on Kenya's financial markets and more specifically its bond market. Kenya is a popular foreign portfolio investors' destination with most of the activity in its financial markets conducted by foreign institutional investors. Moreover, Kenya's bond market had substantial growth between the years of 2009 and 2013. Trade turnover in Government Bonds at the NSE has risen threefold from Ksh.107.85bn in 2009 to Ksh.466.07bn in 2010 and Ksh.453bn in 2013. This study seeks to find out how much of that growth could be attributed to the QE program conducted by the Federal Reserve.

This will be achieved by focusing specifically on the increase in the Fed's balance sheet, and by extension the increase in money supply the US economy, and comparing it with the performance of Kenya's bond market. The study will seek to investigate whether there is any effect on Kenya's bond market performance brought about due to the increase in money supply by the Fed on the onset of the financial crisis.

1.3 Overall Research Objective

The overall objective of this study is to determine the effect of quantitative easing by the U.S. Federal Reserve on the Kenya bond market between 2009 and 2014.

1.4 Research Question

What is the effect of quantitative easing by the U.S. Federal Reserve on the Kenya bond market?

1.5 Scope of the research

This research focuses on the unconventional policy of quantitative easing by the U.S. Federal Reserve and Kenya's bond market and adopts a co-integration model to respond to the research objective. Thus, Kenyan 182-day treasury bills are plotted against money supply in the U.S. to establish whether a relationship exists. The period of study is January 2009 to December 2014.

1.6 Justification of the study

Academic justification

The empirical findings of this study will contribute to the knowledge in this field, since the results will determine the presence of a relationship between the two variables. Depending on the findings, a conclusion based on the nature of the relationship can be drawn; either a uni-directional or a concurrent relationship may exist between U.S. money supply and Kenya's treasury bills.

Policy justification

The findings will be able to be relied upon to act as a foundation for sound economic policy. This will allow policy makers to anticipate changes in the economy resulting from unconventional monetary policies in the developed world. Thus policy could be used as an effective tool in Kenya in managing growth, inflation and other economic variables expectations.

By understanding the relationship between the two variables, policy makers will know which strategies to employ to make the economy less susceptible to shocks, depending on how the variables move together. As a result, they would be able to determine the appropriate policy strategy to be employed in Kenya that will result in optimal economic growth.

2. LITERATURE REVIEW

2.1 Introduction

This chapter outlines the theoretical and empirical framework upon which the premise for this study is built. The study first looks at the theoretical literature explaining the channels through which QE affects financial markets. Then the theoretical framework of the study will be discussed. The study then looks at the empirical literature where related studies on the topic will be discussed and finally we discuss the literature gap.

2.2 Theoretical Literature

Here, the study looks at the signaling channel, portfolio balance channel, liquidity channel, duration channel, and the fiscal channel. Then the study builds on the theoretical framework. Injecting money into the economy by a central bank, in return for other assets, increases private-sector liquidity. Benford et al. (2009) suggest that there are a number of ways through which this greater liquidity can have an impact on the economy.

First, purchases of assets by central banks lead to an increase in their demand which leads to an increase in the prices of these assets. Higher asset prices lead to a reduction in the cost of borrowing, which in turn encourages higher consumption and investment spending. Higher asset prices also lead to an increase in the asset holders' wealth, thus boosting their spending. Other ways in which QE may potentially work is through expectations, by demonstrating that the MPC will do whatever it takes to meet the inflation target and through influencing banks' lending ability. The channels through QE works are discussed below.

According to Joyce et al. (2012), the signaling channel refers to anything market players might learn from the central bank's QE announcements about the underlying state of the economy and the MPC's reaction criteria. This channel captures news about expected future policy rates and is often referred to as the policy news channel. If defined more broadly it can include perceptions of the risks around the path of future short-term interest rates and should also include revisions to term premia. Gagnon et al. (2011), further argue that as well as affecting yields, this channel also feeds through into other asset prices to the extent of affecting relevant discount rates.

Generally, these effects may have either positive or negative implications on yields and prices. The impact of QE on nominal gilt yields may be ambiguous. This is because while QE signals lower policy rates in the short term, it could also signal higher inflation in the medium term and long term.

The portfolio balance channel reflects the direct impact on asset prices of investors rebalancing their portfolios in response to the Fed's QE-related asset purchases. Tobin (1961, 1963, and 1969) and subsequently Brunner and Meltzer (1973) and Friedman (1978), amongst others, showed that if assets are not perfect substitutes, then a change in the quantity of a specific asset will lead, *ceteris paribus*, to a change in its relative expected rate of return. Imperfect substitutability therefore provides a mechanism for QE-related asset purchases by the Fed to affect asset prices by inducing sellers to rebalance their asset portfolios. As long as long-term bonds and money are imperfect substitutes, QE-related bond purchases would be expected to reduce bond yields and lead to an increase in demand for other long-term assets by investors. Impact through this channel occurs both on announcement and over time as investors adjust their portfolios in response to the bond purchases.

Due to its dependency on the perceptions of the path of outstanding stocks of bonds and money, it is expected that this channel will be persistent. However, portfolio balance effects are not present in conventional New Keynesian models which state that QE can only work through a signaling channel (see, e.g., Eggertsson and Woodford 2003). The assumptions made in these models imply that the distinction between government and private asset holdings is unimportant, in a way reminiscent of Ricardian equivalence, thus asset purchases on their own do not change behavior. In these models, QE can only be effective if it changes expectations regarding the future path of policy rates and/or inflation. This naturally leads to the conclusion that determining future interest rates rather than undertaking asset purchases may be more effective. However, in a model with financial frictions or incomplete markets, and with imperfect substitutability between different assets, QE can also affect asset prices by changing the relative supplies of different assets. The importance of imperfect asset substitutability is reflected in an emerging theoretical literature that builds micro foundations for these effects from the earlier contributions of Tobin and others.

For example, André's, L'opez-Salido, and Nelson (2004) introduce an adjustment to household preferences in a New Keynesian model to allow for imperfect asset substitutability between

holdings of long-term bonds and money for certain households. Their framework can be thought of as a way of introducing “preferred habitat” investors (Modigliani and Sutch 1966) into a dynamic stochastic general equilibrium setting. More recently, using a partial equilibrium approach, Vayanos and Vila (2009) propose a theoretical model of preferred habitat, in which bond prices are determined through the activities of risk-averse arbitrageurs and preferred-habitat investors. In this setup, they demonstrate that shocks to bond supply are a determinant of bond prices, thus providing another rationale for expecting QE to have an effect on long-term bond yields.

The other channel through which QE works is through the liquidity channel which is also known as the market functioning channel. According to Gagnol et al. (2011), there may be effects on the prices of longer-term assets if the presence of the Federal Reserve as a consistent and significant buyer in the market enhances market functioning and liquidity. The LSAP programs began at a point of significant market strains, and the poor liquidity of some assets weighed on their prices. By providing an ongoing source of demand for longer-term assets, the LSAPs may have allowed dealers and other investors to take larger positions in these securities or to make markets in them more actively, knowing that they could sell the assets if needed to the Federal Reserve. Such improved trading opportunities could reduce the liquidity risk premiums embedded in asset prices, thereby lowering their yields.

This liquidity, or market functioning, channel, which is distinct from the portfolio balance channel, appears to have been important in the early stages of the LSAP programs for certain types of assets. For example, the LSAP programs began at a point when the spreads between yields on agency-related securities and yields on Treasury securities were well above historical norms, even after adjusting for the convexity risk in MBS associated with the high interest rate volatility at that time. These spreads in part reflected poor liquidity and elevated liquidity risk premiums on these securities. The flow of Federal Reserve purchases may have helped to restore liquidity in these markets and reduced the liquidity risk of holding those securities, thereby narrowing the spreads of yields on agency debt and MBS to yields on Treasury securities and reducing the cost of financing agency-related securities.

Another asset for which this channel is important is older Treasury securities which had become unusually cheap relative to more recently issued Treasury securities. Investors were reluctant to buy the older securities because their poor liquidity meant they would be difficult to sell (See

Gurkaynak and Wright, 2010 p56). However, the yield spreads narrowed to normal levels after the Federal Reserve began buying these bonds.

The other channel is the duration channel. Gagnon et al. (2011) also argue that for Treasury securities, the most important component of the risk premium is referred to as the “term premium” and it reflects the reluctance of investors to bear the interest rate risk associated with holding an asset that has a long duration. The term premium is the additional return investors require, over and above the average of expected future short-term interest rates, for accepting a fixed, long-term yield. The LSAPs have removed a considerable amount of assets with high duration from the markets. With less duration risk to hold in the aggregate, the market should require a lower premium to hold that risk. This effect may arise because those investors most willing to bear the risk are the ones left holding it.

Or, even if investors do not differ greatly in their attitudes toward duration risk, they may require lower compensation for holding duration risk when they have smaller amounts of it in their portfolios. Indeed, in the preferred-habitat model of Modigliani and Sutch (1996) it is possible that some agents seek to hold long-duration assets so that the term premium can, in principle, be negative.

Bernanke et al. (2004) suggest that another possible mechanism for quantitative easing to influence the economy is the fiscal channel. This channel relies on the observation that sufficiently large monetary injections will materially relieve the government’s budget constraint, permitting tax reductions or increases in government spending without increasing public holdings of government debt. Effectively, the fiscal channel is based on the government’s substitution of seigniorage (a tax with little or no deadweight loss in a deflationary environment) for direct taxes such as income taxes.

Alan Auerbach and Maurice Obstfeld (2005) provide a detailed analysis of both the macroeconomic and the welfare effects of the fiscal channel and find that they are potentially quite substantial. These authors also note, however, that the fiscal effect of quantitative easing will be attenuated or absent if the public expects today’s monetary injections to be withdrawn in the future. Broadly, if the public expects quantitative easing to be reversed at the first sign that deflation has ended, they will likewise expect that their money-financed tax cuts will be replaced by future tax increases as money is withdrawn, and this expectation will blunt the initial impact of the policy.

Thus it is crucial that the central bank's promises to maintain some part of its quantitative easing as the economy recovers be perceived by the public as credible. Auerbach and Obstfeld (2005), show that, if the central bank is known to be willing to tolerate even a very small amount of inflation, the promise to maintain quantitative easing will be credible. A similar result would likely obtain if the central bank associates even a relatively small cost with publicly reneging on its promises. Thus it seems reasonable to expect that the fiscal channel of quantitative easing would work if pursued sufficiently aggressively.

2.3 Empirical Literature

Most of the empirical literature on asset purchases by the Bank of England and the Federal Reserve has focused on the effects on financial markets and more narrowly on government bond markets. In this Section, we summarise the literature on the effects of QE or LSAPs on financial variables. We start by looking at the effects of Federal Reserve's QE program, then the Bank of England's QE program, we then look at the Bank of Japan's program, and finally the effect of QE on emerging markets.

The assessment of the effects of the Fed's QE program on financial variables has mostly relied on event study methods. Bernanke et al. (2004), for example, provide a comprehensive analysis of financial market reactions to various unconventional Fed policy announcements that altered the relative supply of US Treasury securities. Their conclusion is that both changes in relative asset quantities and the expectation of such changes have had an impact on yields or asset returns. These findings are supported by vector auto regressions (VAR)-based term structure models.

Bernanke et al. (2004) also provide some evidence that QE as implemented by the Bank of Japan may have generated lower yields over the QE period, although there is weaker support from event studies compared with those for the US. These findings are also supported by Gagnon et al. (2011) who conducted one of the first studies of the US Federal Reserves' large scale asset purchases (LSAPs).

They concluded that the Fed's purchases between December 2008 and March 2010 had economically significant and long-lasting effects on longer term interest rates on a variety of securities, including Treasuries, agency mortgage-backed securities and corporate bonds.

Event studies conducted on LSAP announcements by the Fed in reaction to the great financial crisis, suggest that there was a contraction in Treasury yields and yields on mortgage-backed

securities (MBS) of about 90 and 110 basis points respectively. They suggest that the decline in long-term interest rates largely reflected the fall in risk premia generated by these purchases. They also use a time-series econometric model of asset quantities estimated on the basis of pre-crisis data to determine the impact of LSAPs, which suggests slightly smaller effects. In comparison, D'Amico and King (2010) use a different approach based on panel data analysis of individual bonds. They find that LSAP1 had an effect on longer term Treasury yields of about 30 basis points for the 5 to 15-year sector.

Krishnamurthy and Vissing-Jorgensen (2011) examine both LSAP1 and the second round of Fed purchases (LSAP2) using an event study approach. Their results indicate that there was a large decline in interest rates in the first programme but not the second. However, this may be attributed to the fact that the markets had already priced in much of the expected impact before the second programme was announced. They also identify a number of different channels through which QE may work, such as duration, liquidity and the long-term safety channel. Swanson (2011) revisits the Operation Twist experiment of the 1960s using event study techniques and argues that it was broadly comparable in scale to LSAP2. He finds that both policies reduced longer term Treasury yields by around 15 basis points. Neely (2012) found that the US LSAP announcements also had substantial effects on international long-term rates and the spot value of the dollar.

The UK's experience with QE in the wake of the 2008-2009 financial crisis has been documented in a number of studies. Meier (2009), Bean et al. (2010), Dale (2010) and Joyce et al. (2011), among others, have discussed comprehensively the details of large-scale asset purchases by the Bank of England and analysed various aspects of the impact of these non-standard monetary measures. Meier (2009) used an event studies approach to assess the impact of QE announcements. His findings suggest that long-term government bond yields declined between 40 and 100 basis points following the initial QE announcement by the Bank of England in March 2009.

Joyce et al. (2011) provide an even more comprehensive assessment using event studies and portfolio balance models. In this framework, it is assumed that gilts and money are imperfectly substitutable assets and a multiplier calculated from a Markowitz–Tobin portfolio choice-type model (Markowitz, 1952) determines the effects of changes in the quantity of gilts on excess asset returns in a portfolio with money, equities, corporate bonds and gilts. They suggest that QE lowered long-term gilt yields by about 100 basis points and that most of the decline was generated by portfolio balance effects

The broad orders of magnitude of the estimated effects on long-term interest rates from these US and UK studies is consistent with Kozicki et al. (2010), who examine the empirical relationship between long forward interest rates and the size of central bank balance sheets using data pre-dating the crisis. Most of the empirical studies on central bank asset purchases have used event studies as a key part of their analysis. There is a broad consensus in the literature that central bank asset purchases had economically significant effects, at least on government bond yields. There is, however, more debate on the transmission channels linking asset purchases with asset prices and relatedly on the persistence of the reductions in yields. The majority of empirical studies of central bank asset purchases have concluded that they mainly affect bond yields and other asset prices because they reduce term or risk premia through portfolio balance effects (D'Amico and King, 2010; Gagnon et al., 2011; Joyce et al., 2011).

Ugai (2007) reports that studies of the portfolio balance effect of Japanese government bonds (JGB) purchases under the QEP find either small or insignificant effects on longer-term interest rates, including on corporate bonds. Bernanke, Reinhart, and Sack (2004) also report only a small effect of news about JGB purchases on longer-term yields. Relatively small effects on yields probably reflect that the JGB purchases were not large as a share of GDP and that they were skewed toward bonds with short residual maturities. According to Ugai (2007), the peak increase in BOJ holdings of JGBs under the QEP was about 4 percent of GDP, considerably less than the 12 percent of GDP increase in Federal Reserve holdings under the LSAPs. McCauley and Ueda (2009) show that the additional BOJ purchases were mainly seasoned JGBs with short residual maturities; the average maturity of the BOJ's holdings of JGBs fell from more than five years to less than four years under the QEP.

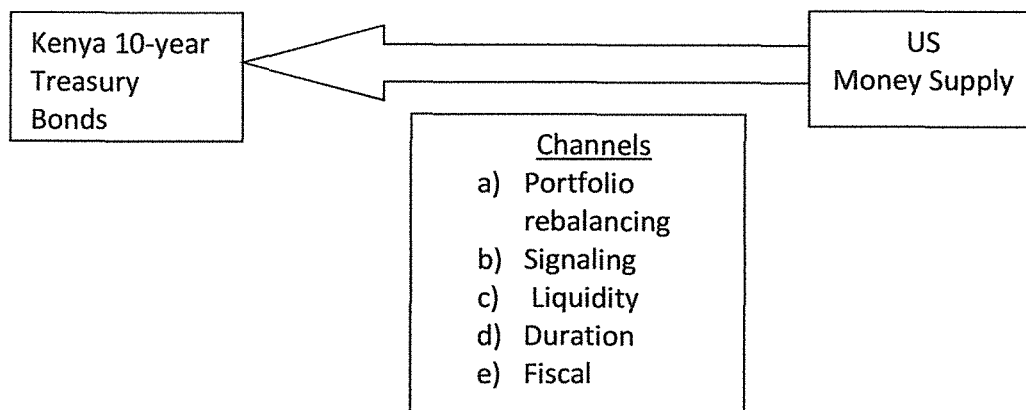
Moreover, the Ministry of Finance increased the average maturity of newly issued JGBs from five years in 2001 to six and a half years in 2005, further offsetting any effect of the QEP on longer-term bond yields. Several studies have been conducted on the impact of Quantitative Easing, Emerging Market Economies (EMEs). Among the more recent studies, Byrne and Fiess (2011) find U.S. interest rates to be a crucial determinant of at least the common component of global capital flows to EMEs. Similarly, using a panel-data approach, IMF (2011a) finds loose policy in the advanced economies to be an important determinant, but so also are the improved fundamentals and growth prospects of EMEs.

Ghosh et al. (2012) identify episodes of capital inflow surges and find a variety of factors to be important in increasing the likelihood of a surge to EMEs; including lower U.S. interest rates, greater global risk appetite, and a particular EMEs own attractiveness as an investment destination. Focusing on effects of Federal Reserve balance sheet changes on net flows to emerging market-dedicated funds, Fratzscher et al. (2012) find that unconventional monetary policies in the United States have exerted sizable effects on net inflows. But they also conclude that the effects of U.S. unconventional policies have been relatively small compared to other factors.

2.4 Literature Gap

Studies conducted reviewing the impacts of LSAPs by the U.S. Federal Reserve have found that the LSAPs led to a reduction in the yields of assets purchased by the Fed. Studies conducted on the impact of LSAPs by the Bank of England have also found that the purchases led to a reduction in the gilt yields. Studies have also been conducted on the wider international effects of the Federal Reserve asset purchases and the Bank of Japan's asset purchases. However there is no study that has been undertaken that seeks to explain the effects of QE on Kenya's financial markets and more specifically its bond market. This study seeks to contribute to the growing literature on QE and to establish whether QE has any effect on Kenya's bond market.

2.5 Conceptual Framework



The above framework seeks to show the channels through which QE, represented by an increase in U.S. money supply affects Kenya 10-year bonds. The channels act in different ways:

- a) **Portfolio balance channel** – This channel reflects the direct impact on asset prices of investors rebalancing their portfolios in response to the Fed’s QE-related asset purchases.
- b) **Signaling channel** – This refers to anything market players might learn from the central bank’s QE announcements about the underlying state of the economy. This channel captures news about expected future policy rates and is often referred to as the policy news channel.
- c) **Liquidity channel** – The presence of the Federal Reserve as a consistent and significant buyer in the market enhances market functioning and liquidity. This may have an effect on the prices of longer-term assets.
- d) **Duration** – The LSAPs have removed a considerable amount of assets with high duration from the markets. With less duration risk, the market should require a lower premium to hold that risk thus affecting asset prices.
- e) **Fiscal** – This channel relies on the observation that sufficiently large monetary injections will materially relieve the government’s budget constraint, permitting tax reductions or increases in government spending without increasing public holdings of government debt.

2.6 Research Hypothesis

Null Hypothesis: There is no significant casual relationship between money supply in the US and Kenya's treasury bills.

Alternate Hypothesis: There is a significant casual relationship between money supply in the US and Kenya's treasury bills.

3. RESEARCH METHODOLOGY

3.1 Research design

The research being conducted is exploratory in nature which means that it is conducted to provide a better understanding of a situation. This type of research is not designed to come up with decisions rather it enables researchers to produce a hypothesis about what is going on in a situation. Therefore by studying the relationship between U.S. money supply and Kenya's treasury bills rates, it is possible to establish the relationship that exists between them.

3.2 Sources of data

The data to be used in the research is primary in nature. It will be constituted of 182 day treasury bills rates from the Central Bank of Kenya and the US money supply from the Federal Reserve website. The data will be collected monthly over six years so that there can be enough data points for a conclusive relationship to be drawn.

3.3 Methodology

The objective of this study is to investigate the effect of the fed money supply (FEDMS) on treasury bills rates (TBRATES) as well as causal connection between the variables. A univariate regression model is designed to test the effects.

$$A \text{ TBRATES} = \alpha + \beta \text{ FEDMS} + \mu t \text{ ----- (1)}$$

3.4 Univariate time series analysis

Various econometric issues can influence the estimation of parameters using OLS when dealing with time series data. Regressing time series variables on one another using the Ordinary Least Squares (OLS) estimation can obtain a very high R^2 even when there is no meaningful relationship between the variables. This scenario can be attributed to the problem of spurious regression between unrelated variables generated by a non-stationary process. (Sarbpriya, 2013)

This leads to the need to examine the stationarity characteristics of the variables, prior to testing and implementing the Granger Causality test. It is therefore recommended that a unit root test be conducted so as to test for the order of integration. A series is said to be stationary if the mean and variance are time-invariant (Sarbpriya, 2013).

The results obtained after evaluating the U.S. money supply and Kenya treasury bills rates will provide insight on how to approach the multivariate tests. This is because they are dependent on the univariate characteristics of the data.

A stochastic process that is said to be stationary simply implies that the mean $[E(Y_t)]$ and the variance $[Var(Y_t)]$ of Y remain constant over time for all t , and the covariance $[covar(Y_t, Y_s)]$ and hence the correlation between any two values of Y taken from different time periods depends on the difference apart in time between the two values for all $t \neq s$. A non-stationary time series will have a time dependent mean making the standard assumptions in the Granger test not be valid. Due to the need for the series data used in standard regression analysis to be stationary, it is important that this requirement is first tested to determine whether the series used in the regression process is a difference stationary or a trend stationary (Sarbpriya, 2013). The (Dickey & Fuller, 1979) (ADF) test is used on the variables to establish the univariate characteristics of the two variables.

The Augmented Dickey Fuller (ADF) is mostly used to test for unit root and is used to test for stationarity. The following equation checks the stationarity of time series data used in the study:

$$\Delta y_t = \beta_1 + \beta_2 t + \alpha y_{t-1} + \gamma \sum \Delta y_{t-1} + \varepsilon_t \text{ -----(2)}$$

Where ε_t is the white noise error term in the model of a unit root test, with a null hypothesis that the variable has unit root. The ADF regression tests for the existence of unit root of y_t which represents all variables at time t . The test for a unit root is conducted on the coefficient of y_{t-1} in the regression. Where the coefficient is significantly less than zero, then the hypothesis that y contains a unit root is rejected. The null and alternative hypothesis for the presence of a unit root in the variable y_t is:

$$H_0; \alpha = 0$$

$$H_1; \alpha < 0.$$

Rejection of the null hypothesis means that there is presence of stationarity in the series.

If the ADF test-statistic (t-statistic) has a less absolute value than the Mackinnon critical t values, then the null hypothesis of a unit root fails to be rejected for the time series. Therefore one can conclude that the series is non-stationary at their relevant confidence level. The unit root test tests for the existence of a unit root in two cases: with intercept only, and with intercept and trend to take into the account the impact of the trend on the series (Sarbpriya, 2013).

3.5 Multivariate time series analysis

The purpose of this analysis is to check whether the series is involved in an equilibrium relationship. This means testing to see if the series are co-integrated. In most cases, combining two variables which are $I(1)$, leads to the combination also being $I(1)$. The controversy that arises in cointegration is that the variables must have a unit root problem. This is essential for a long run relationship to be present.

In response to the concept of non-stationarity, a usual response was to independently take the first differences of a series of $I(1)$ variables. However, this approach is problematic because the pure first difference models have no long run solution (Brooks, 2008). Many time series are non-stationary but “move together” over time. If variables are cointegrated, it means that a linear combination of them will be stationary. A co-integrating relationship may also be seen as a long term relationship.

No co-integration implies that series could wander apart without bound in the long run (Brooks, 2008). This would mean that if we test for co-integration in the data used for research, it would be possible to establish the presence or absence of long run equilibrium relationship of the lending rate and the two asset classes. This would result in a conclusion in support or against the hypothesis of the relationship between the variables.

Engle and Granger (1987) have tabulated a new set of critical values and hence the test is known as the Engle Granger (E.G.) test. This method has its own limitations: unit root and co-integration tests having low power in finite samples; which means we are forced to treat the variables asymmetrically and to specify one as the dependent, and the other as independent variables and cannot perform any hypothesis tests about the actual co-integrating relationship estimated at the first stage (Brooks, 2008).

The Johansen (1989) test is used to complement the Engle Granger Test. It is not based on the Dickey-Fuller test for unit root in the residuals from a single cointegrating relationship unlike the Engle Granger. This test allows robust results to be drawn on the long run equilibrium relationship. The merits and demerits of the two tests result in none being out rightly better. The Johansen (1989) is superior for small samples and multivariate tests, while Engle Granger is better for bivariate tests of financial data. It is important to note that the Johansen (1989) test sometimes indicates the presence of cointegration even where none exists. It is therefore important to carry out both tests before drawing conclusions.

3.6 Vector Autoregressive Models

The Vector Auto regression (VAR) model is one of the most effective and easy to use models for the analysis of multivariate time series. It is an extension of the univariate autoregressive model to dynamic multivariate time series model. The VAR model is especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. It provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. Forecasts from VAR models are quite flexible because they can be made conditional on the potential future paths of specified variables in the model.

The VAR model is used for structural inference and policy. In structural analysis, certain assumptions about the causal structure of the data under investigation are imposed, and the resulting causal impacts of unexpected shocks or innovations to specified variables on the variables in the model are summarized. These causal impacts are usually summarized with impulse response functions and forecast error variance decompositions. The section that follows constitutes of Granger Causality, impulse response and variance decomposition.

3.7 Granger causality test

Causality is a kind of statistical feedback concept which is widely used in the building of forecasting models. Historically, Granger (1969) and Sim (1972) were the ones who formalized the application of causality in economics. Granger causality test is a technique for determining whether one time series is significant in forecasting another (Granger, 1969). The standard Granger causality test (Granger, 1988) seeks to determine whether past values of a variable helps to predict changes in another variable.

The definition states that in the conditional distribution, lagged values of Y_t do not explain movements of X_t beyond that provided by lagged values of X_t itself (Green, 2003). It should be noted that the Granger causality technique measures the information given by one variable in explaining the latest value of another variable. Additionally it also says that variable Y is Granger caused by variable X if variable X assists in predicting the value of variable Y . If this is the case, it means that the lagged values of variable X are statistically significant in explaining variable Y . The null hypothesis to be tested in this case is that the X variable does not Granger cause variable Y and variable Y does not Granger cause variable X . In summary, one variable (X_t) is said to

granger cause another variable (Y_t) if the lagged values of X_t can predict Y_t and vice-versa (Sarbpriya, 2013).

3.8 Impulse responses and variance decomposition

Causality suggests which of the variables in the model have statistically significant impacts on the future values of each of the variables in the system. However it does not, by construction, be able to explain how long these effects require to take place or the sign of the relationship. This is to say that the results will not reveal whether changes in the value of a given variable have a positive or negative effect on other variables in the system, or how long it would take for the effect of that variable to work through the system. Such information will be given by an examination of the VAR's impulse responses and variance decompositions (Brooks, 2008).

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. Thus, if there are g variables in a system, a total of g^2 impulse responses could be generated (Brooks, 2008).

4. FINDINGS OF THE STUDY

In conducting the data analysis, logarithms are incorporated so as to reduce fluctuations observed in the data. This allows us to capture important patterns in the data. The significance level of 5% is chosen. This findings section is divided into two: The first section is the univariate analysis which evaluates the univariate characteristics of the data and the second section is the multivariate analysis which checks for the multivariate characteristics of the data.

4.1 Section I: Univariate Characteristics

4.1.1 Unit root test

The unit root tests evaluate the stationarity of the data. Stationarity is vital for the purpose of forecasting. Moreover, it also reduces the possibility of a spurious regression. The three variables in this study were subjected to unit root tests using the Augmented Dickey-Fuller.

Federal Reserve Money Supply

The graph below shows the time series data of the Federal Reserve money supply:

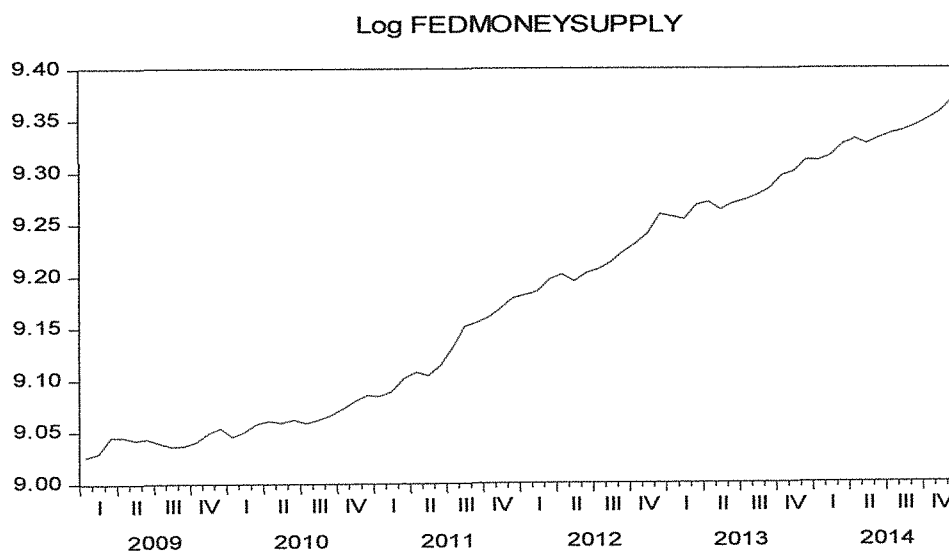


Figure 1: Federal Reserve Money Supply

The graph of the Federal Reserve Money Supply exhibits a form of trend. This allows for the Augmented Dickey Fuller test on the data to be conducted with a trend. The results are presented below:

Null Hypothesis: FEDMONEYSUPPLY has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.145628	0.5118
Test critical values:	1% level	-4.092547	
	5% level	-3.474363	
	10% level	-3.164499	

*MacKinnon (1996) one-sided p-values.

Table 1: Augmented Dickey Fuller Test on Federal Reserve Money Supply

The P-value for the test was 51.18%. It can thus be concluded that the Federal Reserve Money Supply has the presence of a unit root problem with the null hypothesis not being rejected at a 5% significance level. A conclusion can therefore be drawn on the non-stationarity of the Federal Reserve Money Supply in the US. This implies that the data is subject to unpredictable fluctuations.

This is consistent with the findings of Kozicki, Santor and Suchanek (2010) that tested the stationarity properties for government central bank variables or the U.S. using augmented Dickey Fuller (ADF) t-test statistics and their p-values. Money supply in the U.S. is a central bank variable. The null hypothesis of a unit root is not rejected for the variable. The output of the number of times the data needs to be differentiated to make it stationary is given below:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FEDMONEYSUPPLY(-1)	-0.077777	0.036249	-2.145628	0.0355
C	633.7008	285.1585	2.222275	0.0296
@TREND("2009M01")	4.677727	1.877232	2.491821	0.0152

Table 2: Integrating Order of Federal Reserve Money Supply

The above table shows that the Fed Money Supply is I (1) based on a 5% significance level where the null hypothesis can be rejected. This tells us that to make lending rates stationary, you therefore need to difference them once.

Null Hypothesis: D(FEDMONEYSUPPLY) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.307411	0.0000
Test critical values:	1% level	-4.096614	
	5% level	-3.476275	
	10% level	-3.165610	

*MacKinnon (1996) one-sided p-values.

Table 3: 1st order Augmented Dickey Fuller Test on Fed Money Supply

182-Day Treasury Bills Rate

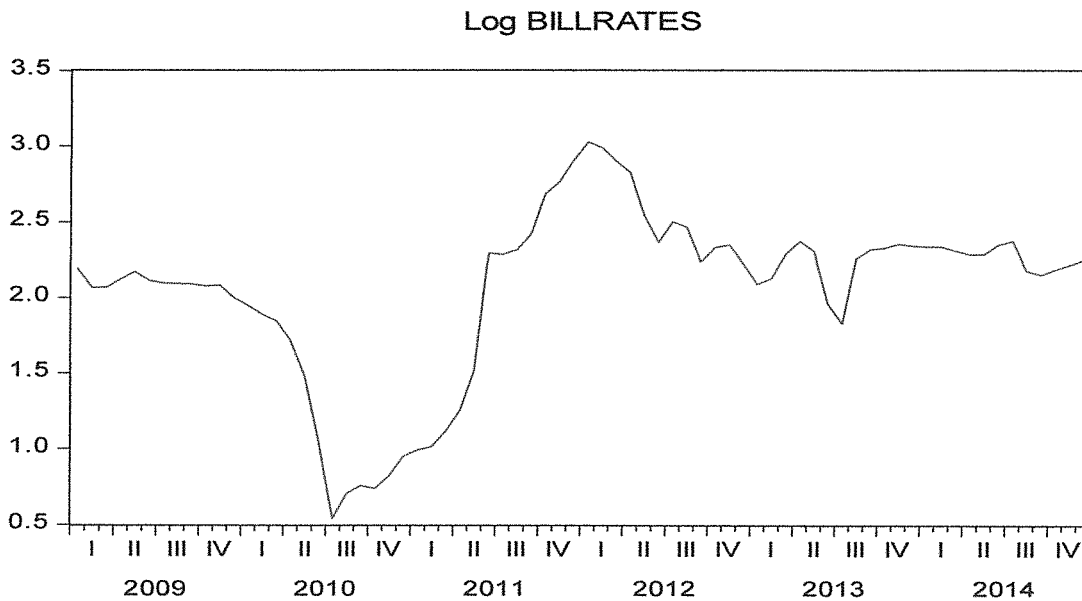


Figure 2: Treasury bill rates graph

From the graph above (figure 3), it can be seen that there does not exist any form of trend. This allows for the stationarity test of the data to be conducted without a trend. Therefore, the Augmented Dickey Fuller Test is conducted on the data without a trend and the results are:

Null Hypothesis: BILLRATES has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.025222	0.2756
Test critical values:		
1% level	-3.527045	
5% level	-2.903566	
10% level	-2.589227	

*MacKinnon (1996) one-sided p-values.

Table 4: Augmented Dickey Fuller Test on Treasury bill rates

The output shows that the unit root problem cannot be rejected at a 5% significance level. The integrated order of the treasury bills rates can be established from the data output and is below:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BILLRATES(-1)	-0.076000	0.037527	-2.025222	0.0468
D(BILLRATES(-1))	0.374650	0.112760	3.322551	0.0014
C	0.697411	0.367054	1.900021	0.0617

Table 5: Integrated order of Treasury bill rates

The output data implies that the data is difference stationary of order 1. The data therefore has to be differenced once to make the data stationary. This means that the rejection of the null hypothesis that there is presence of a unit root is now possible at a 5% significance level.

Null Hypothesis: D(BILLRATES) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.834787	0.0000
Test critical values:		
1% level	-3.527045	
5% level	-2.903566	
10% level	-2.589227	

*MacKinnon (1996) one-sided p-values.

Table 6: 1st order Augmented Dickey Fuller test on Treasury bill rates

4.2 Section II: Multivariate Characteristics

4.2.1 Cointegration

In a multivariate context, the appropriate way to treat non-stationary variables is not straightforward. It is possible that there exists a linear combination of integrated variables that is stationary so that the variables are said to be cointegrated. The relationship between the data expressed in first differences is examined only after obtaining information about the equilibrium relationship between the variables.

Long run equilibrium relationship can only be tested for variables that are of a higher integrated order than 0. Variables which have an order 0 are not used as they imply stationarity. All the variables in the study are I (1) as shown in tables 3, table 6 and table 9 and can therefore be evaluated for cointegration. If they are cointegrated, it would imply that the variables have a long run relationship where they merge and become stationary.

Johansen test of cointegration

This test results shown below in table 9 suggest the acceptance of the null hypothesis that there is presence of a linear deterministic trend between the two variables at a significance level of 5%. This supports the existence of a long run equilibrium relationship between the variables. We can therefore conclude on the cointegrating aspect of money supply in the U.S. and Treasury bill rates

in Kenya. From a policy perspective, this would imply that the variables will be linking in the long run. Due care therefore has to be taken when implementing policies that may be contrasting on the variables.

Trend assumption: Linear deterministic trend				
Series: BILLRATES FEDMONEYSUPPLY				
Lags interval (in first differences): 1 to 4				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None	0.138429	13.01598	15.49471	0.1142
At most 1	0.044261	3.033118	3.841466	0.0816
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 7: Johansen Test

The existence of a long term relationship is consistent with the findings of Kozicki, Santor and Suchanek (2010) who examined the impact of central bank balance sheets on long term forward rates for a sample of developed countries. They used time series regressions to estimate how changes in central bank balance sheets affect international 5-year and 10-year forward interest rates over 28-year samples. They found that controlling for expected inflation, projected deficits and other macro variables, an increase in central bank claims on the central government or central bank assets is associated with a decline in long-term forward rates.

This is also consistent with Gagnon et al. (2010), who conducted event studies on the effect of LSAPs on long term bond yields and found that buy events are usually associated with large reductions in long-term U.S. interest rates in the 2-day windows they were observing. Neely (2010) also finds that the LSAP buy announcements were also associated with large changes in foreign

bond yields: Australian, Canadian, German, Japanese, and British long bond yields cumulatively fell by 78, 54, 50, 19, and 65 basis points during the same 5 buy event windows.

4.2.2 VAR analysis

The VAR model is used for data description, forecasting, structural inference and policy analysis. In structural analysis, certain assumptions are imposed on the causal structure of the data being investigated. The resulting causal impacts of innovations to specified variables in the model are summarized, usually with impulse response functions and forecast error variance decompositions. VAR models make it possible to evaluate the short run relationship between the variables allowing for the relationship to be established. They therefore complement the cointegration test, by providing short run information. The section below comprises of Granger Causality and impulse response.

Granger Causality Test

VAR Granger Causality/Block Exogeneity Wald Tests
 Date: 12/06/15 Time: 23:32
 Sample: 2009M01 2014M12
 Included observations: 70

Dependent variable: FEDMONEYSUPPLY				
Excluded	Chi-sq	df	Prob.	
BILLRATES	2.522705	2	0.2833	
All	2.522705	2	0.2833	
Dependent variable: BILLRATES				
Excluded	Chi-sq	df	Prob.	
FEDMONEYSUPPLY	0.602192	2	0.7400	
All	0.602192	2	0.7400	

Table 8: Granger Causality Test

The Fed Money Supply is found not to Granger Cause 182-day Treasury bill rates at all confidence levels. 182-day Treasury bill rates are also found not to Granger Cause Treasury bill rates at all confidence levels. The null hypothesis for “no Granger Causality” cannot therefore be rejected in both scenarios. This would indicate the absence of a short run equilibrium relationship between the variables implying that neither of the variables can be used to influence the other by the policy makers.

The absence of a short term relationship is consistent to Neely (2010) who documents little strong or consistent movement of international short-term rates during the LSAP buy and sell windows. US short-term rates fell modestly on some LSAP announcements, but these announcements had very little effect on foreign short-term interest rates. This lack of response is consistent with the argument of Gagnon et al. (2010) that the LSAP did not affect expected short rates significantly.

Impulse Responses

An impulse refers to the reaction of any dynamic system in response to some external changes. Impulse responses trace out the response of current and future values of each of variable to a unit increase in the current value of one of the VAR errors. This is assuming that this error returns to zero in subsequent periods and that all other errors are equal to zero. Taking the already established Granger Causality, it is subjected to impulse response test and presents the following output:

Response to Cholesky One S.D. Innovations ± 2 S.E.

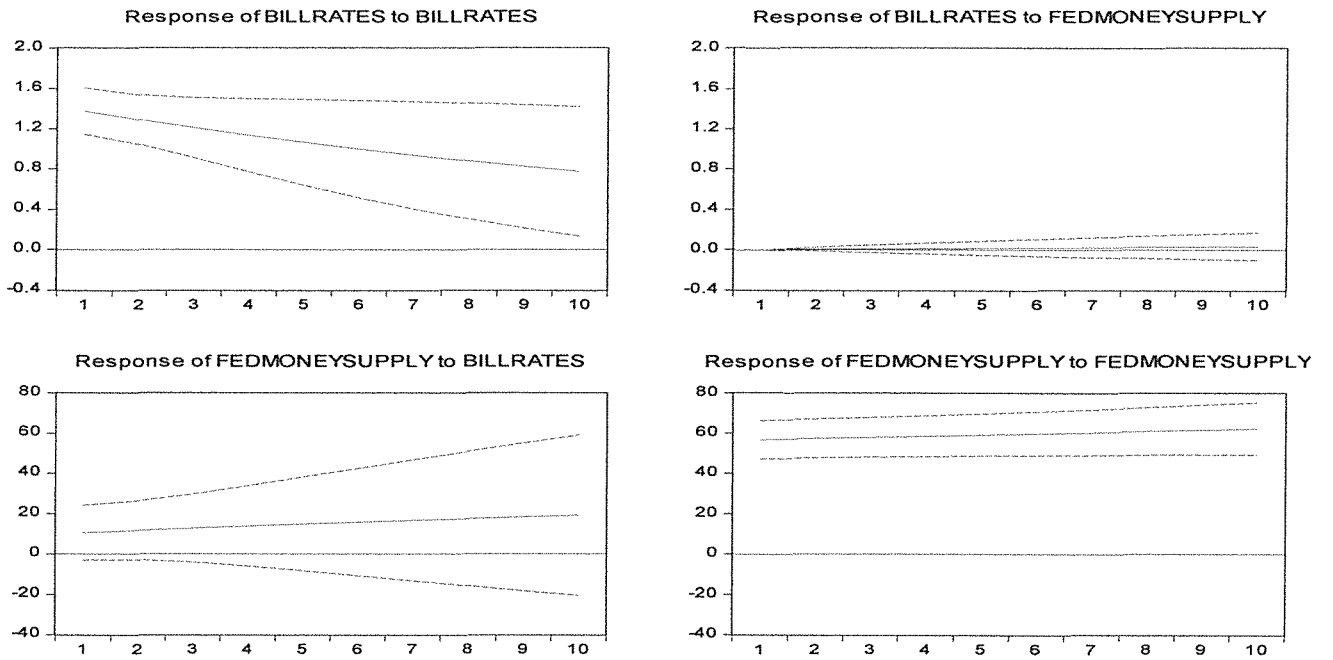


Table 9: Impulse Responses

An impulse shock to US money supply will affect treasury bills rates from the second period and this will increase slowly into the future. This implies that it takes two periods for US money supply to have an impact on Kenya treasury bills.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The main objective of the paper was to determine the effect of quantitative easing by the U.S. Federal Reserve on the Kenya bond market between 2009 and 2014. The first chapter of the paper introduces the issues regarding the topic that are to be addressed in the paper. The objectives and the significance of the research are also mentioned here. The second chapter presents the literature review where the theoretical framework and empirical literature related to the variables that have been conducted to establish the relationship between the variables. The third chapter presents the methodology for evaluating the hypothesis, and finally in the fourth chapter the results for the implementation of the methodology are presented.

First, the hypothesis on the stationarity of the Federal Reserve money supply and 182 day treasury bills was tested. The results showed that both variables were $I(1)$ implying stationarity of order one which means that they had to be differenced once to make them stationary. The second hypothesis was to be evaluating the multivariate characteristics of the data. The Johansen (1989) cointegration test resulted in the presence of a linear deterministic trend between the non-stationary variables. This implies that the federal reserve's money supply have a long run equilibrium relationship with the 182 day treasury bills. The VAR models of impulse response and Granger Causality are used to evaluate the short run relationship between the variables. There was no relationship present for the Granger Causality test in the variables. After evaluating both the long run and short run relationships between the variables, only a long run relationship is established. This relationship was found through the use of Johansen (1989) test.

From the graphs in figure 1 and figure 2, it can be seen that an increase in U.S. money supply coincides with a decrease in the 182-day treasury bills rate from the year 2009 to the third quarter of 2010. This can be attributed to the long term relationship found above. Neely (2010) states that *ceteris paribus*, a fall in U.S. bond yields would cause investors to reduce their portfolio weights in U.S. bonds in favor of foreign bonds, such as Kenya's, pushing up the prices of those foreign bonds and reducing their yields until a new equilibrium was reached.

However the treasury bills rates rise from 2011 onwards until around 2014 despite the presence of a long term relationship and an increase in U.S. money supply. This is contrary to the results of this study and findings of other studies. This could be attributed to other macroeconomic variables

that affected Kenya's treasury bills rates at that period time. These variables include a rise in the Central Bank of Kenya's interest rates which affects the direction of treasury bills rates. Misati, Nyamongo and Kamau (2011) note that policy rate changes are followed by changes in short-term interest rates which are then expected to be transmitted to commercial bank retail interest rates. It is important to note that the Kenya shilling was in gradual decline in 2011 and the CBK intervened by raising interest rates.

5.2 Recommendations

5.2.1 Policy Recommendations

This paper has shown that money supply in the U.S. and treasury bills in Kenya are non-stationary. Consequently, whenever policy makers in Kenya intend to formulate policies to target these variables, they should be aware that the shocks to treasury bills tend to persist for long periods of time and should therefore apply strong policy action to resolve any issues associated with the variables. Due to the presence of a long term relationship, it would be advisable for policy makers to take into account policy decisions in the U.S. setting policy. This will be especially relevant when the policy decisions in the U.S. affect money supply. Policy makers can there set policies with the anticipated effects in mind and therefore prevent any adverse effects in the economy.

It is also important to note that QE is a policy usually conducted with an intention to taper it at sometime in future when the desired effect has been achieved. With this in mind, policymakers should use the knowledge of a presence of a long term relationship to anticipate and try to mitigate the effects of such tapering on the economy. Such effects of tapering include capital flight from economies that had benefited from inflows during the QE period. Capital flight can have adverse effects on an economy, such as disruptions in financial markets, and should therefore be prevented from occurring. Reduction of capital flight represents an important way to increase the resources available in sub-Saharan African countries for both consumption and investment, public and private (Fofack and Ndikumana, 2009).

5.2.2 Further Research

The use of money supply from other countries conducting quantitative easing would better capture the impact of quantitative easing on Kenya's bond market. This includes countries such as Japan, the Eurozone and the U.K. This would enable conclusions to be drawn on whether the relationship

between the variables is country-specific or standard across all relevant countries. As a result, more comprehensive and reliable results would be drawn although acquiring that data posed a challenge during the period of research.

More variables that affect Kenya's bond market could also be included in the model. These include variables such as the Central Bank rate, stock market performance, inflation, investor expectations among other macroeconomic variables. This would allow the research to establish the specific effect of quantitative easing on Kenya's bond market after restricting other variable's effects on the bond market. This research could also allow the effect of quantitative easing on Kenya's entire economy to be captured and not only to the bond market.

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