



**An Analysis of the Causality Effect of Exchange Rate and Interest Yields: A
Case Study of Zambia**

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Obed Bwalya

DEDICATION

With love and affection to the memory of my late parents: Mr. James Mwenge Bwalya and Mrs Joyce Mulenga-Bwalya; may their souls rest in eternal peace. To my wife and daughters: Mrs. Kapambwe Chitoshi-Bwalya, Sandra and Mushili Bwalya. I also would like to thank my supervisor, Professor Enrico Uliana for the guidance; this dissertation would not have been possible without his support. I thank him wholeheartedly for being such a wonderful instructor; I will forever feel indebted to him so words are not enough.

ABSTRACT

This study analyses the relationship between the US Dollar/Zambian kwacha exchange rate and the interest rate yields on the 91-day and 182-day T-bills in Zambia. Using statistical analysis of regression analysis and co integration, the study found that a long-run relationship does not hold for both 91-day and 182-day T-bills taken for any corresponding set of interest rate and exchange rate respectively. Nonetheless, the three variables taken simultaneously demonstrated that a long-run correlation exist. Following a comprehensive analysis of the results from this study, it is concluded that the statistical relationship that exists is not very significant and investors looking forward to invest in Zambia's financial markets should include other factors in order to forecast the exchange rates with regard to the changes in interest rates.

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LIST OF ACRONYMS AND ABBREVIATIONS

BoZ	Bank of Zambia
FER	Floating Exchange Rates
FiER	Fixed Exchange Rates
GDP	Gross Domestic Product
GRZ	Government of the Republic of Zambia
IRP	Interest rate parity
OECD	Organisations for Economic Cooperation and Development
PIA	Pensions and Insurance Authority
PPP	Purchasing power parity
SEC	Securities and Exchange Commission
SoE	State Owned Enterprise
ToT	Terms of Trade
UIRP	Uncovered interest rate parity
US\$	United States of America Dollar
ZMW	Zambian Kwacha

1 OVERVIEW OF THE STUDY

1.1 Research Area

In many studies as well as real life experiences, governments have used the power of adjusting rates to have a target level of economic development. This is because an adjustment in the rates has come to be believed as to having an important impact on such other economic fundamentals such as the exchange rates, inflation, to mention but a few. How much impact a change or movement in the interest rates on the key economic fundamentals has is subject to debate and more certainly how much the market is considered to be ‘free’ or ideal.

Most economic commentators have argued that most of the economic theories are only applicable in ideal markets such as the ones in developed countries. They argue that the applicability of many theories has limited impact on developing countries as the markets in the countries are mostly considered to be ‘inefficient’.

In developing countries like Zambia where the markets are just developing and less ‘free’, investors and policy makers need to understand that if the change in financial dynamics, *vis-à-vis* the rates of interest can influence other factors such as the exchange rate, inflation, balance of payments among others.

This study demonstrates how interest rates relate to exchange rates and tend to show disparities in third world countries as well as industrialised countries. As a consequence, relying on results from one market and apply it in another market will not be able to give the desired results. In addition, the period of most studies around this have mostly being done over two decades ago. Considering the time which has elapsed, a great deal of their use may not be applicable in light of the trends which have since been observed. In addition, the development in the analysis, methodology and technology means that studies done now will be more predictable as they make use of the more precise methods compared to the studies done or performed in early years.

According to a report monitored through a publication by Bloomberg (2014), the appreciation of the Zambia’s currency, the Kwacha (ZMW) or (Zambian Kwacha or simply “Kwacha”) by 9.6

percent in June 2014 coincided with record high yields on Treasury Bills. The report further notes that the observed positive trends witnessed in the performance of the Kwacha attracted foreign investors back to Zambia's Treasury bills (T-bills). During the period under discussion, that is June 2014, the Bank of Zambia (BoZ or “central bank”) sold 475 million Kwacha (US\$76 million) of securities after receiving 603 million Kwacha in bids, the first time demand exceeded supply since February 20, 2014, Bloomberg (2014). Yields on 364-day bills rose to 19.99 percent, the highest since Bloomberg began compiling data in 2005.

These developments led to the financial market participants wondering if at all the improved rates on Zambia's Treasury Bills regained because the Kwacha had appreciated in relation to other currencies.

Engel (1986) conducted a study and the results indicated that the functioning of exchange rates was underpinned by a number of economic elements. To be precise, the elements postulated were in the Standard models of exchange rates were Purchasing Power Parity (PPP) and Relative Economic Strength Approach. A similar idea was conceived in a paper authored by O'Sullivan and Steven, (2003). The two authors attempted to understand how a variable being monitored such as exchange rates, tend to perform when there is no discernible trend. Of particular interest stemming from this study, was the conclusion which put forward a hypothesis that that variables with a discernible trend (random-walk) were observed to perform better than fundamental models which simulated relationships between securities and earnings. In the mid 90's Flood and Taylor (1996) investigated the context in which interest yields and exchange rates were linked. Similar attempts to understand if the apparent trends in interest yields and exchange were in unison had been made in different papers by Pauls and Edison, (1992), Koedijk and Coughlin (1990), Flood, Messe, and Rogoff (1988). Hitherto, the authors in the respective papers cited did arrive at conclusions with divergent findings.

In this regard, it was therefore imperative to set a criterion for assessing the performance of the Zambian Kwacha against other major freely convertible currencies. This study therefore, aims at analysing the impact of the variations in interest yields in Zambia's Treasury Bills on the exchange rate between the United States of America Dollar (US\$) or (USA Dollar or simply “Dollar”)

against the Kwacha. For the specific use in this study, the exchange rate between the US\$ and the ZMW was shortened to US\$/ZMW. This research will also attempt to find if any correlation existed between the interest yields on Zambia's Treasury bills with the rate of exchange of the Zambian Kwacha. In doing so, this research will highlight the position of many scholars on the relationship of these two very important macro-economic factors. It will also bring out some examples from real life experiences both in developed and developing countries. The study will also show the different methodologies that any interested stakeholders can use to arrive at the best forecast before showing the results.

1.1.1 Converting Currency

Financial markets are typically characterised by converting different currencies in order to facilitate various aspects of trade, Miyajima, and Shu (2014). Currencies can be converted at using a predetermined comparative index or ratio commonly known as *exchange rate*. Based on the modified definition adapted from O'Sullivan & Steven (2003), an *exchange rate* is the price (*index* or *ratio*) that is used to change one currency to the other. For instance, the prevailing rates in the financial markets may be quoted as US\$1.00 costing ZMW 10.00 as the *exchange rate*. In this specific example, the equivalent price *index* or *ratio* will be 0.1 when converting ZMW to US\$. On the other hand, corresponding conversional ratio will be 10 when buying US\$ using ZMW as a medium of exchange.

Essentially, there are six distinct features which affect exchange rates as stated by Nicita A (2013). The study mentions *inflation, interest rates, political stability and economic performance, current account deficits, public debt* and *terms of trade* (ToTs) have the decisive determinants of the currency pricing index involving two nations.

Generally speaking, there is consensus amongst different scholars that supports a theory which proposing that inflation and the value of a particular currency are inversely related. The theory is based on the observation from countries with relatively lower values of inflation. At low levels of inflation, these countries usually have a dominant currency which in comparison to other is favoured as a medium because of the purchasing power.

As discussed above, the theory relating to inflation seemingly holds for exchange and interest rates respectively. It is commonly a practice in the financial markets for the central bank to stage-manage interest rates in a bid to counteract the effects of both inflation and exchange rates so as to preserve the integrity of the currency.

Putting other factors into context, it can be said that political stability and economic performance usually tend to affect a conscious decision that a prospective investor will make. Foreign investors and the local ones to some extent will mostly fancy an investment destination which is economically predictable and politically stable while being guaranteed of the necessary of the fiscal policies. This is because they want to be assured that their investment is safe and secure hence political and economic stability are very important factors as far as attracting private and/or Foreign Direct Investment (FDI)

These fiscal policies like private sector protection against nationalising of companies need to be anchored on other economic pillars to instil private investment confidence. A country need to be cognisance of its spending and earnings are within a dynamic equilibrium state so as to balance the current accounts. By so doing, the perceived benefits could be two fold. Firstly, the country can within reasonable limits of acceptance manage public debts which have the capacity to skyrocket the levels of inflation if they are kept huge. The end result will translate be the increased costs of servicing external debts over a period of time.

Often, a comparative analysis of export against import prices respectively, which is sometimes referred to as terms of trade, can form a basis of understanding how currency will perform in view of trade balances. Mathematically, when ToTs are in balance, they can be represented by a number equal to one (1) or simply 100 percent. From this scenario, there are two phenomena's which can be deduced. In the first scenario, it is when the ToTs value increases to more than 1 or above 100 percent. It entails that the value of the exports has increased and there is a rush for the local currency. In turn, this situation will help in pushing down the inflation levels and stabilise the exchange rates. A complete opposite picture occurs in the second incident when the ToTs value is less than 1 or falls below 100 percent.

Figure 1-1 below illustrates the trends in the performance of the ZMW against the US\$ monitored for a 20 year period between January 1996 to January 2015 respectively.



Figure 1-1: Performance of the ZMW against the US\$ over a period January 1996 to January 2015

1.1.2 Treasury Bills

A government can borrow or raise money through the issuance of T-bills. In principle, T-bills can be regarded as a form of a saving or investment on the part of the person or entity that buys the treasury bills. T-bills however, differ from other types of savings on the core of maturity period. Typically, most treasury bills issued will have a maturity period not exceeding twelve months Garbade (2008). In Zambia, the BoZ is responsible for issuing the treasury bills on behalf of the state.

The BoZ issues treasury bills at a discounted rate. A *discount rate* is the difference between the *real value* and the *apparent value* of a T-bill. As an illustration, for a particular maturity date, the *real value* can be ZMW 20, 000.00 and the *apparent value* at ZMW 19, 000.00 on the issued Treasury bill giving a *discount rate* of ZMW 1, 000.00 to the lender. For the purposes of quoting the real markets, the discount rate may be pegged as a percentage of the *real value*.

Treasury bills are auctioned to the general public and other interested parties primarily in two ways. The central bank may opt to make available the treasury bills either by way of *competitive bids* (sometimes referred as *open bidding*) or *simplified bids* (also known as *non-competitive bids*). At the moment, T-bills are available at twenty-eight (28) days, ninety-one (91) days and 182 days respectively.

Open bids require the bidders or market players to determine the *discount rates*. The auctions or bids are awarded to the bidder with the least *discount rate* (interest rate). In contrast, *simplified bids* are usually based on a weighted mean that has a form of capping related to that determined in the *competitive bids*. Discount of these bids is done at the Bank of Zambia and the bank in most cases tend to favour the relatively smaller auctions.

Figure 1-2 below presents interest yields on the 91 days and 182 days T-bills from monitored from January 1996 to January 2015.

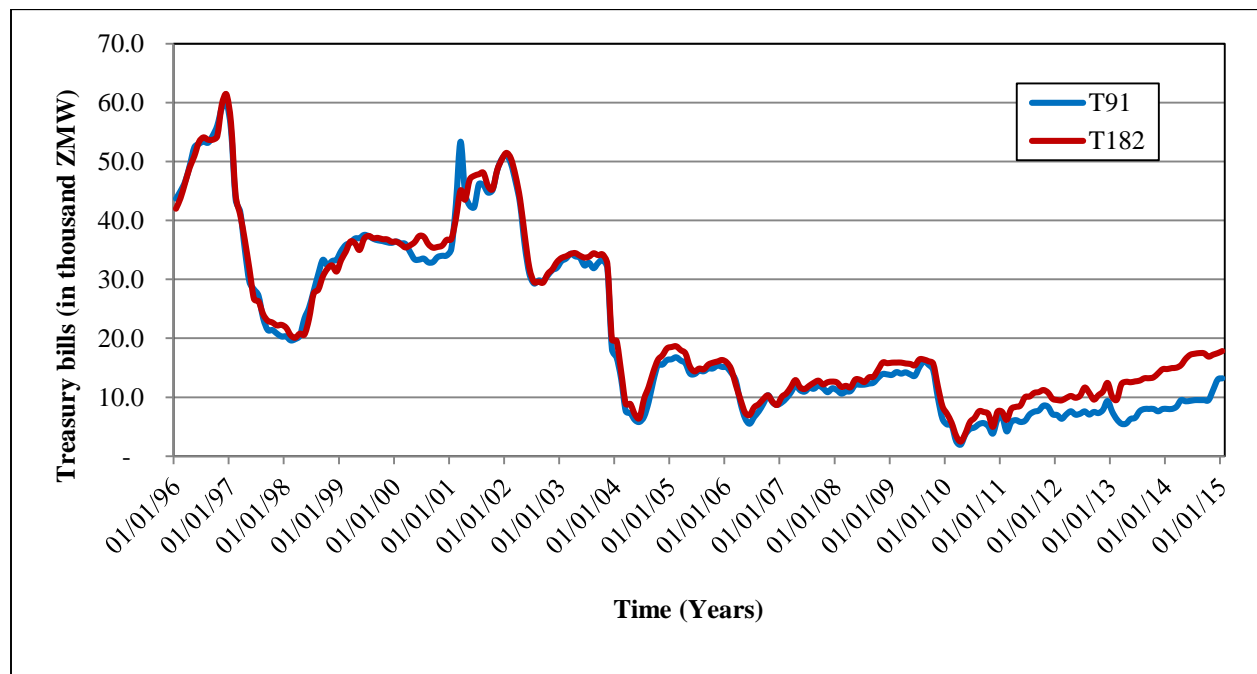


Figure 1-2: Trends in the interest yield on 91 days and 182 days treasury bills monitored between January 1996 to January 2015

1.2 Research Context: Focus on Zambia

1.2.1 Structure of the Financial Market in Zambia

Considering the significant role that underpins the financial sectors contribution to economic development, the Government of the Republic of Zambia (GRZ) enacted three different statutory bodies to regulate the financial markets. The three regulatory bodies of the GRZ are the Bank of Zambia (the "Central Bank" or "BoZ", the Securities and Exchange Commission (the "Commission" or "SEC"), and the Pensions and Insurance Authority (the "Authority" or "PIA"), Banda (2010).

The primary regulatory mandate of BoZ is derived from The Bank of Zambia Act of 1985 and revised in 1996 (The Act). Among other functions enshrined in The Act, the central bank is responsible for ensuring that players in the market are licensed to operate as commercial banks or financial institutors in order to warrant efficient operation of the financial systems¹.

To further enhance the service provision in the insurance sector, the PIA came into existence in 1996 through the promulgation of the Pension Scheme Regulation Act of 1996. From a broader perspective, the PIA's regulatory mandate involves presiding over insurance matters with regards to licensing of insurance companies, re-insurers of insurance, insurance brokers among others².

In 1995, an Act of Parliament was passed to bring into force the regulatory functions of the Commission. The principal functions of the regulation and enforcement actions involving capital markets. For the specific case of this thesis, the term capital market is broadly used to refer to stock markets, brokers, and investment banks³.

While there are discrete legal provisions which deal with the fragmented sectors of the financial sectors highlighted above, the Banking and Financial Services Act provides an overarching statute for regulating matter incidental to the financial markets⁴.

¹ The Bank of Zambia Act of 1985

² The Pension Scheme Regulation Act No. 28 of 19960

³ The Securities Act:1995 Chapter 354 Of the Laws Of *Zambia*

⁴ The Banking and Financial Services Act 2000: Chapter 387 of the Laws of Zambia

The regulatory framework for financial markets discussed thus far only precludes two statutory financial institutions from complying with its provisions Chileshe, Mbao, and Mwanza (2014). To this end, the Development Bank of Zambia operates outside the ambit of the regulatory system obtaining to other entities with similar models. Similarly, the National Savings and Credit Bank operate on the terms of a legal provision enacted for the specific purpose of its existence.

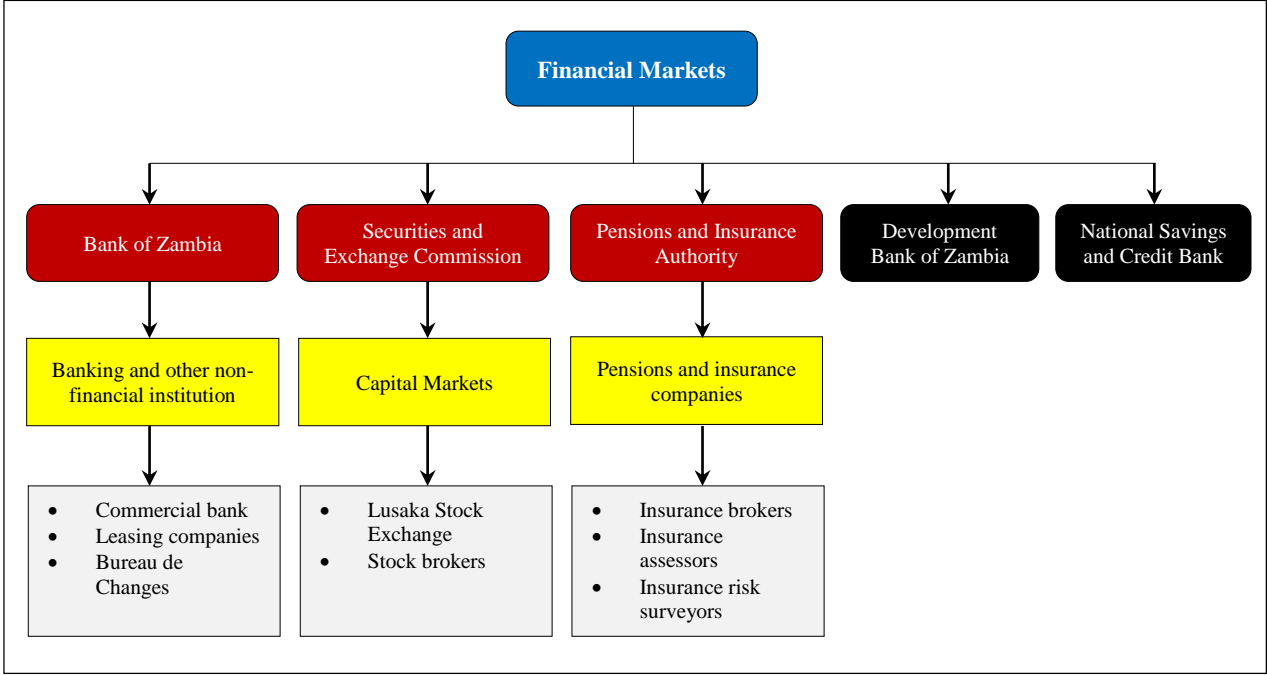


Figure 1-3: A model representation of Zambia’s financial market structure

1.2.2 Policy Transformations in Financial Sector

Since the attainment of her independence, Zambia’s economic path has undergone remarkable transformations, Brownbridge (1996). During the one-party state rule in the mid 70’s, the state embarked on an ambitious program to nationalise the industries. Nationalisation of these industries eventually gave birth to state-owned-enterprises (SoEs). Although the rationale behind these SoEs was to serve as GRZ’s Special Purpose Vehicles (SPVs) for accelerated economic development, it turned out that their performance was inefficient. In a bid to sustain a number of SoEs, the government started undertaking rigorous efforts to subsidize their operations. Over time, this move became unsustainable, the institutions could not cope with the evolution of technology and emerging economic trends.

Even though the country had experienced stiff policy reform to nationalise a number of private owned entities, some foreign owned financial institutions continued to thrive on the Zambian market. The paradox still remained as these foreign owned institutions were regarded as not servicing the welfare of the indigenous locals. Therefore, the government responded with formation of Zambia National Commercial Bank Plc (ZANACO) as part of a redress mechanism. Together with that, subsequent merging of other financial institutions brought to life the now government owned Zambia State Insurance Corporation, Brownbridge (1996).

Despite government taking the measures already drawn attention to in this section, the economic performance continued on a path of falling trajectory until the early 90's. The change of political system in 1991 to Multi-Party saw the start of another era in the history of the country. Government with the support of cooperating partners such as the International Monetary Fund initiated a new wave of economic interventions to resuscitate the economy.

The economy was once again liberalised to allow for private sector involvement and participation. Instead of restricting the entrance of new players in the financial market, government opted to provide a regulatory foresight through the central bank. As earlier alluded to, the Bank of Zambia Act was revised in order to enhance its regulatory mandate and create a favourable investment destination. Arising from these economic reforms, the country's economic performance was once again back on track for growth.

1.2.3 Restrictions on Interest Rate before Liberalisation

Before the country underwent radical economic changes in the early 90's, Zambia's financial market were a constant subject of stern regulatory approach. The central bank assumed the role of regulating the financial markets partly with a specific view to maintain the relatively low interest rates. This was a deliberate ploy by the treasury through the central bank, to ensure that all borrowings from commercial banks attracted small interest rates, Hill (2014).

During the 1980's, Hill (2014) reports that the bank deposit rates were kept below 9.0 percent. On the other hand, the markets could still cope with lending rates which stood at around 14 percent

on average. Later in the mid 1980's, the interest rates were deregulated by the central bank. Furthermore, the same period saw the introduction of the treasury bills. The introduction of a deregulated market on interest rates and the subsequent auctioning of the treasury bills at inception did not augur quiet well. As a result, there was an increase in both the inflation and lending rates which nearly doubled. The problem was further compounded by the tumbling prices of the country's major foreign exchange earner that is copper on international market.

After undertaking a due diligence of the market in light of the sharp increase in the lending rates, interventions were put in place to arrest the situation. There was shift from a decontrol back to a regulated market. In 1987 to be precise, the central bank once again started the regulation of both interest and lending rates, Brownbridge (1996).

1.3 Background on Currency Foreign Exchange Trend

A study done by Mkenda (2001) indicated that the exchange rate mechanism in Zambia was administered in two ways. In two disjoint periods ranging from 1964 all the way up to 1982 and 1987 all the way up to 1991 respectively, Zambia had a fixed exchange rate system (FiER). The authorities sustained this mechanism through a combination of adjustments and issuance of import licenses Mkenda (2001). During the period from 1983 to 1985 for instance, the local currency was kept at par value with respect to other currencies by introducing a one percent crawling mechanism, which was subsequently revised upwards to one and a half percent, as the economic conditions worsened Chiliba (2014). At the end of 1985 the Bank of Zambia commissioned a new regime which saw the birth of *floating exchange rates* (FER). The framework facilitated for the central bank to offer the buying and selling of foreign currency through various forms of bids Chipili, (2009).

Basically, FER system was introduced to allow a broader participation in the foreign exchange rate market by the commercial banks. In order to improve liquidity on the financial markets in the country, the FER system facilitated trading in foreign currency between commercial banks and the Bank of Zambia and trading was consequently increased (Chiliba, 2014).

Owing to the depressed economic conditions and the high exchange rate volatility, the Zambian monetary authorities introduced wide-ranging foreign exchange market between different banks to promote efficiency and improve liquidity through a market determined system of exchange rates as reported in (Chipili, 2009).

The coming of all-embracing foreign exchange markets was regarded as a cornerstone towards cultivating a success and increasing productivity in the financial markets, Mbululu (2013). With the introduction of IFEM, commercial banks were able to allocate counterpart limits to each other and trade foreign currencies on the interbank market, settle all local currency obligations through the central bank and trade foreign exchange with corporate and the general public. In addition, licensed agents got the right to bid as well as offer foreign currency to the general public. It is worth noting that Zambia's foreign exchange market at present happens to be among one of top fully-liberalised markets with limited restrictions when compared with other third world economies, Chiliba (2014).

1.4 Problem Statement

The developing financial market in Zambia faces the problem of uncertainty caused by volatility of financial and economic factors. For instance, the Zambian kwacha lost more than half its value against the US\$ in 2015 caused by plunging metal prices, a power (energy) crisis, a slow-down in the Chinese economy, and a widening budget deficit. A weak ZMW has significant macroeconomic and socio-political ramifications because the economy is commodity export-based while most of the commodities used by the country are imported. In addition, so as to compensate for the economic imbalances, the Zambian government increased its foreign debt from 22 percent of Gross Domestic Product (GDP) in April 2014 to 56 percent of GDP by the end of 2015 Bloomberg (2014).

In order to support the kwacha, the BoZ sold \$510 million of its foreign exchange reserves in 2015, and increased the benchmark lending rates by a record 3 percentage points to rein in inflation after the currency lost almost half its value, Bloomberg (2015). This study in consequence will examine the linkage involving the US\$ and the ZMW rates of exchange as well as the interest yields on the 91-day and 182-day treasury bills in Zambia over the period of January 1996 to January 2015, in

order to determine the extent to which interest rates can be used to manage movements in the Kwacha.

Whilst many other studies have explored the correlation regarding interest rates along with other monetary related factors have being done in Zambia, there is less literature concerning the influence of interest rates on the rates of exchange or *vice versa*. The questions expected to be addressed by the results from this study include; what will be the corresponding difference in the rate of exchange when the interest rate has been adjusted? Will the index value underlining the change remain constant? Suppose there is a change in the rates, is it inversely or directly proportional? Or does the movement in the rates have zero impact?

All these are some of the questions that not only the investors will try and get answers to but also the people who are involved in the long term planning such as development finance specialists as they plan for the future.

1.5 Study Rationale

This research aims at establishing a connection which exists for the purpose of relating exchange rates and interest earned on treasury bills in Zambia. The study will concentrate on the capital and financial markets in Zambia where the capital market side will be captured by interest yields on the 91 and 182 days' treasury bills, whilst the financial markets side will be captured by the US\$/ZMW rate of exchange over the interval spanning from January 1996 to January 2015. The need to analyse data between 1996 and 2015 will be necessitated primarily by the policy transformation which have taken place during this period on Zambia's financial markets. For instance, the removal of price capping's on rates of interests signified the desire to strengthen the markets as these are regarded as distortionary guiding principles.

1.6 Research Questions

Consistent with the rationale of the study spelt out earlier, the foremost question to be explored in this research is: *Is there a significant causality effect linking the nominal rate of exchange of the ZMW against the US\$ as well as the nominal treasury bill yields in Zambia?* The work in the dissertation will undertake a supplementary approach so as to provide an in-depth comprehension

to the key question stated. Thus far, the questions listed below will be mulled using dataset from January 1996 to January 2015:

- a) Which of the categories of treasury bills have a substantial influence on the market's rate of exchange?
- b) What is the possible underlying relationship encompassing the exchange rate and the Treasury bill rates?
- c) What type of effects do economic shocks in rate of exchange simulate in the Treasury bill yields?

1.7 Research Objectives

1.7.1 General Objective

To establish if there a significant empirical relationship between the nominal exchange rate of the Zambian Kwacha/US dollar and the nominal T-bills yield in Zambia.

1.7.2 Specific Objectives

- a) To establish the correlation matrix between interest rates on the 91 and 182 days T-bills and the Zambian kwacha/US dollar exchange rate.
- b) To establish how the appreciation/depreciation of the Zambian kwacha against the US dollar increase /decrease the yields realised on the T-bills in Zambia.
- c) To establish how to hedge currency and interest related products when trading in either the foreign currency market or the bond market in Zambia.

1.8 Importance of the Study

It is the author's considered view that a thorough understanding of causality effects involving rates of exchange and interest yields has the ability to impact positively on the country's socio-economic condition. Certain segments of the financial sector, especially lending institutions have been urging the general public to assume a culture of saving and investing, in a range of products such as

treasury bills to be specific. In spite of this, there has been a lot of inertia from the cross-section of society in adopting policy measures that seek to promote principles of saving and investing. On the whole, the apathy or unwillingness by society has been attributed to lack of tangible data to back up this kind of optimism. Against this background, this study was embarked on with a focus of generating a knowledge base capable of either supporting or neglecting such optimism. To this end, the findings from this research will add to an information resource base that is expected to be very useful to foreign investors looking forward to invest in Zambia, portfolio managers and policy makers as well as other financial market players.

2 LITERATURE REVIEW

From an overall perspective, this chapter basically discusses the reviewed published theories and research work from other reports, books among others which have investigated the behaviour of interest yields and exchange rates. The rationale is to lay a basis for conceptualising the research questions, and put into perspective the techniques for data gathering and processing,

2.1 Financial Sector Background

Both exchange rates and interest yields are dynamic variables which can demand for various theorems to be used in order to explain or manipulate the interrelationship linking the two. Although it is understood that many theories exist which attempt to tackle the problem at hand, this research will set sight on three fundamentals ones, namely:

- a) Interest rate parity (IRP);
- b) Purchasing power parity (PPP); and
- c) Uncovered interest rate parity (UIRP)

2.1.1 The IRP Theory

The IRP theory in the fields of finance and economics provides a very useful tool for understanding the current (spot rate) and the forward rate (future) of two differences. In simple terms, the word *parity* literally means *equal* or *even*. From a broad understanding, the IRP theory states that for any two countries A and B, the variance in their interest rates remains in equilibrium with the corresponding difference involving the current and future exchange rates, Taylor and Feenstra (2008). Going along with Aliber (1973), it can be said that “*the analyses of the behaviour in the foreign exchange market frequently rely on the interest rate parity theorem as the theorem relates the forward exchange rate to the money-market interest differential*”. Therefore, in any event that the theory of IRP holds, it renders null and void the prospect of arbitrage.

In two distinct foreign exchange markets, there is a possibility of realising gains in an event that there is an imbalance in the price of the similar asset. But that should not be the case in an ideal situation since efficient markets takes into account of the changes on spot rate over a specified time frame. As observed in Sikwanda (2011), there is no arbitrage in the currencies of two different countries as the gains made between the difference in the interest rates are offset by identical

adjustments in the rates of exchange at point in time when the investment period is coming to an end.

Haque (2010) came to a conclusion that the theory of uncovered interest parity can be determined using the unbiased expectations hypothesis test. To arrive at this conclusion, the researcher conducted an empirical test of a developed country, the United States against the emerging economies of countries in Asia among them Singapore, Thailand and Pakistan. For all the comparison made involving these countries, Haque (2010) also analysed a series of data set for the period 1996 to 2007 on exchange and deposit rates respectively. By assuming that the transactions costs have no negligible effect, Haque (2010) was able to predict the dependence of forward rates on future spots as well as the other way round. Mathematically, this relation can be represented according to Equation 2.1 as:

$$(1 + i_d) = \frac{R_f}{R_s}(1 + i_f) \quad 2.1$$

where i_d denotes the domestic interest rate of a country
 i_f denotes the foreign interest rate of another country
 R_f denotes the forward rate
 R_s denotes the spot rate

On the whole, the conclusion made from this study put up theory that generalised the IRP for function relating developed countries and the countries with the emerging markets or economies. A two-sample test (t -test) was used to compare if the statistical means of the two groups were statistically significant. Basically, a t -test was preferred since the data set from 1996 to the year 2007 was big enough to generate results with a high level of confidence. Clearly, the results showed a statistically significantly between the two sampled populations. Hence, they arrived at the conclusion that the IRP between a developed country like the USA and the emerging economies is a not so strong in the short term. Nonetheless, there is likelihood of the two sampled population to show some causality effect in the long run.

Hodrick and Bakaert (1993) presented a different dimension to the theory of uncovered IRP. The two scholars argued that the theory did not show statistically significant results since the potential gains in the exchange rates were offset by the high interest rates on the currency. That is to say, the results would be different if a comparison was made involving country with low interest rate and the other with high interest rates while holding the exchange rates constant. Although the conclusion by Maddala and Liu (1992) came to a similar conclusion as Hodrick and Bakaert (1993), the investigators doubted the efficiency of the financial markets of some of the developed countries including that those of Japan, Great Britain and Germany.

2.1.2 The PPP Theory

There are many studies that have attempted to explain the theory of PPP. For instance, Laurentiu (2013) conducted a study in which a proposition that states that the currencies of two countries are in a state of equilibrium if the buying power of the two currencies is the same. To borrow from this proposition, the PPP can be said to be a theory in economics which is used to normalise the variances in the exchange rates of two different currencies in order to have a uniform purchasing power of the respective country.

By taking into consideration the exchange rate of the US\$ against the ZMW, the theory of the PPP can be stated using a mathematical equation as:

$$E_{US\$/ZMW} = \frac{C_{US\$}}{C_{ZMW}} \quad 2.2$$

where $E_{US\$/ZMW}$ denotes the exchange rate of the US\$ against the ZMW

$C_{US\$}$ denotes the cost of an item in US\$

C_{ZMW} denotes the cost of an item in ZMW

Based on the representation in Equation 2.2 above, if the exchange rate for US\$ 1 is ZMW 10 at a particular time, one would expect in the ideal situation the price of a 300 ml bottle of Fanta costing ZMW 2.50 in Zambia to US\$ 0.25 in the USA. But that may not really be the situation prevailing on the ground. The cost of the bottle of Fanta may be more or less than US\$ 0.25 in the USA.

Using this method of cross-comparison, the symmetry or parity in the between exchange rates and the financial markets can be used to determine the pricing index. It is worth noting that in spite of this, the price index for purchasing power parity may not follow the trend as those quoted for both services and goods.

Drawing from the findings made in Sikwanda (2011), the theory of PPP tends to suggest that the financial assets, such as treasury bills, should be the same if the exchange rate for two different countries are put into perspective. For this theory to hold, the study adds that the observation should be made for a relatively long period of time. In this vein, if the exchange rate, say between the US\$ and the ZMW adjusts due to market forces such as inflation, then there should be a corresponding shift to reflect this adjustment in both countries. Going by the preposition of this theory, there would absolutely be no need for the global financial markets to change the currency values on condition that inflation rate was to increase uniformly. Usually, financial markets are characterised by discrepancies in the pricing models which is agitated by the demand for financial assets like treasury bills. The demand creates as well as catalysing some form of market shocks which could either be negative or positive.

Even though there has been extensive research concerning the PPP theory, it still remains a subject of contrasting pronouncements. Actually, the debate dates back to as far back as the early 1970's. According to Laurentiu (2013) the theory is not valid in any of the two circumstances, that is, short term and long term. The assertion by Laurentiu (2013) was made after analysing a decade long data sets from the 70's and 80's respectively for the exchange rates. Through the analysis of time series data, it was realised that in any efficient financial market, interest rates adjust to regulate the influence of inflation. From the empirical investigations, the PPP theory fails to hold due to other interactive barriers such as the difference in the legal frameworks for two countries which are difficult to model. Furthermore, the different countries may not necessarily be producing similar goods or delivering the same services. All in all, the prevailing economic and financial factors may not really be comparable between any two countries for a period under consideration.

Given the complexity which has risen owing to the mixed view expressed by researchers, Laurentiu (2013) proposed a hypothesis in a study to examine the validity of PPP theory. To test

this hypothesis, Laurentiu (2013) used the *nominal exchange rates* for raw data set, courtesy of the International Monetary Fund (IMF) published by its specialised division called the International Financial Statistics (IFS). The *nominal exchange rate for any given financial market* is the index at which that can used to exchange or convert two currencies.

The researcher analysed about 400 discrete data point which comprised the *nominal exchange rates* in US\$ as mean monthly values and the *weighted mean of prices* or *consumer price indices* (CPI). Dataset obtained for USA, Japan, United Kingdom (UK) and contained empirical observations for a period of slightly over three (3) decades with the initial values obtained from January 1980. On the other hand, the single market currency in the European Union commonly referred to as the Euro Zone had dataset since its inception in January 1999 to the first quarter of 2013. Table 2-1 below provides a summary of exchange rates and CPI investigated to ascertain the validity of the PPP hypothesis Laurentiu (2013).

Table 2-1: Countries used to investigate the exchange rates and consumer price index to test the hypothesis of PPP

Country	Symbol	Code	Exchange rate	CPI⁵
USA	\$	USD		<i>a</i>
Japan	¥	JPY	USD/JPY	<i>b</i>
UK	£	GBP	USD/GBP	<i>c</i>
Canada	C\$	CAD	USD/CAD	<i>d</i>
Euro Zone	€	EUR	USD/EUR	<i>e</i>

The motive behind the choice of the dataset was to capture and analyse the impacts of the Great Recession. During the period around 1980 to 1990, and 2000 to 2010, the world markets record a major decline mostly attributed to trade imbalances and uncertainties in the financial markets.

⁵ The CPI values in this case are only represented by arbitrary constants *a* to *e*

The effects of the Great Recession were then investigated using three overlapping models denoted as *full sample*, *pre-crisis sample* and *crisis sample* respectively. Table 2-2 presents an illustration for the periods used to model the three population sizes Laurentiu (2013).

Table 2-2: Illustration of sample periods used to investigate the effects of the Great Recession

Dataset identification	Sample	Period
First	full sample	January 1980 to March 2013
Second	pre-crisis sample	January 1980 to August 2008
Third	crisis sample	September 2008 to March 2013

In an effort to substantiate the argument put forward, Laurentiu (2013) provided an in-depth investigation by undertaking the following;

- a) *Real exchange rate*: An analysis of the pricing involving the local goods in relation to the foreign goods; and
- b) *The law of one price*: A scrutiny of the price index and the exchange rate to understand if there was a stationary or constant linkage.

After taking the said parameters into account, Laurentiu (2013) drew up the following inferences from the study:

- a) The first dataset which involved an analysis of the *full sample* tested the null hypothesis using the Dickey-Fuller test. The Dickey-Fuller test provides a useful for establishing if time series function is not static, and has a unit root. For all the dataset series, the Dickey-Fuller test was within the permissible significance value of 0.01 to 0.05 which was statistically significant. Within the dataset boundaries, there was the existence of both the unit roots and the exchange rates were not static. Hence, the hypothesis could not be rejected and the conclusion was made that the PPP theory was valid for the *full sample*.
- b) In the case of the second dataset were emphasis was on the *pre-crisis sample*, the results obtained were quiet alike to those obtained in the *full sample*. After subjecting the dataset to the Dickey-Fuller test, the results were statistically significant falling within the

maximum range of 5% significance value. For this reason, the same conclusion which drawn in the first dataset was true in the second dataset as well.

- c) When the third dataset was analysed, the results showed that the significance value was outside the range for the Great Britain Pound (GBP). On the contrary, the result was spastically significant for the Japanese Yen and the single currency in the Euro Zone. Based on these contrasting results, the null hypothesis was rejected for the Japanese Yen and the Euro Zone but accepted for the GBP. It can therefore be concluded that the theory of PPP was not valid for the GBP during the crisis, and the opposite was true for the Japanese Yen and the Euro Zone over the period. When all is said and done, the logical conclusion was that the Great Recession did not affect all the countries uniformly and the recovery transitions were not homogenous.

The results from this study reaffirms that the debate surrounding the PPP theory amongst the many researches cannot conclusively be dealt with by merely basing the findings the two conventional approaches only. There is no sufficient basis from the understanding above to ratify the hypothesis suggesting that relative prices and *nominal exchange rate* demonstrate a mutual trend thereby making the real exchange rate an average degenerating static process. That's why, variations credited to short-lived monetary shocks, usually transform into real exchange rate irregularities. Because the price of local goods against foreign goods is an amalgamation of both exchange rates and price levels, any short-lived monetary shocks experienced in the financial markets can have an effect on the nominal exchange, and subsequently impact on the real exchange rate owing to the resistance of the prices.

A study done by (Coakley, Flood, Fuertes, and Taylor, 2005) conducted an investigation of the PPP and the theory of general relativity. In this publication, the authors made a sweeping statement regarding the notion of long-run relative purchasing power parity. This study analysed the prediction of inflation rates for any two given countries in relation the dynamics in the exchange rates within the prescribed boundary conditions. In other words, the changes in the exchange rates of two currencies should correspond to the changes in the price level. Then, they natured an approach for testing the theory of general relativity of purchasing power parity using a regression structure that was rigorous to the country's diversity. A transversal review of the dependence of

both enduring and short-lived shocks to the real exchange rate was equally made. Along these lines, the researchers permitted for the variable aspects of the real rate of exchange to shift into equilibrium at the same time, still testing for a varying attributes of which is responsive to the shift in prices.

The Monte Carlo simulation was used as a test method to predict the uncertainty and error. In this case, the error and uncertainty terms applied to stationary and non-stationary for the recurrent observations or panel estimators. The observation stemmed from the dataset of close to three decades with the inception set in 1970. Dataset comprising the producer price index (CPI) and CPI was obtained from nineteen member states of the Organisations for Economic Cooperation and Development (OECD) and the other was for twenty-six (26) selected third world countries.

Out of the discussion from the above (Coakley, Flood, Fuertes, and Taylor, (2005) was able to able to draw the inference that inflation variances are replicated on a singularity basis in nominal exchange rate decline on the mean in the prolonged period of time. Once again, Coakley, Flood, Fuertes, and Taylor (2005) advanced hypothesis which postulated that there a number of unobserved dynamic factors may be which could be responsible for the variations of the real exchange rate other than the real prices as the PPP is concerned.

2.1.3 The UIRP Theory

The UIRP theory states that for any two arbitrary countries A and B, the variance in interest rates involving A and B is the same as the anticipated adjustment in exchange rates between the currencies of A and B Flood and Taylor (1996). In the absence of this parity on the financial market, there is a potential of making a profit through arbitrage. UIRP in some instances has been referred to by other scholars as the Expectation Theory. It is called the Expectation Theory because the difference in the interest rates of two nations is expected to be of the same magnitude in the alteration in the exchange rates of the same countries, Aliber (1973).

If a comparison is made between the anticipated adjustments in the nominal interest rate against the nominal exchange rate for any two countries, the UIRP theory postulates that there should be a corresponding adjustment should be directly proportional. That is the trend should either shift in

the positive direction for both nominal interest rate and the nominal exchange rate and vice versa. Since the two variables are expected to simultaneously change, the rate of change can be analysed using regression techniques. For this particular case, it can be deduced from the hypothesis that that the gradient of the regression line at an instantaneous point drawn by taking the exchange rate against the interest rate should be equal to one.

The observations made this far gets to an interesting phenomenon concerning the PPP and the UIRP. There is a divergent conclusion in what is postulated in the theories of UIRP and PPP respectively. A study conducted by Chinn and Meredith (2004) dispels the need for an investor to shift the business from an apparently low interest rate to the one with seemingly higher rates since the difference is taken care of in the interest rates. The explanation presented so far is true for the PPP theory. However, the theory of UIRP demonstrates that for a country with higher interest rates there is a tendency for the currency to depreciate which could result in the possibility of arbitrage.

Using dataset for New Zealand and Australia, Bayoumi and Bui (2010) made an investigation through an empirical analysis of the uncovered interest rate parity model. Instead of using the ordinary least squares (OLS) method to estimate the omitted premiums, Bayoumi and Bui (2010) opted for a Generalized Method of Moments (GMM). The underlying principle was that the OLS method typically produced inconsistent and biased estimates which in contrast were corrected in the GMM.

Two currencies for Australia and New Zealand were investigated using the UIRP model against the US\$ for risk premium for the essential economic variables. In this case, the Australia currency is denoted as AS\$ (Australia Dollar) whereas the one for New Zealand is NZ\$ (New Zealand Dollar). The exchange rate between the AS\$ and the US\$ can simply be stated as AS\$/US\$. Similarly, the conversion between NZ\$ and US\$ can be shortened to NZ\$/US\$. By using time series dataset from January 1985 to December 2009 with a monthly time step Bayoumi and Bui (2010) was able to define the exchange rates for the respective currencies. The Reserve Bank of Australia (RBA) and Reserve Bank of Australia (RBA) were the primary source of dataset on spot exchange rates. Dataset on forward exchange rates was accessed on the courtesy of Thomson Reuters Data. In order to investigate the sensitivity of the UIRP model to maturity interest rates,

the researchers made use of bank consented bills of three (3) months (90-days) and six (6) months (180-days) as a basis for validation. As earlier alluded to, data for interest rates for this study was made available by the RBNZ and the RBA. Thomson Reuters Data together with the Federal Reserve Bank of St. Louis were the primary sources of data on consented bills for American Bank. Owing to the accessibility of data on American consented bills, the short-term phase was taking to a period from January 1985 to September 2005. The analysis further incorporated Government treasury bills for two (2) years, five (5) years and ten (10) years respectively.

There was convincing evidence for the results obtained for the two countries, that is, New Zealand and Australia, which indicated a negative relationship between exchange rate depreciation and interest rate differentials in the short-run. The value of the regression coefficients was around - 0.90 on average. This value is within the limits that similar to values obtained in other studies. For interest rate differentials coefficients, values which are obtained are typically closer to zero. In the particular case of Australia, there was no empirical business to reject the null hypothesis. The unit value obtained was not statistically significant which suggested that the null hypothesis was valid. The inference drawn from this study was consistent with the finding made in Chinn and Meredith (2004),Richard and Froot (1990) in which the scholars could not reject null hypothesis of equal to unity since the probability value was not statistically significant. These results tend to demonstrate that the UIRP is more reliable a theory for observations made over a much longer period as opposed to shorter ones.

Just at the beginning of the twenty first century, Alexius (2001) used the long-term government security yields to investigate the UIRP. It is worth noting that there is a component of measurement uncertainty from coupon payments. This uncertainty arises from the difference involving the true returns and the observed data. To negate the effect of the uncertainty term, a number of proxies for the true returns were put together. The findings from this study were somewhat at variance with the common expectation as it held the UIRP true. This study by Alexius (2001) was done by selecting thirteen (13) countries from the OECD including the USA. The sample period was the first quarter of 1957 to the fourth quarter of 1997. Data was found to have two problems which were that maturities for the bonds were not exactly specified, they were vague a situation resulted in measurement errors between the observed and actual period for investments as well as between

the observed and actual return on investment (ROI). This error of lack of exact information is dependent on the slope of the yield curve at long term maturities for the error gets smaller as the relevant segments of the yield curve gets flatter. This error was not as big as initially feared, because for instance, expected future events between a fifteen years' maturity bond and Sixteen years' maturity bond will determine the difference between these two types of bonds. So it is therefore logical that if a fifteen years' maturity bond is mistaken for a sixteen years' maturity bond, the error committed is quite very small, and the flatter this segment of the yield curve will be. The error committed is considered to be quite very small because the financial markets would usually only have limited access to information on future events thus far. It would be unwise on the other hand to expect all the countries during the sample period to have flat relevant segment of the yield curves.

Coupon payments on long-term government bonds was considered as the second source of measurement error. Removing the effects of coupon payments can be done through the use of various methods though only crude techniques could be considered for a lot of information concerning yield curves in the various periods of time was unavailable, and sophisticated methods require a lot of information on the same.

Dalhquist and Svensson (1996) did a study where they came up with different suggestions on capturing discount bond yields from data concerning coupon bonds. The initial examinations on the UIP tests did not consider the coupon payments presence but were only based on the original time-series data on bond yields up to bond maturity. This is only considered to be correct if the bonds are traded at par and the yield curves are flat. Two additional methods concerning the issue of bond coupon payments were examined since the assumptions that the bonds are traded at par and the yield curves are flat were mostly very unlikely to be fulfilled. The approximate coupon payments values were subtracted from coupon bond prices using zero coupon bond yields during a second set of UIP tests. Further, coupon payments were discounted using the relevant interest rates and available information/observations was used to construct yield curves during the same second set of the UIP tests. In the third set of the UIP tests, what was exclusively considered was duration. It was assumed that length of the investment, rather than the prices of the bonds affects coupon payments since the actual length of the investment is reduced by the fact that coupon

payments are made before the principal payment. The maturity period of a bond is an adjusted measure of the investment, supposed to take into consideration coupon payments presence.

It was found from this study that in three-quarters of the cases, UIP cannot be rejected. Ten out of Thirteen Ordinary Least Squares (OLS) estimates of beta were found to be significant and positive at the same time. Further, the estimated parameters were found to be larger as compared to the other/previous UIP tests in other studies by various scholars. Systematic errors were only noticed in Two of the all the Thirteen regressions. Compared to other UIP tests, the OLS and the IV findings seemed to be more consequential in this study. Consequently, the robust IV estimates were made the basis for the conclusions. The impression generally is that; it is less favourable to UIP when the IV results are focussed on rather than the OSL results. One-point estimate was found significant out of the Three which were negative. In terms of the UIP tests, the IV results coincided with those of the OLS. In Seven of the Thirteen cases which were considered in the hypothesis that the regression coefficient b is equal to One was not accepted, hence UIP seemed to hold more often than not.

2.2 Review of Empirical Research

This section is divided into two parts; the first part reviews studies that support the notion that there is a significant relation between interest yields and exchange rates while the second part reviews studies that support the notion that there is no relation between these two financial/economic variables.

In contrast to evidence presented by most of the UIP tests, most of the empirical findings from various studies carried out by various academic scholars review that countries which offer high nominal interest rates witness appreciation of their local currencies, Alexius (2001).

Chinn and Meredith (2005) did a study in which they tested the validity of the UIP theory based on long-term bonds investment looking at currencies from different countries, considering interest coupon payments and bonds with different maturity periods, found that the coefficient of causality between different currencies and interest yields is significantly smaller than one and positive at the same time, Chinn and Meredith (2005). The hypothesis tested in this study was that interest rate differentials are unbiased predictors of expected foreign exchange rates fluctuations by

considering US, Germany, Japan and Canada's yields on bonds with maturities which are long-term in nature. According to this study by Chinn and Meredith, despite the relationship being very small (less than one) a significant relationship does exist, which can get larger if advanced analytical techniques are employed, which may even result in the value increasing to close to one. Further findings show long-horizon regressions were found to be more positive-the coefficients on rate of interest differentials were also found to have the correct sign, and three quarters of them were found to be very close to the expected more than zero in terms of the value of the unity. Sikwanda (2011) also affirms that the results are robust to using various data frequencies, base currencies, different periods for sample and interest yield definitions, Sikwanda (2011).

Another study which concluded that indeed there is a relationship between the exchange rate and various other economic fundamentals like rate of interest, inflation rate, GDP and others was done by Flood and Taylor (1996). However, Flood and Taylor (1996) noted that for this relationship to be conclusive, consideration of the maturity period for the investment (especially in securities such as bonds) is very important. This is because short-term fluctuations in foreign exchange rates seem to be affected by other low explanatory fundamentals due to 'noise', when advanced econometric techniques such as co-integration are used for data analysis, results usually show that long-term investments prove that there is a relationship between the exchange rates and other economic fundamentals such as the interest rate, Flood and Taylor (1996).

Brown (1990), Blundell-Wignall and Browne (1991), did a study in which they used real interest and foreign exchange rates instead of the nominal rates and found that there is a relationship between exchange rates and interest rates. In this study, Blundell-Wignall and Browne included the relevant countries' differences in the share of the cumulated current account in relation to the countries' GNP. However, results from these studies by Brown (1990), Blundell-Wignall and Browne (1991) are limited to the mark/dollar exchange rates only, are as a result of extending the period for the sample and making use of very recent data on exchange and interest rates.

Coughlin and Koedijk (1990) did a study in which they tried to find out the determinants of the long term foreign exchange rates and found that there a relationship between the real exchange rate and the long-term real interest differentials for West Germany and the United States of

America. The main objective of this research was trying to establish theoretical approaches to what determines the long-term real exchange rates. Variables that were identified through the use of numerous approaches were tested for their relationships to the changing values of the real exchange rates. Among the real exchanges that were examined are those for the United Kingdom, West Germany, Japan, and the United States of America. The data set used approximately covered the same period of time for all the involved countries, and a straightforward clear picture that exchange rates movements are determined by real interest differentials was presented. The findings from this study disputed findings from studies done by other scholars such as Campbell and Clarida (1987) and Meese and Rogoff (1988) whose studies failed to establish any relationship between the exchange rates and interest yields. Though the findings from this research are not very conclusive because for instance, the findings only show that the relationship between exchange rates and interest differentials only existed between U.S.A and Germany, whilst no relationship was found to exist between other countries like UK/West Germany and West Germany/Japan. Further, it was shown through use of advanced analysis of co-integration that the residuals were non-stationary and therefore not related under long-term conditions, Sikwanda, (2011).

The next section will now review studies that have not found or established relationship between the exchange rate and interest rates. It's imperative to note that many earlier studies which modelled exchange rate fluctuations as a function of the real rate of interest differentials and various other financial and economic fundamentals, found statistically significant coefficients on real interest differentials. On the other hand, recent studies have not found a long-run relationship between exchange rates and interest differentials, especially after making use of sophisticated empirical techniques as tools of analysis.

Edison and Pauls (1992) did a study to re-examine the link between real exchange rates and real interest differentials making use of co-integration analysis and error-correction models. Quarterly observations for 1974-1990 was the data used in this research. Exchange rates considered in this study were the Federal Reserve Board staff's trade-weighted value of the U.S. dollar against the other G-10 currencies, and the Japanese yen, German mark, British pound sterling, and Canadian dollar against the U.S. dollar. Ten-year constant maturity rate on treasury bonds as well as yields

on government bonds for the foreign G-10 countries were the nominal interest rates considered in this study. CPIs was used for measuring prices. Adjusting the nominal value of the dollar by the ratio of the United States Dollar to the international CPI was the method used to come up with the weighted average dollar value in real terms. Assuming that the cumulated current accounts of the various countries involved in this study were in balance as of 1972.Q4 was the approach used to create cumulated current account balances, the current accounts were therefore accumulated as of 1973: Q1.

Edison and Pauls (1992) found that real interest rates and real interest differentials are non-stationary, but again not co-integrated against each other. Further, the indication by the dynamic models that exchange rates and interest rate differentials might be related could not be verified or concluded. They used unit root tests to examine the statistical properties of the data, but results showed that they could not reject the null hypothesis of a unit root for real exchange rates, real interest rates, and most of their measures of expected inflation as well as other economic fundamentals. Next test they carried out was to examine long-run implications of the model for the co-integration of real exchange rates and real interest rates but still similarly to studies by other scholars like Meese-Rogoff, Edison and Pauls failed to find any long-run relationship between real exchange rates and real interest rates. The Engle-Granger co-integration tests were then employed and used to carry out tests over the entire period for the sample, and tests were expanded so as other variables such as the cumulated current account balance could be allowed for they thought that these other variables could be affecting the possible expected long-run real exchange rates, but still no evidence of co-integration between these two variables (exchange rates and interest differentials) was found. This study concludes that empirical evidence to support that there is a systematic relationship between exchange rates and interest differentials is not enough, and these findings are robust across foreign exchange rates, maturity periods, and measures of expected inflation as well as other economic fundamentals.

Meese and Rogoff (1988) did a study to investigate the empirical relationship between major currency real exchange rates and real interest rates covering the modern (post March 1973) and found no significant relationship between exchange rates and long-term interest rate differentials.

In this study, the variables used were the real and exchange rates and they conducted it through the examination of the relationship between real foreign exchange rates and real interest rate differentials for Japan, Germany, United Kingdom and the United States of America. Among the exchange rates examined in this study included: US Dollar/GBP Sterling, US Dollar/Japanese Yen and US Dollar/German Mark. Meese and Rogoff (1988) considered both out-of-sample and in-sample tests in this study. Meese and Rogoff (1988) found very little evidence to conclude that there is a stable relationship between real interest rates and real exchange rates, findings which contradict theories on the joint hypothesis which asserts that home/domestic prices are sticky and monetary disturbances are predominant. From the findings in this study, it may be concluded that real disturbances and shocks in the economy like productivity shocks could be the major source of fluctuations in the foreign rates or simply put, exchange rate volatility, because this is one of the hypothesis that was consistent with their findings in this research. The two major findings from this study by Meese and Rogoff (1988) were that; to begin with, there was no indication of a strong correlation between real interest rate differentials (both short-term and long-term) and real exchange rates, as indicated by the data. These findings contradict predictions by most, financial, monetary and portfolio balance models of exchange rate determination, though if aggregate disturbances are primarily real in nature (i.e. changes in productivity etc.), the conflict can be substantially reconciled. Further, the correlation is not stable enough to be statistically significant, despite some signs of the estimated exchange rate-interest rate differential relationship being consistent with the possible predominance of financial market disturbances in most cases, Meese and Rogoff (1988).

Secondly, the findings from this study by Meese and Rogoff (1988) further show that real exchange rates and long-term real interest differentials do not seem to be linearly co-integrated, despite some signs of a unit root in both real exchange rates and long-term (but not short-term) real interest differentials.

Campbell and Clarida (1987) did a study to examine if exchange fluctuations can be explained by movements in real interest rate differentials but discovered that much of the movements in the US Dollar's real exchange rate cannot be accounted for by the size of Campbell and Clarida's innovation variance, and also that the expected real interest differentials have not been persistent enough to conclude that exchange fluctuations are influenced by movements in the real interest

rate differentials. The results from this study are consistent with those from the studies by other scholars such as Meese and Rogoff (1988) who failed to reject the null hypothesis of non-co integration between real long-term interest rate differentials and real exchange rates after testing for co-integration, Sikwanda (2011). Campbell and Clarida (1987) further suggested that the results from their study may indicate that the omission of a variable like the expected value of some future real exchange rate from the relationship, may have a huge variance which, if included, would lead to finding co-integration, Sikwanda (2011).

2.1 Exchange rates and Yield Curves

According to Pylypczak (2014), the yield curve is a curve that is used to show or display different yields or rates of interest across different maturities for a similar debt instrument, Pylypczak, (2014). Pylypczak (2014) further asserts that, *"the curve shows the relation between the (level of) interest rate (or cost of borrowing) and the time to maturity, known as the "term", of the debt for a given borrower in a given currency"*, Pylypczak (2014). Future exchange rates can be predicted through the use of yield curves.

A study to find out if at all changes in exchange rate at different times horizons can be influenced or explained by the rate of interest rates derived from the yield curve was done by Yung (2014). The model employed in this study was the dynamic term structure. In this study, exchange rates are modelled as the ratio of two countries' stochastic discount factors. The advantage of this model or framework is that, it can be estimated by maximum likelihood because factors are easily observable. Results from this study find that half of the changes in one-year rates of exchange, and also up to ninety percent of five-year movements, for free-floating currencies from 1999 to 2014 can be explained through the use of interest rate factors, suggesting that yield curves indeed contain a lot of vital information for modelling exchange rate dynamics, especially for longer time horizons, Yung (2014). Yung (2014) was motivated to carry out this study because it had been observed that a few common factors affect most of the changes in asset prices. Yung (2014) further argues that, *"investors deciding how to allocate their wealth consider portfolios with different risk profiles, assets with various time horizons, and investment opportunities in different countries"*,

Yung (2014). A unique pricing mechanism model that can be used to predict prices for various financial assets like debt instruments, the rate of exchange and others, considering the limited amount of data available on the market, was thought of. In this research, it was examined whether movements in the foreign exchange rates over various time horizons can be explained from interest rates observed from yield curves. A total of 181 observations of monthly interest rate data from January 1999 to January 2014 were considered. This data was accessed from Bloomberg, L.P. 2014. The covered period of January 1999 to January 2014 was considered because it covers the period the Euro was created, it witnessed increase in the relevance of the prices for assets, the period witnessed drastic changes in the behaviour of interest rates and the period covers the period for some of the global financial crises, like the 2008 global financial crisis.

The data consisted maturities of 3 and 6 months as well as 1 to 10 years for Australia, Canada, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States. All of these countries have free-floating currencies. The interest yields were in the form of percentage points, expressed in the local currencies, monthly and on an annual basis.

In conformity with the findings by other scholars like Mark (2014), on the subject of the use of yield curves in predicting movements in interest rates, Yung and Koch (2014) found that interest rate factors can be used to model exchange rates, especially at time horizons which are longer.

The results from this study by Yung and Koch (2014) suggest that interest rate factors are indeed helpful in modelling exchange rates, particularly at longer horizons. Yung and Koch (2014) further asserts that, *“interest rate factors, level, slope, and curvature, can explain half of the variation in one-year exchange rates for countries with free-floating currencies from 1999 to 2014: Australia, Canada, Japan, Norway, Sweden, Switzerland, and the U.K., with respect to the U.S. dollar”*, Yung and Koch (2014). Furthermore, the results showed that as the time horizons increases, the fit of the model increases as well, implying that yield curve factors capture expected long term movements in the exchange rates.

One of the limitations in the literature on the subject of using yield curves to predict movements in the interest rates is that a clear link between interest rate factors and the macro-economic

fundamentals, like the curvature factors has not been established Yung and Koch (2014) has however presented in his research evidence suggesting that yield curves can indeed be used to predict movements in the interest rates, despite the curvature factors explaining a small fraction of yield curve fluctuations. Yung and Koch (2014) further notes that, *when using fewer factors, either the level or the level and slope, the explanatory power of the model decreases, suggesting that the curvature factor is important in explaining exchange rate fluctuations for most currencies in the sample, key implication of the model is that a risk premium, nonlinear in the interest rate factors, drives most of the variation in exchange rates*", Yung and Koch (2014).

A high degree of uncertainty on how exchange rates react with movements in expectations, especially for out of sample still exists despite the availability of a lot of literature dedicated to modelling movements in exchange rates. Driven by the idea that uncommon stochastic discount factors are required to account for pricing of various assets, equities are incorporated as an extension version to the research by Yung and Koch (2014)). Considering the fact, the very stochastic discount factors are responsible for the pricings of securities in the foreign exchange and bond markets, prices in the securities markets need to be priced by the same as well. According to (Fama & French, 1988), *"similarly to exchange rates, the equity returns literature also finds a long-run 24-month predictable component in stock returns: the price-dividend ratio which is a characteristic observed in other assets as well"*, Fama and French (1988).

The fact that the stochastic discount factor can't be derived from within a general equilibrium framework as far as preferences for consumption are concerned is still a huge challenge currently faced by the literature in this area. In view of the same, Fama and French (1988) suggest that, *integrating term structure models into a preference-based framework is of interest not only to academics seeking to understand the theoretical connections of asset pricing dynamics, but also to monetary policy makers, bond investors, and other financial market participants concerned with fluctuations in asset prices from a general equilibrium perspective*, (Fama & French, 1988).

Sang and Tech (2009) did a study in which it was showed that future rates of exchange fluctuations as well as excess currency returns One to Twenty-Four months ahead can easily be predicted through the use of the Nelson-Siegel factors which are extracted from relative yield curves from

two different countries. According to Sang and Tech (2009), "*when the home yield curve becomes steeper relative to the foreign one, over the subsequent months, the home currency tends to depreciate and its excess return - currency returns net of interest differentials - declines* (Sang & Tech, 2009). In this study, it was found that the home currency tends to appreciate in value with the increase in the curvature for the yield curve, or simply put, when the domestic yield curve shifts upwards, though the curvature is not as robust. Further findings include that the rate of exchange can be forecasted out-of-sample at least 1 to 2 months ahead better than a random walk, jointly using the relative factors because of the well-known macro-economic interpretations and ability to capture expected dynamics of various economic activities by the Nelson Siegel model. The findings by Sang and Tech (2009), suggest that the currency risk premia largely depends on the country's economic status such as expected output, inflation rate, GDP and other macro-economic fundamentals, hence providing a lot of support to the asset pricing model of the rate of exchange determination.

2.2 Central Bank Sterilization and Exchange Rates

Most of the studies on central bank interventions and its effects on the foreign exchange markets has concentrated on the impact of the interventions on the FX spot, and research findings from various developing countries on the subject has produced mixed findings.

Studies done by various scholars like Menkhoff (2012) and Ostry (2012) assert that central bank interventions have both managed to address exchange rate volatility issues and having a systematic impact on the movements in the exchange rate as well.

Central bank interventions usually only work or achieve the intended purpose when these interventions are consistent with economic/monetary policy, and appear not to be effective if they are carried out for merely manipulating the foreign exchange rates, Amato, Filardo, Galati, Peter, and Zhu (2005) and Kamil (2008). For this reason, results differ depending on the instruments used for interventions and the period they are carried out. According to Calvo (1993), "*sterilization may lead to an increase in domestic nominal and real interest rates, lower aggregate demand, and mitigate the appreciation of the real exchange rate*". From this, it is clear that central bank

sterilization has an effect on exchange rates and interest yields on instruments such as treasury bills.

A study on the operations of foreign exchange markets in Latin America was conducted in 2012, and this research was sponsored by the BIS Consultative Council for the Americas (CCA). Participation came from central banks of Latin American countries like Brazil, Chile, Colombia, Mexico and Peru. The main objective of this study was to find out the effect of central bank interventions on the foreign exchange rates of these countries. Among the various findings include: (Moreno, 2013) *“found that foreign exchange intervention can affect exchange rate returns and volatility, although the effects may be transitory”*. Echavarría (2013) found that, *“in Colombia, the exchange rate responds differently to discretionary intervention and intervention following pre-announced rules”*. In the context of Peru, Lahura and Vega (2013) *“found that central bank sales of foreign exchange have a larger impact on the exchange rate than purchases”*. (Kohlscheen, 2013) argues that; *“in Brazil, foreign exchange intervention reduces the impact of order flows on exchange rate returns”*. According to Pincheira (2013), *“intervention in Chile used to have a substantial (but transitory) impact on inflation expectations but not any longer”*. In the case of Mexico, García-Verdú and Zerecero (2013) *“found that the impact of foreign exchange auctions on market liquidity and conditions depends on the procedure of these auctions”*.

It is generally believed that (according to available literature) that central bank foreign exchange interventions may have a larger effect in developing countries like those of the Sub-Saharan Africa than they do on developed/industries countries like most of the European and North American countries. Because the level of substitutability between domestic and foreign assets is considered to be lower in developing countries, portfolio balance channel tends to be stronger in these countries (developing countries). Further, according to (Kriljenko, 2003) in developing countries, central banks appear to have easy access to information as compared to other market participants because of their regulatory powers over the operations of financial institutions in their countries.

Sarno and Taylor (2001) and Menkhoff (2012) further asserts that, *“non-sterilization of intervention can strengthen the impact of intervention, as observed, and the signalling or*

expectations channel, through which sterilised intervention affects market expectations about future fundamentals, is likely to be weaker in EMEs because policy credibility may be lower”.

2.3 FX Risk and Interest Rates Yield

A country’s risk profile is partly determined by that country’s currency volatility which is also referred to as the exchange rate risk, Sikwanda (2011). The volatility comes up through the movements in prices between two different currencies. According to Hauser and Levy (1991), “*the correlations between returns of bonds and foreign exchange rates are significantly lower for longer-maturity bonds than for shorter ones; the rates of change of exchange rates are more volatile than those of bond prices; and the variance of return of non-dollar-denominated bonds are primarily due to exchange-rate risk*”, Hauser and Levy (1991).

The management of exchange rate risk can be important for developing countries home currency government securities such as treasury bills and government bonds, this is because foreign investors are always exposed to foreign exchange risk on their investments, for expected movements in the exchange can affect yields on their investments in treasury bills and government bonds. In addition, risk of default on sovereign bonds is increased by huge currency mismatches in corporate, banking or household sector balance sheets by developing countries governments.

Gadanecz et al (2014) carried out a study on how exchange risk affects yields on government securities such as treasury bills and government bonds in developing countries. In this study, exchange rate expectations and uncertainty around them, as measured by volatility were accounted for. In the analysis, it was discovered that foreign investors require high yields as compensation for holding developing countries local currency government bonds with high exchange rate volatility. When it was discovered in May 2013 that the US Federal Reserve Bank would reduce the volume of its financial assets purchases sooner than all the other financial players expected, high level attention was suddenly given to the exchange rate volatility. Gadanecz, Miyajima, and Shu (2014). According to Gadanecz, Miyajima, and Shu (2014), “exchange rate risk is a key determinant of EME local currency sovereign bond yields, and it could rise due to both domestic and international factors and amplify the negative impact of these factors on bond yields. For

example, exchange rate instability and weakening of the local currency for developing countries can be caused by reduced economic development or increase in the fiscal deficit, situations that can result in reduced investments in the sovereign bonds of these countries or foreign investors investing in the sovereign bonds of these countries demanding increased yields on the securities in order to compensate for the increased risk they are running. This same situation can be experienced due to adverse shocks in the international financial markets, similarly resulting in demand for increased risk premium in order to cover for the increased expected default risk as well as increased uncertainty in the movements of the exchange rates. The findings from this study are in support with the findings in the literature from studies carried out by other scholars related to the importance of local and international determinants of developing countries home currency government bond yields. In accordance with these literature, individual country financial factors like short-term rates of interest and positive or negative fiscal balances are the major influencers of developing countries' home currency government bonds yields, but again also noting that international financial conditions, like the 2008 financial crisis do have an effect on home currency bond yields. Gadanecz, Miyajima, and Shu (2014) further asserts that, *“the significant easing in monetary policy in advanced economies has prompted investors to search for higher yields probably reflecting growing foreign participation in EME domestic bond markets, and local currency bond yields in EMEs have since been moving more closely with the US long-term yields.*

Detailed examination of the effects of exchange rate hedging for domestic currency government bond yields can be very important for studies to be conducted in future. In view of the same, McCauley (2014) argues that, *“such hedging conducted in forward markets, particularly offshore, has implications for local currency bond yields, and when exchange rate exposure is hedged less – owing for instance to a less flexible exchange rate regime – the impact of exchange rate volatility on local currency bond yields could be larger”.*

Other related studies on interest rate yields and exchange rate risk include: Gale and Orszag (2003) who did a study and found that increased government bond yields are synonymous with weak fiscal balance positions. Miyajima et al (2014) finds that stability of government bond yields is usually enhanced with increased credibility in the formulation, implantation and management of economic policies such as monetary and fiscal policies. Peiris (2010) finds that in developing

countries, fiscal position (whether positive or negative) do have a huge effect on the domestic currency government bond yields in most developing countries, larger than monetary aggregates and various activities taking place in the economy. Baldacci and Kumar (2010) findings supports the hypothesis of the importance of the local economic conditions in the determining of the domestic currency government bond yields in both developing and developed countries. Finally, Piljak (2013) argues that, *“domestic macroeconomic factors, particularly monetary policy and inflation, are more important than global factors for domestic government bond markets in EMEs”*.

2.4 Studies on the relationship between exchange rates and interest yields in Zambia

To the author’s best knowledge, research on this topic in Zambia is non-existent. Most of the studies have analysed the effect of movements in the Fx rates on other economic variables like GDP, Inflation, Consumer Price Index (CIP) and others. (Chiliba, 2014) did a study to re-examine the hypothesis of exchange rate overshooting and the US\$/ZMW long-run equilibrium relationship. In this study, they considered the monthly nominal US\$/ZMW and other economic variables, including interest rates covering period from January 2000 to December 2012. According to findings from this study by (Chiliba, 2014), no evidence of exchange rate overshooting was found and no relationship was found to exist between exchange rate and other economic variables like interest rates. The method used in this study was the Autoregressive Distributed Lag (ARDL).

Moono (2010) adopted an eclectic approach to testing the PPP between Zambia and South Africa from January 1992 to November 2009 (period covered was for floating exchange rates). In this research, "they subjected the PPP hypothesis to various econometric tests ranging from ordinary least squares estimation to testing a Co-integration relationship between the exchange rate and the ratio of prices". The source of data used in this research was the Bank of Zambia, the International Monetary Fund (IMF) International Financial Statistics and South Africa's central bank-the Reserve Bank of South Africa. In this research, the domestic and foreign price levels were represented by the Consumer Price Indices (CPI) for Zambia and the Republic of South Africa respectively. CPI was considered because according to Tshipinare (2006) a consumer price index

represents the cost of a representative bundle of goods overtime relative to some arbitrary base year.

Despite noting the biases in the use of CPIs created due to components of domestic services and other items which are not tradable like prices for housing, Moono (2010) still used the CPI because data for CPI is easy to collect even in developing countries where data collecting and reporting is a big challenge. For instance, they easily found data for Industrial Production (Producer Price Index) for South Africa but found it completely difficult to find the same data for Zambia. The second reason they used CPI despite the biases was that, changes in prices for goods like housing prices (non-tradable goods) affect the prices for tradable goods through changes in the cost of living.

Moono (2010) rejected the null of PPP in all the tests. The PPP theory was not supported because the criterion was not met by the estimated coefficients. Further, this study failed to reject the null hypothesis of a random walk of the real exchange rate, which is not stationary, and hence not in support of the PPP, after considering the mean reversion examinations as done by other scholars such as Rogoff and Froot (1996). Moono (2010) did a final examination of the PPP by way of a cointegrated analysis which also failed to find any stable long run relationship between price indices and the exchange rate, further confirming results from other studies by various scholars that have shown that the PPP doesn't hold. In conclusion, like other studies on the PPP, this study by Moono (2010) fails to support the PPP by way of considering CPIs between Zambia and South Africa. Limitations noted in this study include that CPI contain a huge number of goods that are not tradable in nature and these goods do not go on the international market in order to affect the movements in the foreign exchange rate, and the imperfect competition that exists in international trade such as costs of transport, tariffs and other barriers and these invalidate the PPP foundation, Moono (2010) Further, the Ballssa -Samuelson Effect is also suspect to be at play in Zambia and South Africa, and they are also of the view that it would take a lot of time to establish the long run adjustment to PPP, so they only used data for 18 years despite having a huge number of monthly observations. Moono (2010) suggested doing a similar study in the regions where there are minimal trade imperfections and use data on price indices on goods which are tradable in nature and covering a long period of time.

Odhiambo (2009) did a study to examine how economic growth in Zambia has been affected by the various reforms that has taken place in Zambia's interest rates. The model which was used in this study was the two models in a stepwise fashion. *"In the first model, the efficacy of interest rate liberalization is examined by regressing the interest rate on the level of financial deepening, while the causal relationship between financial depth and economic growth is examined by incorporating savings as an intermittent variable in the bivariate setting, thereby creating a simple trivariate model in the second model"*, Odhiambo (2009). Co-integration-based error correction model was used, and liberalization of interest rates is found to passively affect financial deepening, in the strongest sense of support. Further, the research finds that economic growth in Zambia is Granger caused by financial deepening, brought about through various reforms of the interest rates mechanisms that Zambia has had undertaken. *"The results apply irrespective of whether the causality is estimated in the short run or in the long run, and other results show that: (1) lagged financial depth leads to further financial deepening; (2) savings and economic growth Granger cause each other; and (3) financial development Granger causes savings in the long run"*, Odhiambo (2009).

Mungule (2004) finds that prevailing real fundamentals such as price differentials and real shocks determine the effective exchange rate in Zambia, in a research were they studied the determinants of the real exchange rates in Zambia. "The models used in this study are Vector Error Correction models on quarterly time series data between 1973 and 1997", Mungule (2004).

Mkenda (2001),"using annual data from 1965 to 1996 and co-integrating analysis find that terms of trade, government consumption and investment are key influences on real exchange rate for imports while terms of trade, foreign reserves and trade taxes impacts the real exchange rate for exports in the long run", Mkenda (2001)."

From the foregoing, our study which is looking at the causality effect of exchange rate and interest yields in Zambia will help policy makers in Zambia know how to manage movements in both exchange rates and interest rates, and it will also contribute to already existing literature on these two variables (exchange and interest rates) by way of conducting the analysis in a fully liberalised developing economy.

3 METHODOLOGY

The first part of the methodology is a description of the design of the research, which will be followed by an explanation of the procedure which was followed during empirical analysis and the third and final part will be a description of the data which was used in the research.

3.1 Research Design

This study makes use of a quantitative deductive approach. Quantitative deductive approach involves hypothesis (hypotheses) developing using existing theories, so as to design a research strategy to test the hypothesis Collis and Hussey (2009). To test the hypotheses in the Zambian set up, hypotheses were formulated based on the theory. A statistical approach was used to observe the actual quantitative observations. The statistical tool used to analyse the hypotheses regarding the impact of the Fx rate on interest yields on T-bills in Zambia, and vice versa was regression analysis. The statistical package used for data analysis was STATA 13.⁶

3.2 Research Variables

The variables considered in this research are interest rates on the 91 and 182 days treasury bills and the US\$/ZMW Fx rate.

The data for this research covered the period from January 1996 to January 2015, on a monthly basis. The Bank of Zambia was the sole source for the data for this research.

3.3 Data Limitations

Zambia's bond market is relatively undeveloped. Before 2005, the government of Zambia through Bank of Zambia had never issued bonds for more than 18 months so we therefore had to consider

⁶STATA is a computer package developed by StataCorp in 1985. It is used for data analysis in quantitative based research like the field of economics, biomedicine and epidemiology.

the 91 and 182 days' treasury bills in order to cover a longer period of over ten years, which is the acceptable standard for time series analysis studies.

3.4 Research Hypotheses:

3.4.1 Causality Effect of Exchange Rate and Interest Yields in Zambia

Main objective of this research was to examine if at all the movements in interest rates of the 91 and 182 days T-bills has any significant impact on the Fx rate (US\$/ZMW). This was assessed by employing simple regression analysis incorporating co-integration analysis.

The equation below was formulated in the analysis of the causality effect: -

$$E_{rate} = \vartheta_0 + \vartheta_1 X + \sigma \quad 3.1$$

where E_{rate} denotes the Fx rate, which is the dependent variable,
 ϑ_0 Is the constant term,
 ϑ_1 Is the vector of the parameters
 σ denotes the uncertainty term involving uncorrelated variables
x denotes the 91 and 182 days T-bills.

Therefore, the criterion for hypothesis testing in this research paper was set as follows:

- a) The *null hypothesis*, $H_0: \vartheta = 0$, the probability value is not statistically different. Hence the causality effect does not exist; and
- b) The *alternate hypothesis*, $H_1: \vartheta \neq 0$, the probability value statistically varies from zero and the causality effect exists

Therefore, the criterion for hypothesis testing in this research paper was set as follows:

- c) The *null hypothesis*, $H_0: \vartheta = 0$, the probability value is not statistically different. Hence the causality effect does not exist; and

- d) The *alternate hypothesis*, $H_1: \vartheta \neq 0$, the probability value is statistically varies from zero and the causality effect exists

3.5 Analysis

The approach used to conduct empirical analysis was as follows:

(I) data tested for stationary properties, (ii) non-stationary variables tested for co-integration, (iii) VECM model formulated, (iv) diagnostic test, and (v) Granger causality analysis because this helps in assessing whether one-time series has an impact on another, or can be used to forecast the movements in another time series. This is exactly to what we are testing in this study i.e. investigating whether we can use movements in interest yields on treasury bills to forecast movements in the exchange rates in Zambia.

3.6 Stationary tests

When data is not stationary, most economic time series exhibit upward and downward trends, that why it's always important to check for the stationary of the variables under investigation before commencement of data analysis, Engle and Granger (1987). In this research, we had to check if all the variables met the stationary tests, to avoid getting significant regression results despite non-existent of any meaningful relationship between the two variables under investigation, but through a third variable which is not even included in the model. Unit roots were checked by way of the ADF test in order to determine the stationarity of the variables.

3.6.1 Testing for Co-integration

Co-integration is carried out after establishing the stationarity of the variables. According to Nelson et al (1982), Co-integration is a statistical property of a collection (x_1, x_2, \dots, x_n) of time series variables. The Engle and Granger Two step approach is the two common approaches for testing for co-integration, Engle and Granger (1987)

3.6.2 VECM

The empirical model is formulated after it's established whether the variables are stationary or non-stationary and whether there is co-integration or not. Since there is no co-integration between the pairs of exchange rate and each pair of interest yields, the Vector Auto Regressive (VAR) model will be used for analysis. According to Hatemi (2004), the VAR is an econometric model used to capture the linear interdependencies among multiple time series. According to Toda and Yamamoto (1995), VAR models generalize the univariate auto regressive model (AR model) by allowing for more than one evolving variable. All variables in a VAR are treated symmetrically in a structural sense (although the estimated quantitative response coefficients will not in general be the same); each variable has an equation explaining its evolution based on its own lags and the lags of the other model variables. Vector Error Correction (VEC) model describes the dynamic evolution of a number of variables from their common history, shown below;

$$\mathbf{EXR}_t = \eta_0 + \psi_1 r_{91}_t + \psi_2 r_{182} + e_t \quad (2)$$

Where;

EXR_t denotes the Nominal Kwacha/USD spot exchange rate,

r_{91}_t denotes the yield on 91-day Treasury bill,

r_{182} denotes the yield on 182-day Treasury bill,

e_t denotes the error term.

3.7 Diagnostic tests

Having produced the VAR/VEC model, a series of diagnostic examinations are conducted in order to ensure that the formulated model is correct. The examinations carried out in this study included the Lagrange-multiplier test for autocorrelation (LMS-Stat), multivariate normality tests, and a plot of the Inverse Roots of AR characteristic polynomial.

3.8 Granger Causality

A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X (and with lagged values of Y also included), that those X values provide statistically significant information about future values of Y , Granger and Newbold (1974)

If a time series is a stationary process, the test is performed using the level values of two (or more) variables. If the variables are non-stationary, then the test is done using first (or higher) differences. The number of lags to be included is usually chosen using an information criterion such as the Akaike information criterion or the Schwarz information criterion, Diebold (2001). Any particular lagged value of one of the variables is retained in the regression if (1) it is significant according to a t-test, and (2) it and the other lagged values of the variable jointly add explanatory power to the model according to an F-test. Then the null hypothesis of no Granger causality is not rejected if and only if no lagged values of an explanatory variable have been retained in the regression. In practice it may be found that neither variable Granger-causes the other, or that each of the two variables Granger-causes the other.

The Granger causality has limitations, as its name implies, Granger causality is not necessarily true causality. If both X and Y are driven by a common third process with different lags, one might still fail to reject the alternative hypothesis of Granger causality, Eichler (2012). Yet, manipulation of one of the variables would not change the other. Indeed, the Granger test is designed to handle pairs of variables, and may produce misleading results when the true relationship involves three or more variables.

Hence, assessing the possible causal relationship between the exchange rates and interest rates yields will make use of the regression equations;

$$EXR_t = \sum_{i=1}^n \eta_i r91_{t-i} + \sum_{i=1}^n \theta_i r182_{t-i} + \sum_{i=1}^n \gamma_i EXR_{t-i} + u_{1t} \quad (3)$$

The above equation postulates that Exchange rate is related to past values of itself as well as that of the yields on the 91-day and 182-day treasury bills. Hence the Granger causality hypothesis that there is:

- a) Unidirectional causality from r91 to EXR if the estimated coefficients on the lagged r91 are statistically different from zero as a group (i.e. $\sum \eta_i \neq 0$).
- b) No causality if the sets of r91 and r182 coefficients are not statistically significant.

4 RESULTS AND ANALYSIS

4.1 Testing for Unit Roots:

Augmented Dickey-Fuller (ADF) tests and Phillips Perron (PP) tests were employed on each of the two-time series variables. The selection of the optimal lag was made on the basis of the Akaike (AIC), Hannan-Quinn (HQIC), and Schwarz Bayesian (SBIC) information criterion. The results presented in Table 1 below show that all of the information criteria selected 2 lags as optimal.

Table 4-1: Lag order selection

Information Criteria	EXR	r91	r182
Lags selected by AIC	2	2	2
Lags selected by HQIC	2	2	2
Lags selected by SBIC	2	2	2

Source: Author's calculations based on STATA 13.0 software

Having identified the optimal lag, the next step is to run the ADF and PP unit root tests. The results presented in Tables 2 and 3 indicate that all of the variables are first-difference stationary

Table 4-2: Unit root tests results in 1

Variables	Augmented Dickey-Fuller		Phillips-Perron (PP test)	
	Test Statistic	Critical value (5 %)	Test Statistic	Critical value (5 %)
Exr (without trend)	-1.255	-2.882	-1.283	-2.881
Exr (with trend)	-2.313	-3.433	-2.124	-3.433
91-day (without trend)	-2.152	-2.882	-1.763	-2.881
91-day (with trend)	-2.858	-3.433	-2.263	-3.433
182-day (without trend)	-2.438	-2.882	-1.781	-2.881
182-day (with trend)	-2.972	-3.433	-2.019	-3.433

Source: Author's calculations based on STATA 13.0 software. ***, ** and* denote significance at the 1%, 5% and 10% levels respectively.

Table 4-3: Unit root test results in first differences

Variables	Augmented Dickey-Fuller Test		Phillips-Perron (PP test)	
	Test Statistics	Critical value (5%)	Test Statistics	Critical value (5%)
Exr (without trend)	-7.674***	-2.882	-10.878***	-2.881
Exr (with trend)	-7.655***	-3.433	-10.856***	-3.433
r91 (without trend)	-6.708***	-2.882	-9.928***	-2.881
r91 (with trend)	-6.739***	-3.433	-9.929***	-3.433
r182 (without trend)	-5.975***	-2.882	-9.037***	-2.881
r182 (with trend)	-6.015***	-3.433	-9.044***	-3.433

Source: (WDI) Author's calculations based on STATA 13.0 software. Significance Level Codes: "****", "****" and "****" denote the 1%, 5% and 10% significance levels respectively.

4.2 Co-integration

Having established that all of the variables are I (1), the next step is to determine whether the variables are co-integrated, which is achieved by using the Johansen trace and max. eigen tests. The results set out in Table 4-4 below show that there is no co-integration between the pairs of exchange rate and each of interest yields. However, there exists a long-run relationship between the exchange rate and both interest yields from the two securities. Results of co-integration tests and estimates of the co-integrating parameters are reported in table 4-4, 4-5 and 4-6. They show that exchange rates and the interest rates on the 91-day Treasury bill rate and 182 –day Treasury bill rates for Zambia are co-integrated. This means that there is evidence of a long-run relationship among the three variables of interest because the P-values for the independent variables support the null hypothesis that the probability value statistically varies from zero and the causality effect exists at 1%,5% and 10% significance level.

Table 4-4: Tests for Exchange Rate and r91

Trend: constant

Number of obs = 227

Sample: 1996m3 - 2015m1

Lags = 2

Maximum rank	Eigen value	Trace Statistic	Critical Value at 5%
0	—	7.3030*	15.41
1	0.024	1.7892	3.76
2	0.008	—	—

Source: Author's calculations based on STATA 13.0 software; * number of co-integrating ranks

Table 4-5: Tests for Exchange Rate and r182

Trend: constant		Number of obs = 227	
Sample: 1996m3 - 2015m1		Lags = 2	
Maximum rank	Eigen value	Trace Statistic	Critical Value at 5%
0	—	7.585*	15.41
1	0.025	1.766	3.76
2	0.008	—	—

Source: Author's calculations based on STATA 13.0 software; * number of co-integrating ranks

Table 4-6: Tests for Exchange Rate, r91 and r182

Trend: constant		Number of obs = 227	
Sample: 1996m3 - 2015m1		Lags = 2	
Maximum rank	Eigen value	Trace Statistic	Critical Value at 5%
0	—	44.105	29.68
1	0.149	7.462*	15.41
2	0.025	1.718	3.76
3	0.008	—	—

Source: Author's calculations based on STATA 13.0 software; * number of co-integrating ranks

4.3 Vector error correction model

Having determined that the variables share a co-integrating relationship, the next step is to formulate the VECM using two lags. The short-run relations are summarised in Table 7 below and show that estimated coefficient of the error correction term has the anticipated negative sign but is only significant at the 10 percent level. The error correction term coefficient (-0.012) implies that 1.2 percentage point of the adjustments towards the equilibrium will occur within one month through changes in exchange rates.

The long-run relationship further shows that there is a negative and significant long-run relationship between the interest yield on the 91-day Treasury bill and exchange rate while there is a positive and significant relationship between the exchange rate and the yield from the 182-day Treasury bill.

Table 4-7: Short run relations

Dependent variable ΔEXR

Independent Variables	Coefficient	Std. Err.	Z	p-value
u_{t-1}	-0.012*	0.006	-1.85	0.064
EXR_{t-1}	0.300***	0.068	4.44	0.00
EXR_{t-2}	-0.013	0.067	-0.19	0.847
$r91_{t-1}$	-0.013	0.009	-1.48	0.138
$r91_{t-2}$	0.004	0.009	0.51	0.608
$r182_{t-1}$	0.004	0.009	0.47	0.641
$r182_{t-2}$	-0.001	0.010	-0.16	0.872
Intercept	0.016*	0.009	1.66	0.097

***, ** and * denote 1%, 5% and 10% significance levels respectively.

In the long run, a 10 percentage point increase in the interest yield from the 91 –day Treasury bill is associated with a 9.6 percentage point appreciation of the exchange rate while the similar increase in the 182–day Treasury bill rate is associated with a 9.7 percentage point depreciation of the exchange rate. It is of interest to note that the yields from the 91-day Treasury bill and 182-day Treasury bill have opposing associations with the exchange rate. It is intuitive to expect a negative correlation between the interest rates and exchange rates because they imply that the demand for Zambian securities increases other things held constant. However, the positive correlation between the 182-day Treasury bill implies that rising interest rates decreases the demand for Zambian securities and hence a decrease in the demand for Kwacha relative to the US dollar.

Table 4-8: Long-run relationship equation / Co-integration Equation

$$EXR = 2.1684 - 0.9567r91 + 0.97r182 \quad 4.1$$

Standard error	(0.186)	(0.199)
P-value	(0.000)	(0.000)

4.4 Diagnostic Checks

4.4.1 Lagrange-multiplier results

The results of the test for autocorrelation are presented in Table 8 below and show that there is no autocorrelation present up to the fourth lag.

Table 4-9: Lagrange-multiplier Test for autocorrelation

Lag	Chi-square	p-value
1	11.554	0.240
2	9.634	0.381
3	14.272	0.113
4	6.891	0.648

4.4.2 AR Plot

The plot of the inverse roots is presented in figure 2 and show that none of the Eigen values are outside the unit circle. Hence, the AR plot indicates that the VECM is stable.

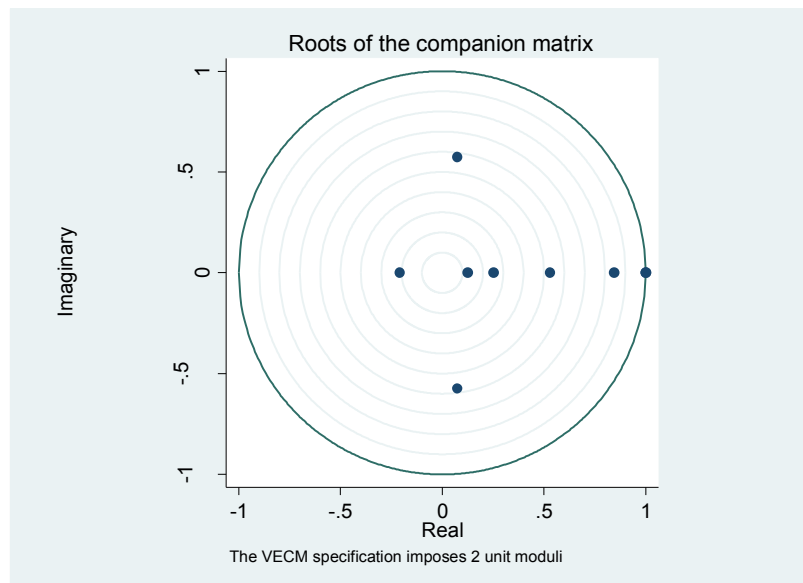


Figure 4-1:

4.4.3 Normality test of errors

The Jarque-Berra test for normality of the residuals are presented in Table 9 below and indicate that the errors are normally distributed and do not suffer from significant skewness or kurtosis.

Table 4-10: Normality tests

Test	Chi-square	df	P-value
Jarque-Berra test	1963.683	6	0.000
Kurtosis	1840.067	3	0.000
Skewness	123.616	3	0.000

4.4.4 Impulse Response Analysis

In order to determine the effect of a shock of the interest rate on itself or on another endogenous variable like exchange rate, we will need to compute impulse response functions (Lütkepohl, 1991). In figure 1 below an unexpected increase in the 91-day interest rate has a negative effect which doesn't die out even after 12 months. In figure 2, an unexpected increase in the 182-day interest rate would have an immediate effect on the exchange rate that lasts even up to 12 months.

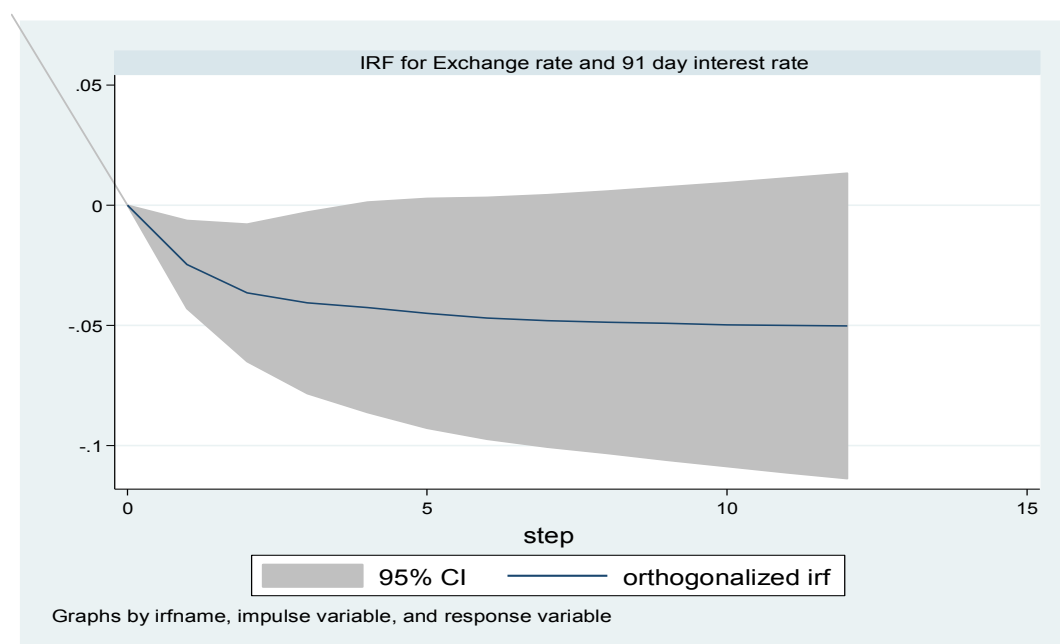


Figure 4-2: Impulse Response functions

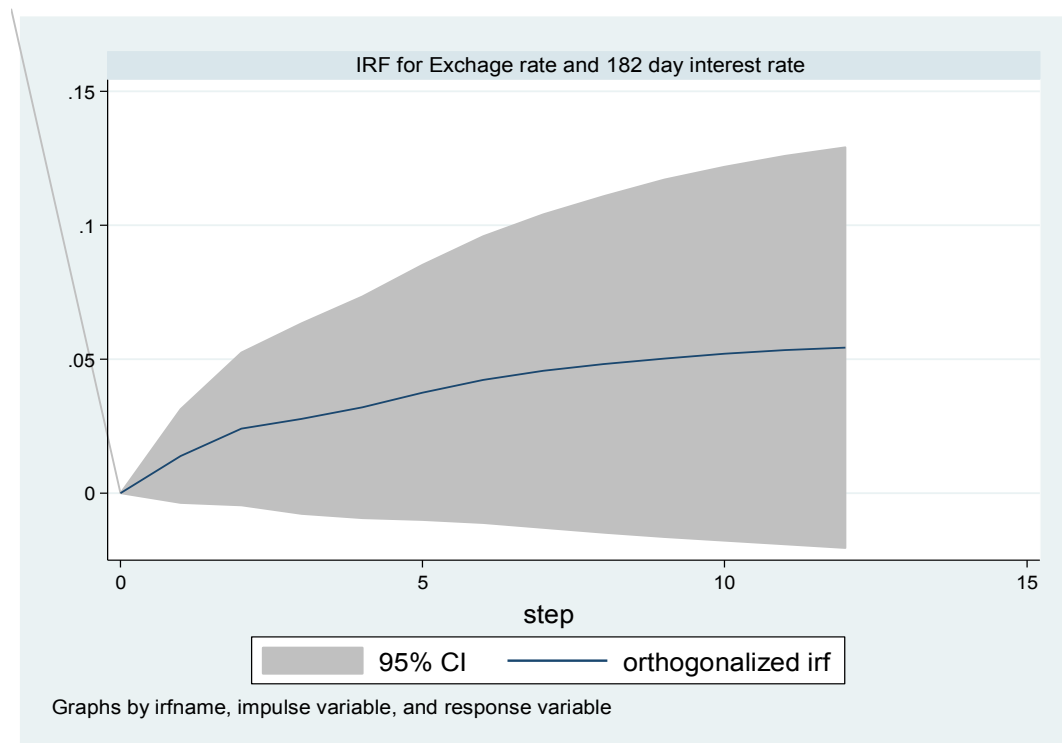


Figure 4-3:

By the seventh month, the negative effect of the 91-day Treasury bill rate on the exchange rate outweighs the positive effect of the 182-day Treasury bill rate. After 8 months, the 182-day Treasury bill rate has a larger positive effect than the negative effect from the 91-day Treasury bill rate which converges reaches a constant value.

4.5 Granger Causality

The final part of the analysis is to determine whether there is unidirectional causality, bi-directional causality or no causality between the three variables. This is achieved using Granger causality tests (Granger, 1969). The results presented in Table 10 below show that the null hypothesis of no causality running from $r91$ and $r182$ to EXR is not rejected at 5-percent level. This means that the interest rates do not contain information that is helpful in predicting future exchange rates.

Table 4-11: Pair wise Granger Causality test

Null Hypothesis	Chi-square-statistic	df	P-value
<i>r</i> 91 does not Granger cause <i>EXR</i>	2.61	2	0.271
<i>r</i> 182 does not Granger cause <i>EXR</i>	0.24	2	0.888

Source: Author's calculations based on STATA13.0 software

4.6 Graphical representations of results

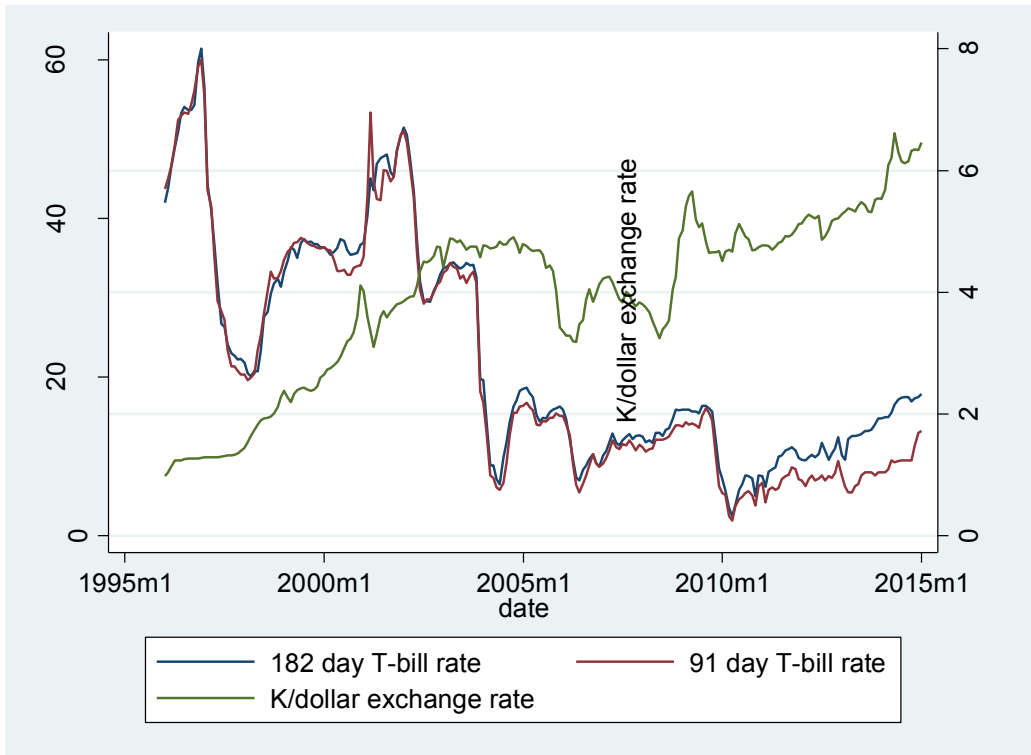


Figure 4-4:

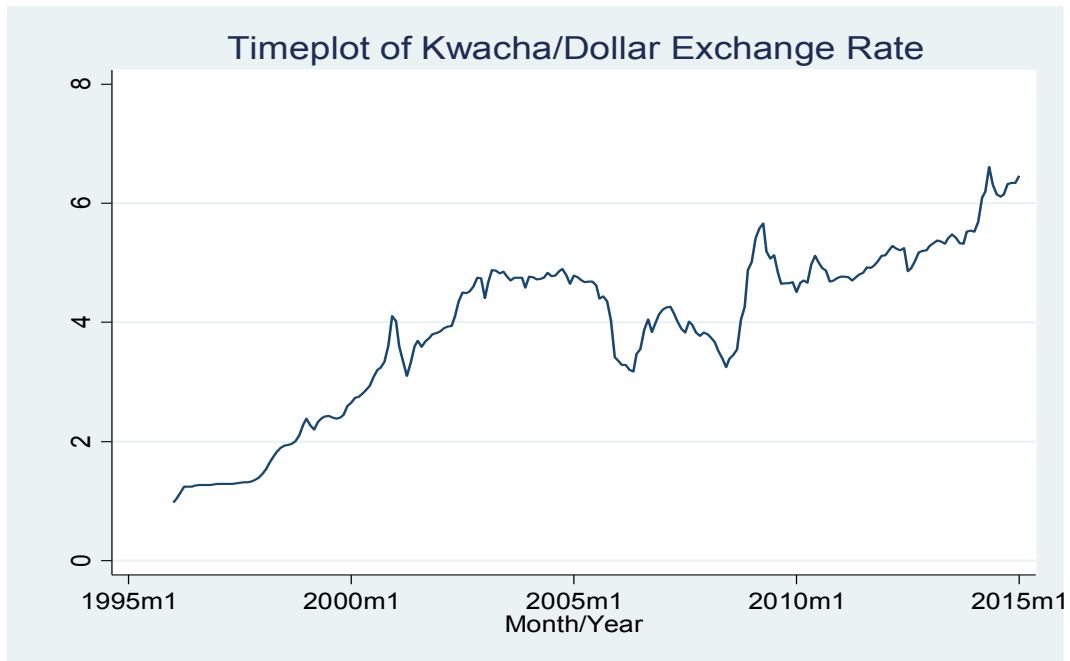


Figure 4-5: Foreign Exchange: Zambian Kwacha/US Dollar

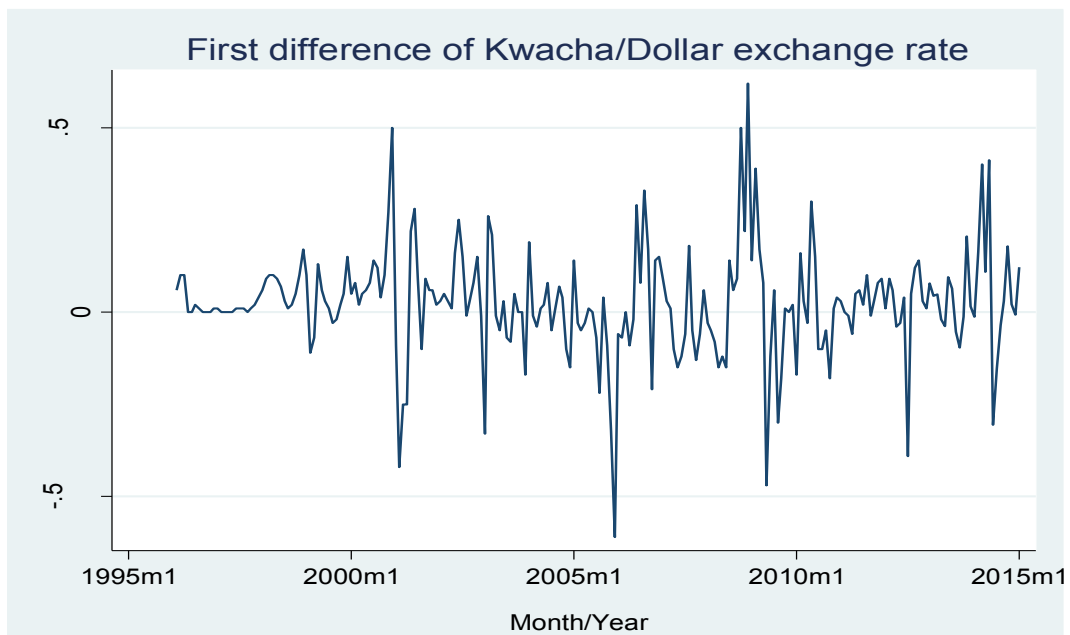


Figure 4-6: Exchange rate: Zambian Kwacha/US Dollar after differencing

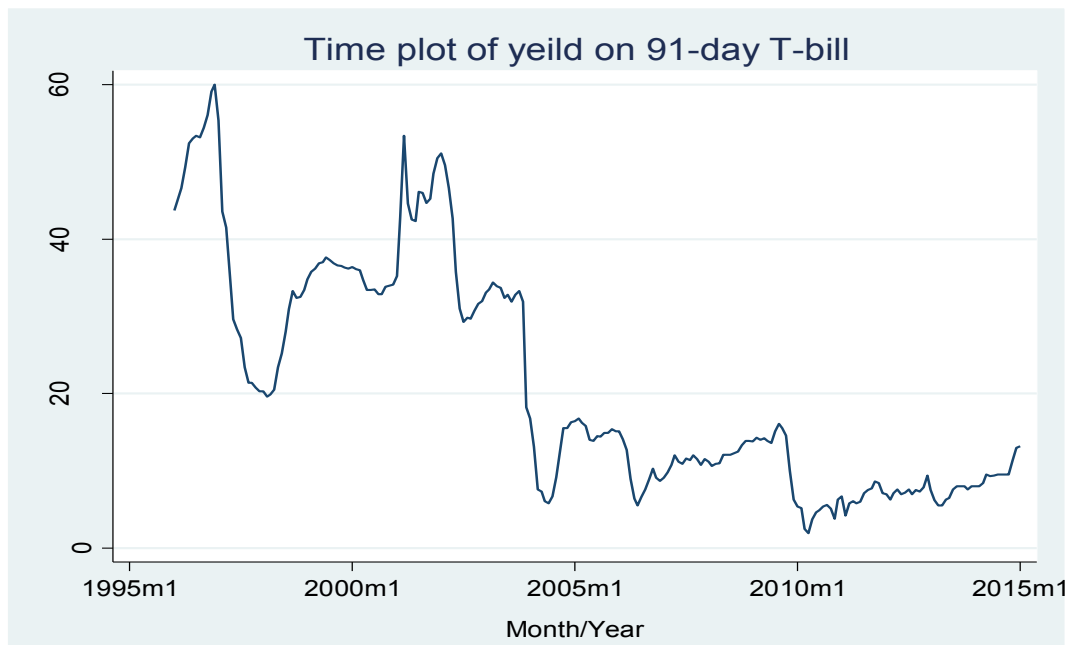


Figure 4-7: Treasury bill Yields for 91 days

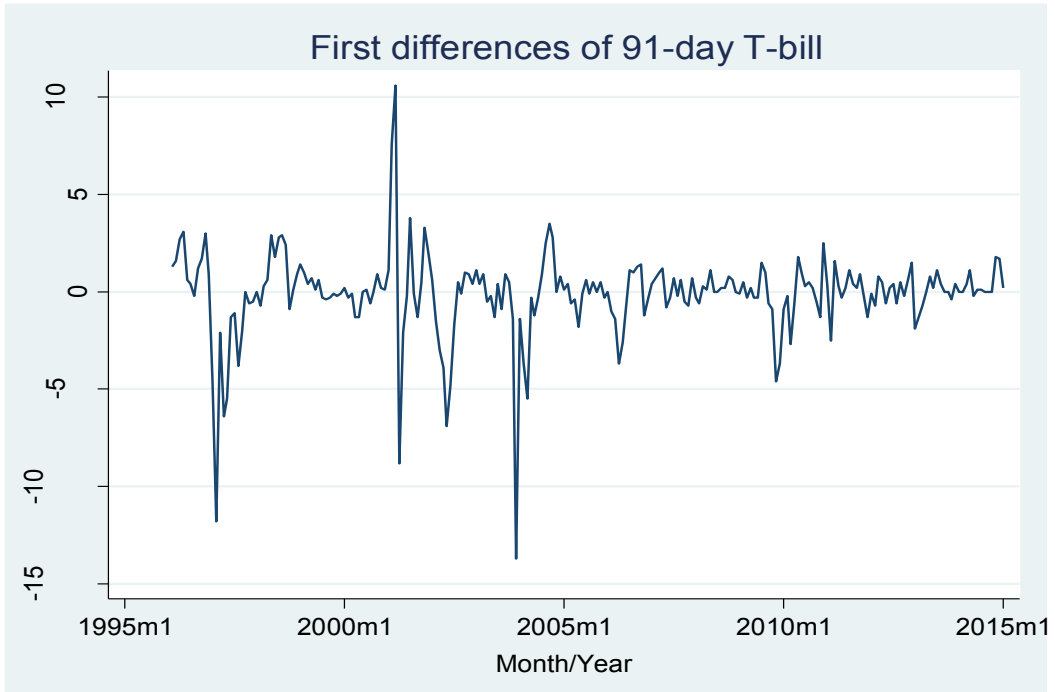


Figure 4-8: Treasury bill Yields of first difference of 91 day Treasury bill

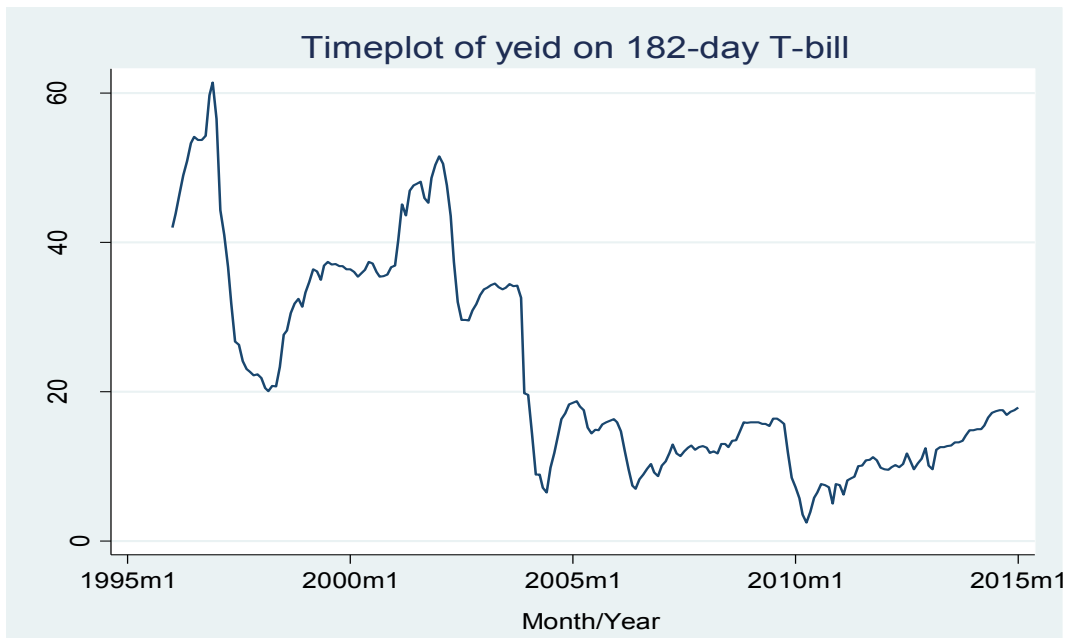


Figure 4-9: Treasury bill Yields for 182-Day Treasury Bills

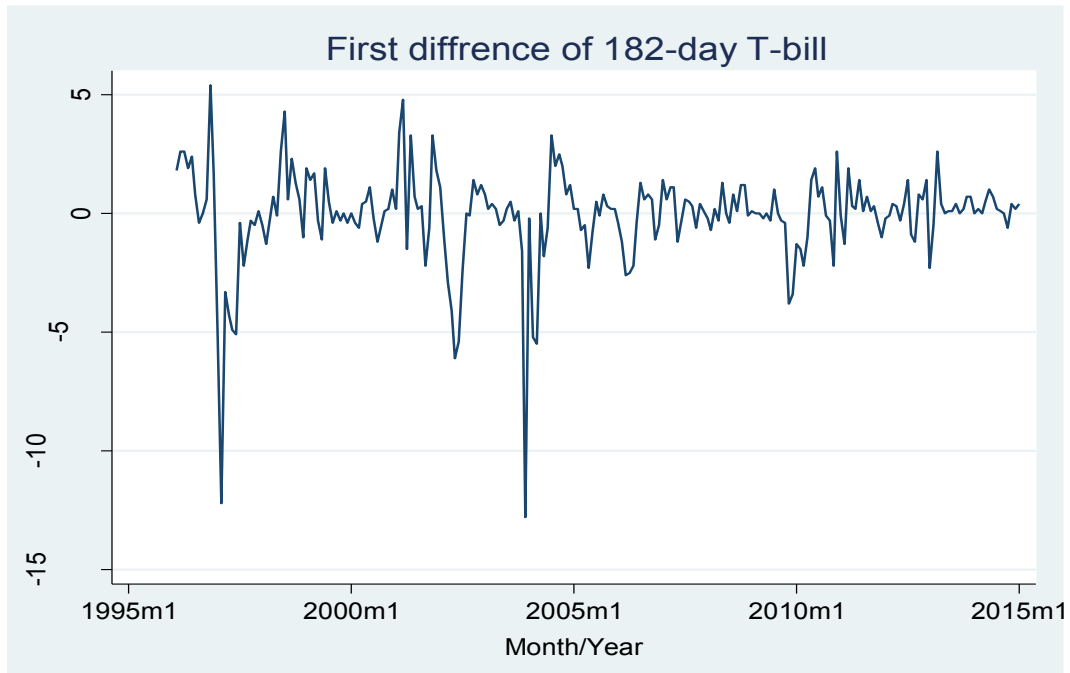


Figure 4-10: First difference of 182-day treasury bills

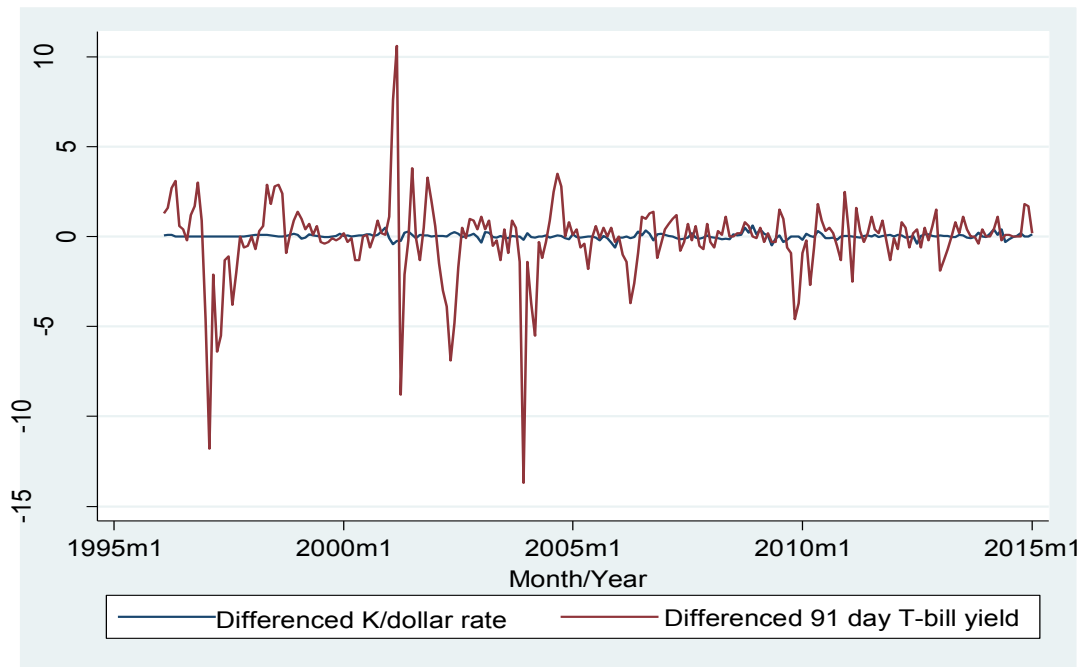


Figure 4-11: Graphical representation of Co-integration between 91-day Treasury bill and Exchange rate (After differencing)

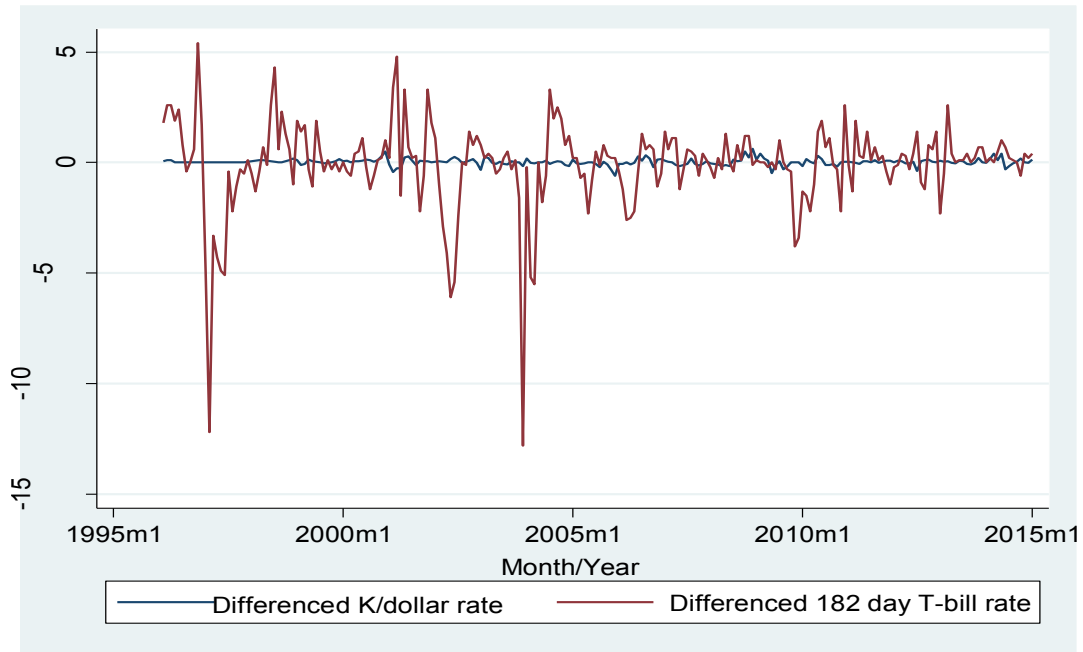


Figure 4-12: Graphical representation of Co integration between 182-day Treasury bill and Exchange rate (After differencing)

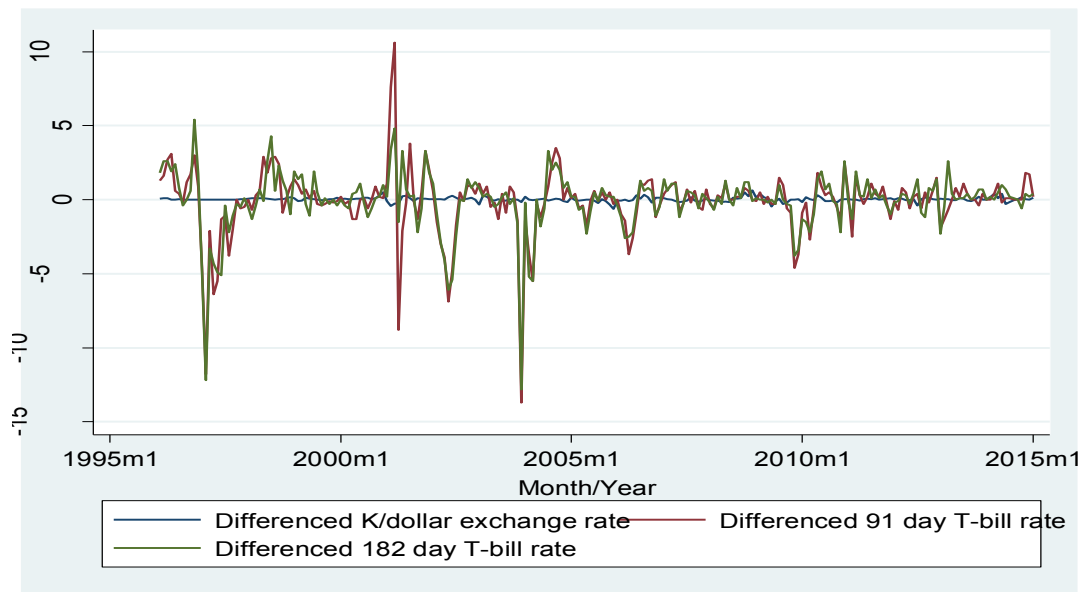


Figure 4-13: Graphical representation of Co-integration between 91-day treasury bill, 182 day Treasury bill and Exchange rate (After differencing)

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the forgoing analysis, there is no long-run relationship between pairs of the exchange rate and each of the interest yields from the 91-day Treasury bill and 182-day Treasury bill respectively. However, there exists a long-run relationship among all three variables jointly. In the short-run, it was found that exchange rates will have to adjust to equilibrium by 1.2 percentage points in each month. In the long-run however, the yields on the 91-day treasury bill have a negative relationship with exchange rate in that a 10 percentage point increase in the yield will be associated with a 9.5 percentage point reduction in the US\$/ZMW exchange rate which in effect, is an appreciation of the exchange rate. The yield on the 182-day Treasury bill has a positive relationship with the exchange rate in that a 10 percentage point increase in the yield is associated with 9.7 percentage point increase in the kwacha dollar exchange rate which, in effect, is a depreciation of the exchange rate. Further, the 182-day treasury have the most significant effect on the exchange rate.

According to the impulse response functions, the shock in the 91-day interest rate (182-day interest rate) has gradual impact of appreciation (depreciation) on the US\$/ZMW exchange rate but this persists even until 24 months. The interesting relationship between the yield on 182-day Treasury bill and the US\$/ZMW exchange rate is counter intuitive. It was also found that there was no causality from interest rates to exchange rates in that past values of interest rates do not contain helpful information to predict future values of the exchange rate.

The diagnostic check on our model shows that our model estimates are stable, hence reliable and not misspecified, has normally distributed errors with no autocorrelation.

5.2 Recommendations

Having set the reasons and expectations of this research and taking into account the results, it can be concluded that the research has shown that the relationship between the interest yields and exchange rate, though present, is not very significant. In this light, financial stakeholders (investors, fund and investment managers and policy makers among others) should exercise some degree of caution when coming up with decisions that involve making use of the correlation of

these two variables. Further, specific cautions should be taken as below in how the results of this research are used:

5.2.1 Results should not be used in isolation with other economic factors.

As can be expected with all other results from academic researches, financial markets players and other stakeholders should be wary of the dangers of making decisions solely based on the position of the exchange rates and interest yields. This is because the movements in the Zambian kwacha's exchange rate may not always be a significant determinant of the future outlook for the respective treasury bills yield. Stakeholders need to consider other factors such as inflation rate, GDP, commodity prices as well as other economic factors that have not been included in this study. For instance, The Zambian Kwacha is arguably a commodity currency, whose value is largely determined by the price of Copper, Zambia's major export. Consequently, much of the movements and volatility of the Zambian Kwacha is due to the movements in the copper price (Bova, 2009).

5.2.2 Consider use of other hedge options in addition to the results of this study.

As set out in the research, one of the expectations of the study is that investors can make use of the relationship so as to hedge their losses. However, investors should also take into account the significance of the correlation that this study has shown. It has been shown that the correlation, though present, is not significant and as such investors who may want to hedge the value of their expected yields on their investments in the treasury bills should be careful to do so. Investors may need to use the results of this study in combination with other available hedge options such as the traditional derivatives (interest rate swaps and currency options). The findings of this research should however help them to try and include both the interest rates and exchange rates in their structural risk models. The resultant co-efficient calculated here together with the co-efficient of these variables in the structural risk model should provide an adequate risk management tool in their portfolio management.

5.2.3 Use of the results for policy monitoring

While the theory in this research has shown how momentary policy makers from various countries have turned to the use of the correlation of interest rates and exchange rates in stabilising the exchange rates, for Zambia, this should be taken with due care. This, again, is because of the level of relationship between these two variables is not that significant. It should also be taken as a sign that what may work in one economy/market may not be the solution in another economy/market as economic fundamentals are different (Sikwanda, 2011). It therefore goes without saying that policy makers should try and ensure that the models used should be customized according to the country and region as well as the markets. What may work in a developing country like Zambia may not be the case with a developed economy such as the United States of America.

It is also hoped that this study has shown without doubt how various stakeholders can make use of the relationship between the exchange rate and the interest rates and also sets a basis of the many research studies in this subject. As noted through this research and the results therefore, it is clear that there is need for further research to be done so as to enhance the scope of how the results are used. The study has also shown how the ever changing global economy has made the use of the 'supposedly workable' relationship of increasing yields on government bonds should have resulted in a stable rate but never did due to other factors in the economy.

Of particular areas that need to be researched is the inclusion of other macro-economic factors such as; Gross Domestic Product (GDP), Inflation rate, Commodity prices and others.

The addition of the above factors would help to measure the effect of the other variables in the financial markets on the exchange rate and the degree of co-integration with yield rates. The above factors would also make it possible for the financial markets players to ascertain the impact of other equally significant factors on their returns on those Investments. For instance, the inclusion of commodity prices in the model can help explain or give insight on how foreign currency would move. This is especially important for a market like Zamia whose dependency on copper is significant and imports all the oil used in the country.

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