Predictability of the term structure of interest rates in the G7 and BRICS countries: Application of the Expectations Hypothesis

By

Sinethemba Mposelwa

232 484 24

Dissertation submitted in partial fulfilment of the requirements for the degree

MASTER OF COMMERCE IN ECONOMICS

In the

SCHOOL OF ECONOMIC SCIENCES

At the

NORTH-WEST UNIVERSITY – VAAL TRIANGLE CAMPUS

Supervisor:

Dr Paul-Francois Muzindutsi

November 2016

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

It all starts here ™

DECLARATION

I declare that the dissertation, which I hereby submit for the degree Masters of Commerce in Economic Sciences, is my own work and that all the sources obtained have been correctly recorded and acknowledged. This dissertation was not previously submitted to any other institution of higher learning.

Signature: _____   Date:_____

ACKNOWLEDGEMENTS

ABSTRACT

The predictive ability of the term structure of interest rates is tested by way of applying the expectations hypothesis in BRICS and G7 countries. The study compares the validity of the expectations hypothesis of the term structure in each country and also according to the country's respective group. An effort to assess the effect of the financial crisis on the term structures of the countries is made to check whether or not it may contribute to the expectations hypothesis not holding, thereby affecting the term structure's ability to predict future interest rate movements. The Autoregressive Distributive Lag model is employed as the cointegration method and results from the individual and the grouped countries are compared. Sample period consists of 157 monthly observations from May 2003 to May 2016 using the 90-day Treasury yield rate and the 10-year government bond.

The study shows that the expectations hypothesis holds in China, India, South Africa, Canada, France and Germany, and it also provides evidence suggesting that in these countries the short term interest rate is able to predict the long term interest rate in the long-run. The results provide further evidence as suggested by the validity of the expectations hypothesis that, monetary policy is able to influence decision making in the economy through changing the short term interest rate and expectations in the market, ultimately influencing the long rate. The United Kingdom and the United States provides inconclusive evidence of the expectations hypothesis and the predictive ability of each of the country's term structures. Brazil, Italy, Japan and Russia provide no evidence supporting the expectations hypothesis and the term structure's ability to predict future interest rate movements in the respective countries. Interest rates in these countries indicate sharp volatility during and after the financial crisis when compared to countries where the expectations hypothesis holds. The financial crisis delayed the adjustment process for the developed countries compared to the developing countries.

The expectations hypothesis holds in both the pooled BRICS and G7 country groups. The short rate is able to predict the long rate in both the BRICS and G7 countries, interest rates in BRICS indicate rapid adjustment back to equilibrium in the short-run; while the adjustment is sluggish in the G7 bloc. Based on the outcome of the study, the sluggish result in the G7 gives the impression that the financial crisis had an impact on the group's term structure of interest rate as the G7 countries were directly affected by the crisis.

Key words: Expectations Hypothesis, Term Structure, ARDL.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADF   : Augmented Dickey Fuller

AIC   : Akaike Information Criteria

AR   : Autoregressive

ARDL   : Autoregressive Distributive Lag

ARMA   : Autoregressive Moving Average

BOJ   : Bank of Japan

BRICS   : Brazil Russia India China South Africa

CCAPM   : Consumption Capital Asset Pricing Model

CUSUM   : Cumulative Sum Chart

DF   : Dickey-Fuller

ECB   : European Central Bank

ECM   : Error Correction Model

ECT   : Error Correction Term

EH   : Expectations Hypothesis

EHTS   : Expectations Hypothesis of Term Structure

G7   : Group of Seven

GDP   : Gross Domestic Product

HQIC   : Hannan–Quinn Information Criteria

IFS   : International Financial Statistics

IMF   : International Monetary Fund

IPS   : Im, Pesaran and Shin

KPSS   : Kwiatkowski-Phillips-Schmidt-Shin

LLC   : Levin, Lin, and Chu

LM   : Lagrange Multiplier

MPTM   : Monetary Policy Transmission Mechanism

NDB   : New Development Bank

OECD   : Organisation for Economic Co-operation and Development

OLS   : Ordinary Least Squares

PMG   : Pooled Mean Group

PP   : Phillips-Perron

SBIC   : Schwarz Bayesian Information Criteria

CHAPTER 1: BACKGROUND TO THE STUDY

1.1 INTRODUCTION

The increased financial integration among economies in the world over the years has had quite a significant role in the fluctuation of interest rates in different countries, and has also had significant implications for various market participants. In order to make well-informed financial decisions and to hedge against interest rate risk, economists and monetary policy authorities are often assigned with the challenging task of forecasting future interest rate movements. By using the expectations hypothesis (hereafter EH) of the term structure in the forecasting of interest rates provides an understanding of the underlying dynamics of interest rates for the management of risks and financial security valuations (Modena, 2008:1-2).

The expectations hypothesis is the standard term structure model (Gurkaynak & Wright, 2012:337), mostly used to predict short-term interest rates. The EH is one of the theories that attempt to explain the relationship between interest rates of different maturities. The theory proposes that, the long term interest rate is an average of the current and the expected future short rates (Hardouvelis, 1994:256). The fundamental principle of the theory is that, the long term interest rate is determined by the sum of current and future expected short term rate plus the risk premium (Campbell & Shiller, 1991). Essentially this implies that for the following year, the two interest rates will yield the same returns. Accordingly, this means that the long term interest rate comprises information regarding the market's expectation about future short term interest rates (Guidolin & Thornton, 2008:19).

The term structure of interest rates provides information on the yield to maturity of different securities at a given point in time (Rose & Hudgins, 2013:223). The term structure contains valuable information regarding the changes in the short term interest rate and in predicting the likelihood of economic state, thus making it beneficial as it is able to forecast future economic conditions (Van der Merwe & Molletze, 2010:107). Furthermore, this implies that investors are able to predict future changes in interest rates by simply observing the slope of the yield curve; that is, the spread between long term and short term interest rates (Modena, 2008:1). Under normal economic conditions, the long term interest rate is of a higher yield than the short term interest rate (Campbell & Shiller, 1991). These economic conditions, often reflected by an upward sloping yield curve, also indicate that investors demand higher risk premiums on long term securities (Bonga-Bonga, 2010:45). On the other hand, a

recession is characterised by the long term interest rate yield that is lower than the short term interest rate yield, where the yield curve is negative or inverted (Nel, 1996). Lower long term yields compared to higher short term yields also indicate an increase in inflation and an increase in short term interest rate expectations, this implies that there is a positive relationship between the term structure of interest rates and economic activity (Modena, 2008:1). In addition to this, when comparing the rate of money growth permitted by the central bank to the predictive ability of the term structure, Koukouritakis (2010:757) asserts that superior prediction of a country's monetary policy stance is found in the spread between the long and the short term interest rate. That is, the term structure of interest rates.

Monetary policy operates through indirect channels by inducing the expectations of the private sector and consequently influences the long term interest rates (Bernanke, 2004). This proposes that the long term interest rate plays an important role in transmitting monetary policy (Kozicki & Tinsley, 2008). Guney (2013) further states that EH enhances the effectiveness of monetary policy as the long term interest rate has an impact on capital asset prices and the investment decisions of firms. Thus, monetary policy is able to influence this rate by controlling the short term interest rate. Accordingly, the validity of the EH has major implications for monetary policy. Monetary policy authorities are able to influence future expectations and the long term interest rate by making changes on the short term interest rate. This implies that monetary policy authority is able to influence macroeconomic activity, aggregate spending and investment decisions as these are closely related to the long term interest rates (Tabak & de Andrade, 2001:5), thereby also influencing real economic variables. However, for monetary policy to influence aggregate spending there should be a long term relationship between short term and long term interest rates (Tabak & de Andrade, 2001:5), that is, the EH should hold. The validity of the EH is often tested by using a cointegration approach which is an econometric model that tests long run association between variables. The absence of a long run association between the long term and the short term rates would imply that the EH does not hold. The validity of EH implies that there are no unexploited profit opportunities since the long term interest rate is able to impartially predict the short term interest rate (Gurkaynak & Wright, 2012:339). Thus, in forming expectations market participants make use of all accessible information, and these expectations are reflected in future interest rate changes (Cargill, 1975:769). However, should the EH not hold, then this would indicate that there are arbitrage opportunities present in the market, meaning that market participants are able to profit from the different returns of the two rates. Furthermore, the implication of the EH not holding

would suggest that it is difficult to evaluate a country's interest rate dynamics (Ghazali & Low, 2010).

For over more than a century, the EH has been perceived as the best theory for the term structure of interest rates (Longstaff, 2000). It has been quite a central theory for the policy makers and economists as well as receiving substantial attention in literature, and has on the other hand become controversial over the years (Koukouritakis, 2010:758). All available literature is divided in terms of the validity of the EH (Koukouritakis, 2010:758). Tabak and de Andrade (2001) tested the expectations hypothesis and conclude that the theory tends to hold for interest rates up to 6 months maturity; while the 12 month interest rate showed a great degree of deviation from the EH of term strucuture's instability. In addition, some researchers such as Campbell and Shiller (1991), Hardouvelis (1994), and Thornton (2000) validated the EH. However, Campbell (1995); Fama (1986), Shiller (1990), and Tabak and de Andrade (2001) found no evidence to support the theory, making the EH quite a controversial theory.

Campbell and Shiller (1991); Engted (1993), and Mankiw (1986) find evidence supporting the term structure's ability to predict future changes in short term interest rates. Similarly, Fama (1984) found evidence that supports the term structure's ability to predict changes in interest rates over a few months. Dueker (1997) used the term structure of interest rates to predict recession in the USA from 1959 to 1995 and found it more appropriate compared to other forecasting tools used. According to Stojanovic and Vaughan (1997), a rising spread between the two rates often implies that the short term interest rate is expected to rise in the future. This is indicated by a steep yield curve. On the other hand, an expectation of falling rates is signalled by a flat yield curve (Stojanovic & Vaughan, 1997). While the interest rate spread specifies expectations on future short term rates, it also gives an indication of where on the business cycle an economy is (Stojanovic & Vaughan, 1997). Thus, the EH is relevant for both monetary and real economic sectors.

1.2   PROBLEM STATEMENT

Interest rate risk is one of the major risks faced by various market participants (Rose & Hudgins, 2013:220). A movement up or down in interest rates directly affects the market value of assets and liabilities, thereby changing the net worth of a firm and the value of an investor's investment (Rose & Hudgins, 2013:220). Understanding the dynamics between the long and short term interest rates becomes essential not only for managing this risk, but

also for the ability to forecast interest rate movements and other macroeconomic variables. Despite there being no overall consensus regarding the validity of the EH, it is necessary to test the theory in the modern day economies where the approach of monetary policy seems to be varying. The variation in monetary policy is due to the implementation of quantitative easing in developed countries, particularly the US and Europe, where the government injects money into the economy to restore economic activity post the financial crisis (Guidolin & Tam, 2013). In testing the validity of the EH, changes in the monetary policy framework of the countries under observation, and changes in financial markets should be considered (Beechey *et al*., 2008:18). This is the case in most of the BRICS countries where the deregulation of financial markets took place post 1990, with most of the countries adopting inflation targeting as a monetary policy framework (Beechey *et al*., 2008:18).

On the other hand, G7 countries were severely hit by the 2007/2008 financial crisis, and interest rates in these countries have been significantly low (Danthine, 2012:3-5), while interest rates in BRICS countries have been relatively high; thus becoming an attractive alternative for investors despite the higher level of risk in these countries compared to the developed nations (Druck *et al*., 2015:30-31; Magud & Sosa, 2015:4). Consequently, there has been a shift in monetary policy in most of the G7 countries and the effects of the financial crisis further spread to developing countries' term structures. For that reason, it becomes interesting to assess whether the financial crisis had an impact on the validity of the EH. Furthermore, in light of the low interest rates in some G7 countries currently, the EH may contribute towards monetary policy authorities' desire to stimulate economic activity in the affected economies by influencing the expectations of future monetary policy, as suggested by the EH (Gurkaynak & Wright, 2012: 333).

The EH has significant implications for financial development, particularly, for the newly formed BRICS bank – the New Development Bank (NDB). Features found on the term structure of interest rates provide valuable information in the future prediction of expected economic cycles within financial markets (Van der Merwe & Molletze, 2010:107). These features may assist the NDB in attracting financial investments, and in also reducing any arbitrage opportunities that may arise as a result of possible gaps found among the country rates. In addition, the information embedded on the term structure also becomes significant for various reasons (Panigrahi, 1997:2662). These reasons include the use of the information contained on the term structure by central banks as a guide to monetary policy as outlined by Mishkin (1991), and Gurkaynak and Wright (2012). Interest rate changes on the term

structure give an indication of the direction of future interest rates and the cyclical behaviour of an economy (Panigrahi, 1997:2662). They are also significant for projecting asset returns, hedging strategies and investment portfolio allocation (Gurkaynak & Wright, 2012:333) – all which may benefit market participants who are interested in taking advantage of interest rate movements or hedging against interest rate risk.

The term structure's predictive ability however, ought to be tested under modern economic conditions in order to assess its suitability as a tool for forecasting given the shift in monetary policy and structural changes in the G7 and BRICS economies.

1.3 OBJECTIVES OF THE STUDY

The following objectives have been formulated for the study:

1.3.1 Primary objective

The key objective of this research is to compare the predictability of the term structure of interest rates in the G7 and BRICS countries and assess the likelihood effect of the financial crisis on the validity of the EH.

1.3.2 Theoretical objectives

In order to achieve the primary objective of the study, the following theoretical objectives are formulated to;

- Review theoretical concepts of the EH;

- Provide theories that link the EH to monetary policy;

- Contextualize the reliability of the term structure as a predictor of the future interest rate movements and different phases of the business cycle; and

- Review empirical studies on the validity of EH within developed and developing countries.

1.3.3 Empirical Objectives

In accordance with the primary objective of the study, the following empirical objectives are formulated to;

- Determine the relationship between the short term and long term interest rates for each of the countries in the BRICS and G7;

- Test for the predictability of the term structure of interest rates in the selected developing and developed countries;

- Compare the validity of the EH in the selected developing BRICS and developed countries (G7) and;

- Assess the effect of the financial crisis on the validity of EH in developing and developed countries.

1.4   RESEARCH DESIGN AND METHODOLOGY

The study comprised a literature review and an empirical study design.

1.4.1   Literature Review

Secondary sources were employed in conducting this research. These sources included books, journals, newspaper articles, and the internet. Literature review consisted of theoretical and empirical literature to give more details on the EH and its implications for developed and developing countries.

1.5   EMPIRICAL STUDY

1.5.1   Data collection and sampling

The research made use of secondary data of BRICS and G7 countries collected from the World Bank in order to compare developing and developed countries. In the study of the EH, the Treasury bill rate is commonly used to represent the short-term rate (Nel, 1996) and the long term rate is often represented by the 10-year government bond, consistent with previous literature (Campbell & Hamao, 1991). Literature also shows that the theory can be tested at different periods. Then the EH test will be measured at 6 months and 10 years. The 91-day Treasury bill is converted to a monthly bill by calculating averages from weekly interest rates to monthly data; the employment of monthly data is consistent with that of previous studies of Modena (2008) and Güney (2013). The sample period spans between January 2000 and December 2015 due to the unavailability of data in some BRICS countries prior the year 2000. The main reason for the selected period is to take into consideration the

structural changes that took place, and for assessing developments in the financial markets more precisely before and after the 2007/08 financial crisis period.

1.5.2 Data analysis

In order to achieve the set objectives, the study used various econometric models. The behaviour of the term structure of interest rate in each country was evaluated by graphical and descriptive analyses. The assessment of the impact of the financial crisis on the validity of the EH was done by evaluating the EH of the observed countries before and after the financial crisis to see if there are any significant changes and also the comparison of the behaviour of the EH in the G7 countries to that of BRICS countries. In determining whether the long-run relationship between the long term and the short term interest rates exists, the Autoregressive Distributive Lag (ARDL) model was employed. A long-run relationship between the two interest rates would imply that the theory holds and that it can be used as a guide for monetary policy and investment decision making. On the contrary, failure of long-run association between the interest rates would imply that the theory does not hold.

Comparing the EH in BRICS and G7 countries was done in two folds. Firstly, by evaluating the ARDL results from each country in the two blocks to see whether the theory holds in most countries of each block. Secondly, a panel cointegration was used to test if the EH holds within each block and results of the two blocs were compared.

1.6   ETHICAL CONSIDERATIONS

The study employed secondary data that is publically available through central banks databases of the countries under observation. All NWU ethical considerations in this regard were followed to ensure ethical requirements were met.

1.7   CHAPTER OUTLINE

Chapter 1 – Introduction: This chapter serves to introduce and give a background of the study. It consists of the problem statement, the overall research objective, including both the theoretical and empirical objectives and the scope of the study.

Chapter 2 – Literature Review: Review of the literature, which consist of theoretical as well as empirical studies conducted on the expectations hypothesis of the term structure of interest rates. This chapter also reviews the expectations hypothesis of term structure of

interest rates' theoretical framework, the monetary policy and basic term structure of interest rates concepts.

Chapter 3 – Methodology: This chapter explains the sample period, data collection and econometric models employed in order to achieve the empirical objectives of the study.

Chapter 4 – Research Findings: This chapter presents conducted tests and provide results of the analysis of empirical findings, and discuss the findings in relation to theories and previous studies.

Chapter 5 – Conclusion: This chapter summarises the study, draws conclusions of the findings and provides recommendations and identifies possible opportunities for conducting further research on this topic.

CHAPTER 2: LITERATURE REVIEW

2.1   INTRODUCTION

The use of the term structure for forecasting the future economic activity, the market's expectations on future inflation, and subsequently, future interest rates, all have an essential role in financial markets (Estrella & Mishkin, 1996:1). A wide range of studies available assess the information contained on the term structure and its ability to predict future economic variables. In assessing the predictability of the term structure, the study considers the relative significance of the expectations hypothesis; the long rate, the economic cycle, and the need for a central bank to exert influence on the long rate using the short rate. Similarly, a relationship between the long rate and the short rate as implied by the expectations hypothesis would mean that monetary policy has substantial influence on the spread of the term structure. Therefore it is able to influence economic activity for some time, suggesting that the predictability of the term structure of interest rates may be a valuable forecasting tool (Estrella & Mishkin, 1996:1).

The focus of this chapter is on the theory and concepts that relate to term structure of interest rates. Specifically, the linkages of the term structure to the expectations hypothesis; monetary policy, the long term rate and the economic cycle, and finally the effects of the financial crisis. This forms the body to the theory behind the predictability of the term structure of interest rates. However, the focus is on the expectations hypothesis (EH) of the term structure of interest, the concept and the implications of the theory. Thereafter, the chapter looks at the ability of the term structure to predict the future interest rates; and how this ability of the term structure could have a significant role for monetary policy.

The study uses different states of the world to assess the predictability of term structure of countries that fall within two economic categories: developed and developing countries. In particular, the Group of Seven (G7) countries represent the developed nations, while developing countries are represented by Brazil, China, India, Russia and South Africa (BRICS). The G7 bloc consists of the world's leading and most advanced economies, which are: Canada, France, Germany, Italy, Japan, United Sates, and the United Kingdom. The BRICS group consists of five of the world's major emerging market economies, which account for about two-thirds of emerging market GDP (Global Macroeconomics Team, 2016). Given the brief background of the countries under observation, it is quite clear that

the term structures in each of these countries may behave differently owing to the unique economic setting and market forces in each country.

Moreover, investors often invest in securities that are from more than one national market with the hope of achieving excess returns and reduced risk exposure through diversification (Brooks, 2014:391). In light of this, the recent financial crisis, and the gradual emergence of financial markets in the BRICS group, it becomes significant to test for the predictability of term structure using the EH of term structure on the economies of both BRICS and G7 countries. This is to assess the effects that the crisis had on the validity of the theory on the different states of the world, and compare the outcomes as both groups face unique challenges. These challenges uniquely affect investor patterns. The BRICS and G7 countries provide an opportunity to assess the validity of the theory, the predictive ability of the term structure of interest rates, as well as the possible influence that monetary policy may be able to exert on changes on the term structure of interest rates (Estrella & Mishkin, 1997:1376).

2.2   CONCEPTUALISATION OF THE EXPECTATIONS HYPOTHESIS

2.2.1   Defining EH

The expectations hypothesis is one of the theories that explain the term structure of interest rates, and it has been chosen particularly for this study due to its explicit explanation of the term structure of interest rates. The expectations hypothesis is defined as a theory of the term structure that explains the relationship between the long rate and the short rate (Campa & Chang, 1995:530). The theory proposes that, an investment that consists of a series of short term securities should have the same returns as an investment on a longer term security for the next holding period (Hardouvelis, 1994:256). That is to say, default-free bonds are priced so that the return on a long term bond is the same as the expected return on repeated investments of short term bonds (Cox *et al*., 1985:385). Thornton (2014:208) refers to an assumption made about the theory relating to default free Treasury debt, stating that this kind of debt is perfectly substitutable across different maturities in the interest rate term structure. The theory further explains that over time, interest rates on bonds with different maturities move together, and that investors are mostly concerned about returns over maturity of securities (Mishkin & Eakins, 2006:115).

Accordingly, for the next holding period, the returns expected on bonds with different maturities is equal (Cox *et al*., 1985:385). In addition to this, Stojanovic and Vaughan

(1997) further advocate that investors are more concerned about returns than the maturity of the investment. Investors are likely to trade in securities that have varying maturities until the long term interest rates mirror an average of the future expected short term interest rates. Furthermore, Corte *et al*. (2008:158) affirms that an investor that apportions capital using the predictions of the EH is in a better position compared to an investor who exploits departures from EH.

2.2.2   Historical Overview

The EH of the term structure is one of the oldest and well-known theories in finance and economics (Longstaff, 2000:989). The theory dates as far back as the 1800s when it was introduced by Fisher (1896) and analysed by the likes of Macaulay (1938) and Malkiel (1966). Since then, it has gradually formed the basis for interest rate prediction and has been employed as a standard framework for the analysis of interest rates (Longstaff, 2000:989). However, there seems to be opposing views regarding the validity of expectations hypothesis. MacDonald and Speight (1988) found evidence in their study that is in favour of the EH. Mankiw and Miron (1986) found support for EH in their study, stating that the conduct of monetary policy contributes towards market participant's ability to predict movements of the future short rate.

Economies that have fixed exchange rate have been found to support EH mainly due to the occasional pressures on the exchange market leading to spikes in short rates (Gerlach & Smets, 1998). Further evidence supporting the theory include studies by Campbell and Shiller (1991) and Svensson (1994).

2.2.3   Criticisms of EH

In cases where there is statistical rejection of EH Campbell and Shiller (1987,1991) contend that the statistical rejection are immaterial as these often do not hinder the use of the theory as a tool for analysing movements in the term structure. Some studies (Carriero, *et al*., 2003; Duffee, 2002; Diebold and Li, 2006) point out the low performance of the theory as an issue that is likely caused by an inability to forecast the direction of short term interest rates. Assenmacher-Wesche and Gerlach (2008:6) contend that the rejection of EH is large in data with high fluctuation in short periods and it tends not to hold information on the future movement of interest rates. Other studies that reject the theory include those of Bekaert *et al*. (1997); Bekaert and Hodrick, 2001; Campbell and Shiller (1991); Clarida *et al*. (2006);

Fama (1984); Fama and Bliss (1987); Frankel and Froot (1987); Roll (1970); Sarno *et al*. (2007); Stambaugh, (1988).

The rejection of EH has implications for market observers and monetary policy makers. Unpredicted movements in the conduct of monetary policy may lead to large and often undesirable valuation gains and losses (Assenmacher-Wesche & Gerlach, 2008:6). Hence, the need for high transparency in the conduct of monetary policy as predictability is improved and risks associated with low transparency are reduced. In spite of this, the theory is employed in the analysis of interest rate movements in various sectors such as academic, central banks and financial sectors (Assenmacher-Wesche & Gerlach, 2008:5).

2.2.4   Relevance of EH

The expectations hypothesis of the term structure provides a simple way of understanding interest rate dynamics which are essential for several reasons including; derivative security pricing since it depends on market rates, hedging for investment strategies, and macroeconomics (Modena, 2008:1). The theory forms a basis for economic understanding through the analysis of movements of interest rates. However, apart from the reasons mentioned, forecasting is the most important one (Sangvinatsos, 2008:1). As Mankiw *et al*. (1986:61) affirm that the short rate is the opportunity cost of holding money and on the other hand, aggregate-spending decisions are contingent upon the long rate.

EH is able to clarify two out of three characteristics of the term structure; the first relating to the habit of bond yields, proposing that over time interest rates on bonds with varying maturities move together, and that investors are mostly concerned about returns over maturity of securities (Mishkin & Eakins, 2006:115). Accordingly, for the next holding period, the return expected on bonds with different maturities is equal (Cox *et al*., 1985:385). This implies that the long term interest rate reflects information about the expectations of the future short term interest rate in the market (Guidolin & Thornton, 2008:19).

The second characteristic pertains to the slopes of the yield curve. When the short term interest rates are low, yield curves are likely to have an upward slope (Mishkin & Eakins, 2006:111). In addition to this, yield curves are likely to have downward slopes and invert when short interest rates are high (Mishkin & Eakins, 2006:111). The second characteristic clearly indicates that there tends to be more volatility on short rates compared to the longer

term rates (Spaulding, 2016). The third characteristic states that the yield curve is almost upward sloping, owing to yields on long term securities that tend to be higher than that of short term securities (Mishkin & Eakins, 2006:111). Although the reason for the long term rate being higher than the short term rate under normal economic conditions is still unclear (Spaulding, 2016), there are a few links within the expectations theory that are able to explain this characteristic. One relates to the forward-looking characteristic of the long rate as it is an essential part of the expectations theory. Thus, even though there is no clear explanation for the long term rate being higher than the short term rate in normal conditions, there is a definite link. If, however, future rates are expected to repeatedly increase in the short-run, the expectations theory is able to give this condition as one of the other reasons for this characteristic (Spaulding, 2016). Moreover, in explaining the relationship between the long term and the short term securities the first two characteristics are explained quite well by the expectations theory. According to Mankiw *et al*. (1986:61), the term structure of interest rates seems rather significant to the monetary transmission mechanism, as the central bank has control over the short rate. Even so, should it be costly to amend capital or should capital cause a delay when needed for use, investment decisions possibly will be contingent upon the long term interest rate (Mankiw *et al*., 1986:61).

The expectations in the market regarding the direction that monetary policy stance will take lies in the difference between the long- and short term interest rate (Bernanke & Blinder, 1992). According to the EH, monetary policy is able to affect the long term interest rate simply by influencing the short term interest rates, which monetary policy is able to control, and also by altering expectations of future short term interest rates in the market (Walsh, 2003:465). Though monetary policy has a direct influence on the short term interest rate, it tends to affect the long term interest rates only through expectations (Estrella & Trubin, 2006:6). The long term interest rate is affected by more than one factor. For instance, its movement is influenced by economic activity and long term expectations of inflation, and it is quite challenging to find a close empirical relation between the two interest rates (Estrella & Mishkin, 1997:1376). Moreover, a rise in the short term rate is often followed by a relatively small rise in the long term rate. However, this may not always be the case, as at times the long rate can move in a different direction without any coinciding movement in the short term interest rates (Estrella & Trubin, 2006:6).

In essence, a significant feature of the long term rate as outlined by Guidolin and Thornton (2008:19) is that it is a forward-looking rate. In that way suggesting that, if the expectations

hypothesis is valid, it could serve as a useful tool in the prediction of the future movements of the short term rate as well as the term structure of interest rates (Campa & Chang, 1995:530). Sangvinatsos (2008:1) also supports this notion maintaining that should the theory hold, it will prove to be a necessary tool for forecasting, as forecasting affords most investment firms, financial institutions, individuals and policy makers a starting point in their decisions making. Furthermore, the expectations hypothesis is valid when there is a long-run relationship between the short term interest rate and the long term interest rate. Ultimately, the spread between the two rates, when the theory is valid, helps to forecast future short term interest rate movements (Campa & Chang, 1995:530). Failure of this kind of relationship to hold may result in a higher demand for the bond with higher yield compared to the bond with a lower yield. In addition to this, it may lead to arbitrage opportunities in the market.

2.2.5 The EH of Term Structure's Predictive Ability

The employment of interest rates to conduct monetary policy raises to prominence the role of the term structure of interest rates (Walsh, 2003:465). The term structure of interest rates measures the relationship among the yields on default-free securities that differ only in their term to maturity (Cox *et al*., 1985:385). The term structure spread, excluding term premiums, is a measure of monetary policy stance in relation to expectations in the long-run (Wright, 2006:1). This is because of the difference between the current short term interest rates and the average of the expected future short term interest rates over a longer horizon. By offering a complete schedule of interest rates across time, the term structure embodies the market's anticipations of future events (Cox *et al*., 1985:385).

Since the 1980s, the slope of the term structure – the spread between the short term and long term interest rate – has been at the centre of debate. Economists debate whether or not the slope of the term structure is a reliable predictor of future interest rates and future economic activity. Historically, current and future interest rates have been used to determine the direction of future interest rates, including that of inflation and exchange rates (Soderlind & Svesson, 1997:384). Extensive literature in the past links the changes in the shape of the term structure to changes that subsequently occurred in investment, GDP, and consumption (Estrella & Trubin, 2006:1). A model by Philippon (2009) proposes that the predictive information of corporate bond spreads regarding economic activity reflects deterioration in economic fundamentals stemming from a decline in the expected present value of corporate

cash flows prior to a downturn. In turn, credit spreads that are continuously increasing ought to be indicative of disruptions in the supply of credit due to deterioration in the standing of financial intermediaries or the deterioration of the quality of corporate balance sheets (Philippon, 2009; Guidolin & Tam, 2013:19).

Studies from most of the G7 countries provide evidence of the term structure's ability to predict future interest rate movements or future economic activity. However, accuracy is contingent upon the period of data chosen and maturity levels of securities under observation. Assenmacher-Wesche and Gerlach (2008:5) find that the short rate embodies quite a great ability to predict future movements in periods spanning between six months to four years due to the conduct of monetary policy. Conversely, the term structure seems not to have much information regarding future interest rates during high frequency fluctuations or in the short run, in such cases, Assenmacher-Wesche and Gerlach (2008:6) suggest that the term structure should be disregarded.

Estrella and Trubin (2006:2), state that the sensitivity of the term structure to changes in the financial market caused by technical or fundamental factors should be considered, to ensure that term structure demonstrates some persistence in order to be meaningful. Moreover, the difference in the development of the financial markets could lead to variations in terms of the predictability of the term structure in each country. As pointed out by Khomo (2005:10), the term structure of countries with vastly developed financial markets is able to provide valuable information regarding the state of the economy. All of this allow for increased insight on the analysis of the predictability of term structure, similar to a proposition by Thornton (2004) on the empirical relevance of the relative variance of short to long term rates for the success of the expectations hypothesis.

2.2.6   Comparison of the Term Structure's Predictive Ability to other Forecasting Measures

The expectations about future policy have quite a significant role in the determining the shape of the term structure of interest rates (Walsh, 2003:465). In comparison of the term structure spread with other forecasting measures as future economic activity predictors, Estrella and Mishkin (1998) found that the term structure's predictive ability often outperforms the other highly considered forecast indicators in finance and economics. The term structure's spread is a valuable tool for future prediction, particularly the spread between the three month Treasury bill and the ten year Treasury note (Estrella & Trubin,

2006:3). The term structure's predictive ability proves to be powerful again in a study done by Mishkin (1988), where the author re-examined evidence found by Fama (1984) on the information contained in the term structure about future spot interest rate changes. Fama's findings provide proof that the difference between the spot and the forward rate assist in forecasting future changes in the spot rate, while the forward rate makes it possible to forecast changes in the spot rate at least a month ahead (Fama, 1984).

Using the ten year Treasury note and the three-month Treasury bill, the term structure yet again proves to be relatively more powerful when it comes to forecasting future economic activity especially on a long term forecast (Estrella & Mishkin, 1996). Mishkin (1988) conducted this study by employing econometric procedures that accurately apply standard errors for heteroscedasticity and for data that is overlapping. The study conducted by Fama (1984) made use of ordinary least squares and found that the spread between the spot and forward rate was able to forecast future interest rates. Furthermore, Mishkin (1988) employed data that was more recent compared to the work done by Fama, the outcome generally agreed with that of Fama (1984). The term structure proves to be a valuable forecasting tool as it is able to predict movements for several months ahead of the spot interest rates (Mishkin, 1988:11). Furthermore, Ang *et al*. (2006:359) predict and confirm by predicting GDP out of sample that, the short term rate has more power than any term spread when it comes to forecasting. While Sangvinatsos (2008:1) asserts that forecasting is essential in assisting the central bank monitor the effect of its policy implementation on the expectations in the market and on the underling forces of prices. This then makes the ability of the term structure to forecast interest rate movements important for the implementation of optimal monetary policy (Sangvinatsos, 2008:1).

When compared to other leading indicators, the predicting ability of the term structure spread proves to be the strongest leading indicator throughout literature. However, there are few concerns that are not clearly addressed by available literature. Estrella and Trubin (2006:1) outline these concerns with the first one relating to an explanation that is particular and recognized regarding the relationship between the term structure and stages of the business cycle such as the recession. Opposing views on the existence of this relationship amongst economists weakens confidence in the term structure as a leading indicator (Estrella & Trubin, 2006:1). Another concern relates to the creation of forecasts purely on the movements in the term structure. The authors state that literature lacks a standardized method in the creation of forecasts (Estrella & Trubin, 2006:1). In assessing the predictive

power of the term structure the question of a measure of economic activity to be employed still remains (Estrella & Trubin, 2006:1).

The term structure of interest rates has been found to have significant predictive ability when it comes to the forecast of future changes of the short term interest rates. Evidence has been found by Mankiw, *et al*. (1986), Campbell and Shiller (1987, 1991), Engsted (1993), Engsted and Tanggaard (1992). By observing the slope of the long term interest rate, Fama (1984) suggests that it is possible to forecast the direction of future change in short-term rates. Estrella and Hardouvelis (1991) found that a positive slope of the yield curve signals a future rise in economic activity; whether this increase is in consumption or in investment. Mishkin (1990b) looks at the information in the longer maturity term structure and provides evidence that a downward sloping yield curve reflects expectations of a depressionary state and a normal yield curve is indicative of rising inflation. The term structure seems to be a more compelling tool for the prediction of future economic activity, particularly interest rate movements. This is owing to the term structure of interest rates' prediction that is found to outperform the other indicators on a long term horizon, a horizon that is quite valuable to policymakers since policy decisions are normally effective in the long-run (Estrella & Mishkin, 1996:4).

2.3   THE ROLE OF MONETARY POLICY IN EH

Economists and monetary policy authorities frequently face the challenge of predicting the future direction of interest rates. Market participants, analysts and central banks alike are challenged by movements in the interest rates and it is vital for them to comprehend the dynamics of interest rates for better financial security valuations and for risk management practices (Modena, 2008:2). Interest rate forecasts enable them to moderate risks that are linked to the movement of interest rates, thereby maximizing profit opportunities from the interest rate predictions.

The central bank plays a pivotal role in the guiding the expectations for future changes in the interest rates in most countries. Through implementing monetary policy the central bank is able to achieve macroeconomic objectives, in most cases proving that monetary policy is a significant tool (Mathai, 2012). Central banks pursue macroeconomic goals such as growth, stability, and unemployment using different monetary policy frameworks. However, the most common framework of late is inflation targeting. In pursuing these goals the central bank makes changes in the short term interest rate, the main instrument of monetary

policy which the central bank has direct control of, and the change is soon transmitted through various channels (Mathai, 2012). Adjustment in the short rate enables the central bank to influence the market's future expectations regarding the policy rate, also allowing the central bank to affect the economy (Thornton, 2014:205).

The economy goes through periods of high and low economic activity. Both situations may be corrected through implementing contractionary or expansionary monetary policy respectively. Contractionary monetary policy is implemented by increasing the short rate, consequently reducing the demand and economic activity as the cost of borrowing rises (Estrella *et al*., 2003:632). The main aim of contractionary monetary policy in most cases is to reduce inflation. A lower demand in an economy is associated with a reduction in inflation consequently, lowering the prices of goods and services in the market. The policy leads to less a probability of business taking on new investments such as investing on new buildings, equipment and taking on new projects.

In addition to this, a higher interest rate affects the ability of households and businesses to qualify for credit due to a decline in net worth. The implementation of expansionary monetary policy on the other hand tends to lead to an increase in economic activity and in a higher demand as the cost of borrowing becomes lower. The main intention of this monetary policy action is to encourage economic activity; enabling business to take on new investments and access to credit facilities eventually leading to a rise in inflation. During times of weak economic activity monetary policy authorities carry out expansionary monetary policy. Expansionary monetary policy involves the lowering of the central bank's main instrument, thereby making the term structure, which is the spread between the long and the short term interest rate steep, leading to a recovery in the economy (Estrella *et al*., 2003:632).

The change in the main instrument of monetary policy is the ability to influence the economy through the main interest rate channel (Taylor, 1995). The changes made in the stance of monetary policy are reflected in the monetary policy transmission mechanism (MPTM) (Bonga-Bonga, 2010:43). The MPTM refers to a process that develops following a change in monetary policy stance. More oftenly, this is referred to as the interest rate channel of MPTM (Mishkin, 1995). The channel has four main transmission channels: short term interest rates, long term interest rates, asset prices and real effective exchange rate of the currency (Van der Merwe & Mollentze, 2013:203). The main focus of this study

however, is on the short term interest rate and the long term interest rate channel, and the relationship that exists between the two interest rates, if any at all.

Monetary policy is also susceptible to interest rate changes in foreign countries such as the normalization of interest rates in developed countries. Due to an increasing integration among various countries, the liberalization of international financial markets and the advancement of the economies in the world, economic activities and interest rates tend to be interdependent (Van der Merwe & Mollentze, 2013:415). Often the implication of this is that a shock in one country's financial system affects several other countries. The liberalization of financial markets opens up the influence by foreign monetary policy on the domestic term structure of interest rates (Holmes *et al*., 2011:680). Furthermore, the interdependence and integration affects the implementation of monetary policy, as changes made in monetary policy go through a number of channels and influence decision making in the economy (Van der Merwe & Mollentze, 2013:415).

With reference to the interest rate channel, the effectiveness of the MPTM process is determined by the ability of monetary policy to influence a range of interest rates of securities or bonds with different maturities. In essence the ability of monetary policy authorities to effectively guide the economy partially lies on monetary policy's ability to influence long term interest rates which then ultimately affects the decision making of various market participants (Taylor, 1995). This is due to the ability of the central bank to influence the economy mainly through indirect channels precisely through influencing the expectations of market participants, especially those of the private sector, thereby influencing the long term interest rates (Bernanke, 2004). According to Roley and Sellon (1995); Bonga-Bonga (2010:43-44), the relationship between the monetary policy and the long term interest rate is difficult to determine as the response of the long term rate to changes via monetary policy can be quite variable.

Furthermore, Taylor (1995) asserts that determining which of the interest rates between the long and the short rate has greater effect on economic activity is not an easy task. The author states that the long rate ought to receive considerable attention as long term decisions that involve investment in plant and equipment depend on this rate (Taylor, 1995). The long term rate channel is directly linked to bond rates and these rates comprise future policy rate expectations of bond traders (Kozicki & Tinsley, 2008:72). As such, (Bonga-Bonga, 2012:3955) asserts that the ability of monetary policy authority to influence the long term

interest rate depends on the validity of the expectations hypothesis of term structure (EHTS).

The role of the long rates in monetary policy transmission is a significant one, and it is one in which the link between expectation and observed or announced policy is not completely understood (Kozicki & Tinsley, 2008:72).

Moreover, Estrella and Trubin (2006:6) assert that the implementation of monetary policy in an attempt to influence the long rate tends to be unreliable, making the relationship between monetary policy and long term rates quite vague. Bonga-Bonga (2010:43-44) also notes that the relationship between the monetary policy and the long term interest rate is difficult to determine as the response of the long term rate to changes via monetary policy due to its variability. Furthermore, Taylor (1995) asserts that attempting to find which of the two interest rates has a greater influence on an economy's consumption and investment activity is rather challenging. The long term interest rate is affected by more than one factor; its movement is influenced by economic activity and long term expectations of inflation. Thus it is quite challenging to find a close empirical relation between the long rate and the short rate (Estrella & Mishkin, 1997:1376). Even so, the challenge points back to how effective the MPTM process is, the effect of monetary policy action on the varying interest rates following a change in monetary policy stance (Bonga-Bonga, 2010:43).

Essentially, the behaviour of the long term interest rate is to a certain extent or in an indirect manner affected by monetary policy action (Bernanke, 2013:1). For that reason, in the employment of interest rates to conduct monetary policy, monetary policy authorities are only able to influence the short term rate. The long term rate does not react rapidly to changes made on the short term interest rate (Modena, 2008:2).

Evidence in a study conducted by Estrella and Mishkin (1997:1377) give a clear indication of the extent to which the central bank can influence the spread between the long and the short term interest rate, also pointing out that the central bank is not able to have complete control over the spread between the two interest rates. Moreover, changes in the long term interest rate affect the macro-economy through the cost of borrowing, the value of savings over time, the sustainability of fiscal deficits and the valuation of investment projects (Cochrane, 2015). Bonga-Bonga (2012:3961) found evidence that the long term interest rate in South Africa, a developing country, is to a large extent influenced by fiscal policy, while the short term interest rate is influenced by monetary policy. The author found a positive

relationship between long term interest rates and the budget deficit, which implied that the long term interest rate would increase when the budget deficit increases (Bonga-Bonga, 2012:3961). Thus proposing investment is discouraged by higher long rates and this has a direct bearing on economic activity. Since the public debt's maturity structure is able to affect the government budget, treasury can perform active debt management, thereby influencing the long term rates (Modena, 2008:1).

Monetary policy also affects the economy mostly through financial markets (Kohn, 2005). Moreover, information extracted from asset prices gives the central bank an indication of market participants' future expectations (Soderlind & Svensson, 1997:383). Asset prices have information that can be valuable to central banks since this information reflects market participants' expectations for the future direction of monetary policy, inflation, economic activity and possible risks (Kohn, 2005). Asset prices have more accurate and updated macroeconomic data than information that is available to policy authorities (Soderlind & Svensson, 1997:383). Nevertheless, long term securities often have higher interest compared to short term securities, owing to maturity risk as there are greater opportunities for loss over the life of the long term security (Rose & Hudgins, 2013:223). Thus in the implementation of monetary policy, a change in the short term interest rate is only significant when it is able to affect the long term interest rate, thereby affecting aggregate spending decisions (Walsh, 2003:465). That is, the long term interest rate is generally driven by the market and not directly influenced by monetary policy (Modena, 2008:2).

While monetary policy has a direct influence on the short term interest rate, it tends to affect the long term interest rate only through expectations (Estrella & Trubin, 2006:6). A rise in the short term rate is often followed by a relatively small rise in the long term rate. However, this may not always be the case, as at times the long term rate can move in a different direction without any coinciding movement in the short term interest rates (Estrella & Trubin, 2006:6).

2.4   YIELD CURVE AND EH

The yield curve explains the term structure of interest rates for securities such government bonds (Mishkin & Eakins, 2006:110). It is a curve that is obtained from government bond prices and is also referred to as the interest rate term structure (Hackworth, 2008:259). The term structure measures the relationship among interest rates of bonds with different maturities, that is, the association of yields on securities that differ in terms of maturity is

reflected on a yield curve (Cox *et al*., 1985:385). Throughout the study, the yield curve will have the same meaning as the term structure of interest rates as the yield curve is a graphical illustration of the term structure of interest rates (Nel, 1996:162).

2.4.1 The Yield Curve as a Forecasting Tool

Defined as a measure of the market's risk free rate of return, the yield curve is able to indicate the future direction of the short rate (Hackworth, 2008:259). The yield curve is indicative of how the yield on a bond changes with time to maturity; and just like the term structure of interest rates, it depicts the spread between yields of securities such as bonds that differ in terms of maturity (Nel, 1996:162). The spread between the long and short term interest rates is a useful measure that is employed by central banks in assessing the credibility of the monetary policy regime and inflation expectations. To assess the likelihood of recessions and to determine the expectations in the market regarding future changes in monetary policy the slope of the yield curve becomes a useful tool (Assenmacher-Wesche & Gerlach, 2008:7). The term structure embodies information regarding market interest rate movements that enables it to predict how changes in the underlying interest rates may affect the yield curve (Cox *et al*., 1985:385). This is a feature that, if proved to be reliable, could contribute immensely to the financial decision making process. The term structure enables market participants to make deductions based on the information that is embedded on it, thereby giving market participants the ability to predict future changes and how these changes will affect the yield curve and possibly their security holdings (Cox *et al*., 1985:385).

The use of yield curve in the world of finance is common to Economists and fixed income security analysts, and it serves as a significant tool for policymakers (Campbell, 1995:1). The information on the yield curve is employed for a number of reasons. These reasons include; benchmarking, valuation of security prices, and the assessment of strategies for monitoring interest rate risk as most strategies are reliant on the changes of the yield curve and its shape (Spaulding, 2016). In addition to this, market participants are concerned greatly with their security holdings during turbulent financial times. Market participants are more inclined to reallocate their holdings to less risky investments when a default risk is perceived to rise (Guidolin & Tam, 2013:19). Generally, securities with long maturity often have high yields owing to the additional risk that the holders of these securities are exposed to (Rose & Hudgins, 2013:220). Consequently, Guidolin and Tam (2013:19) assert that a

rise in the perceived default risk tends to widen the default risk premium as market participants shift their assets to hedge against unfavourable interest rate movements.

Furthermore, the authors affirm that this is owing to the asymmetric adjustment process which characterises turbulent financial periods and sets them apart from normal periods (Guidolin & Tam, 2013:19). Information on the yield curve thus gives the ability to forecast interest rate movements which is important for the management of risk, bond portfolio management and derivatives pricing (Diebold & Li, 2006:338). Sangvinatsos (2008:1) asserts that forecasting is essential in assisting the central bank monitor the effect of its policy implementation on the expectations in the market and on the underling forces of prices. This then makes the ability of the theory to forecast interest rate movements important for the implementation of optimal monetary policy (Sangvinatsos, 2008:1). Since the expectations hypothesis proposes that market participants are mainly concerned with the return on their investments more than the maturity of the investment, this is likely to have implications for the slope of the term structure. Hedging activities in the market that result into increased demand for one asset maturity over the other, more often than not, are the source of temporary shifts in the slope of the term structure (Estrella & Trubin, 2006:2).

2.4.2 Interpretation of the Yield Curve

The employment of the yield curve in the analysis of interest rates has led to a common assumption in a vast amount of literature (Litterman & Scheinkman, 1991; Balduzzi *et al*. 1996; Bliss, 1997a, b; Dai & Singleton, 2000) that the curve consists of underlying factors that are often interpreted as level, slope and curvature (Andersen & Lund, 1997; Diebold *et al*. 2008:351). The underlying key factors of the yield curve are often associated to a country's macroeconomic factors such as economic activity and inflation (Ang & Piazzesi 2003; Diebold *et al*. 2006; Diebold *et al*. 2008:356). A graphical illustration of the different shapes of the yield curve are on Figure 1. The level of a yield curve refers to a shift up or down of the curve owing to changes in expected future inflation. Thus an upward shift in the level of the yield curve may be interpreted as being reflective of growth or upward strength in the economy, consequently higher inflation expectations that may induce a hike in the short term interest rate should inflation rise (Walsh, 2003:474). The curvature of the yield curve includes a humped curve which may signal the expectation of a rise in short term interest rates in the coming year however, in the long-run interest rates are expected to

decline (Spaulding, 2016). A steep yield curve on the other hand would tend to have a fast increase of interest rates as the maturity of the bond held lengthens.

Figure 1: Yield Curve Shapes

Normal — Yield / Maturity

Inverted — Yield / Maturity

Humped — Yield / Maturity

Steep — Yield / Maturity

Flat — Yield / Maturity
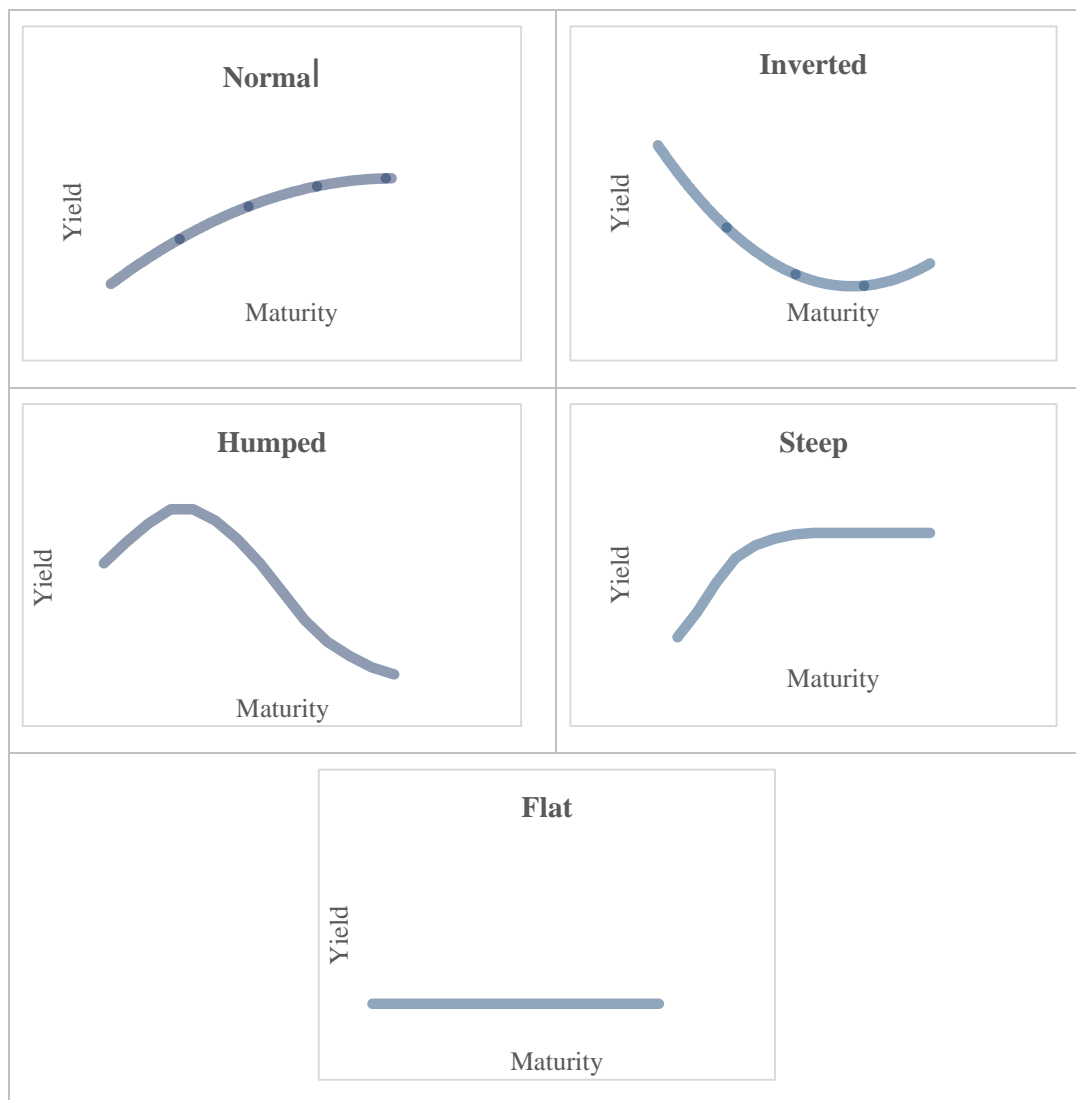
Source: Compiled by author

The difference between the yield of a long and a short maturity bond defines the slope of the yield curve (Ang *et al*., 2006:360). The slope of the term structure is influenced by changes in the market's expectations. And since the future inflation and the demand for credit in the future are linked to the market's expectations of future short term interest rates, accordingly the slope of the yield curve is able to assist with predicting the direction the future short term interest rate may take (Estrella & Trubin, 2006:2). The expectation of a rise in future interest rates is often indicated by a long term rate that is higher than a short term rate, thus signalled by an upward sloping yield curve (Spaulding, 2016). While on the other hand, an

expectation of a decline in future interest rates is indicated by a long term rate that is lower compared to the short term rate signalled by an inverted yield curve (Spaulding, 2016).

Accordingly, the shape of the yield curve can take various forms, with each shape of the yield curve giving different signals. Furthermore, the shape of the yield curve appears to be contingent upon various factors. These include; economic conditions, expected interest rates, inflation, and fiscal policy to name but a few. A normal or upward sloping yield curve is shown by a long term interest rate that is greater than the short term interest rate. Often, when the yield curve is sloping upward, the yield is said to rise as the maturity of the bond lengthens, clearly suggesting that a longer term bond would pay a higher yield (Spaulding, 2016). The expectations hypothesis suggests that the short term interest rate is expected to rise in the future. Here the average of future short term rates is expected to be higher than the current short term interest rate; this only happens when the short term interest rates are expected to increase (Mishkin & Eakins, 2006:115). The expectation of an increase in the short term interest rate affects total demand and inflation in the economy through indirect channels (Mollentze, 2000).

A downward sloping or inverted yield curve on the other hand, is illustrated by a long term interest rate that is below the short term interest rate. This indicates that the average of the future short term interest rate is expected to fall below the current short term interest rate in the future (Mishkin & Eakins, 2006:115). A flat yield curve indicates that the average future short term interest rates are expected to remain the same as current short term interest rates. Other times, it may signal an expectation of declining short term rates and the possibility of a recession when the short rate declines (Mishkin & Eakins, 2006:110). This in turn signals that the demand in the economy will decline, encouraging the central bank to lower the short term rate so as to stimulate demand. Declining short term interest rates reflect the market's future expectations on monetary policy action and the state of the economy.

There is a link between a yield curve with a positive slope and a future rise in economic activity such as consumption and investment (Estrella & Hardouvelis, 1991:555). The slope of the yield curve is found to have forecasting power that outperforms other leading indicators as it is able to predict inflation, activity in the economy and short term interest rates (Estrella & Hardouvelis, 1991:555; Khomo 2005).

Shiller (1979:1190) alludes to a form of implied forecasting ability in the long rate when a model uses cumulative short rates as long rate averages, this suggests that long rates are less volatile while the actual volatility in long rates exceeds model limits.

2.5   EH AND THE BUSINESS CYCLE

2.5.1   The Business Cycle and the Term Structure of Interest Rates

Generally, the price of financial instruments is related to the market's expectations of future economic activity (Estrella & Mishkin, 1998:45). Panigrahi (1997:2662) asserts that the term structure of interest rates has definite bearing on asset pricing and on the direction of the business cycle. This is due to the close relationship that exists between asset pricing, the direction of the business cycle and the term structure of interest rates (Panigrahi, 1997:2661). Apart from the ability to indicate future interest rate movements, Nel (1996:162) affirms that the term structure of interest rates is also quite informative regarding economic activity or the business cycle. In addition, Guidolin and Tam (2013:19) assert that the use of the information embedded on yield curves is important due to it being indicative of a significant channel through which financial prices have an impact on the real side of the economy. It is thus important to study the term structure and its content as the term structure is able to provide market participants with information that is essential in decision making. It is also able to give a precise direction of the future movements of indicators such as interest rates, inflation, business and economic activity (Panigrahi, 1997:2661). This allows the security holders to hedge against risks and position their securities in a way that is favourable.

The existence of information pertaining to future economic activity on the spread of the term structure clearly indicates that there may be a correlation between future activity and the term spread (Peel & Ioannidis, 2003:147). The EH of term structure provides the basis for forecasting economic activity by employing the term structure of interest rates (Estrella & Mishkin, 1998:45). Peel and Taylor (1998:353) found evidence of a demand side effect of the yield curve on economic activity, indicated by a strong association between the slope of the yield curve in the United States, and temporary components of economic activity.

The information found on the term structure of interest rates may be significant as it is likely to reveal an important channel through which financial prices affect the real side of the economy (Guidolin & Tam, 2013:19), thus, making the anticipation of future events

imperative. In addition to the central bank's ability to use the term structure of interest rates as a guide to monetary policy, central banks are able to indirectly control the economic cycle and the long term interest rate by influencing the short term interest rate (Panigrahi, 1997:2662).

2.5.2   The Term Structure as a Predictor of Business Cycles

Employing the term structure of interest rates for its forecasting ability requires an approach that will first validate its ability to predict historical content and then apply it steadily. Thus predicts economic downturns using the steepness of the yield curve as a measure (Estrella & Trubin, 2006:2). Apart from other economic factors, the movement in interest rates are the cause of some economic events (Panigrahi, 1997:2661). There is a wide range of literature available that capture the existence of a positive relationship between the slope of the term structure and several measures of the economic activity information contained on the term structure of interest rates.

The implementation of contractionary monetary policy is accompanied by a decline in the long rate in most cases, in that way dampening nominal long term interest rates and future short term interest rates (Walsh, 2003:474). Yet, the inverted shape of the term structure has been deemed as a predictor of recessions that is robust (Wright, 2006:10). The shape of the term structure is found to contain more information about the probability of a recession occurring compared to information provided by just the term spread alone (Ang *et al*., 2006). The slope of the term structure of Treasury rates is often referred to as a leading indicator of economic activity, while on the other hand, a recession is signalled by a downturn of the term structure of Treasury rates (Wright, 2006:1). The spread of the term structure is used to forecast real future recessions or output growth as Estrella and Hardouvelis (1991) found evidence supporting the slope of the term structure's ability to forecast future activity. Furthermore, the employment of external habit formation combined with a model by Campbell and Cochrane (1999), the consumption capital asset pricing model (CCAPM), makes available a valuable framework (Estrella *et al*., 2003:631). In this framework, a remarkably positive or a remarkably negative term structure slope serves as a leading indicator of future economic conditions (Estrella *et al*., 2003:631). The positive slope is able to indicate improvements in future economic conditions, while the negative slope is able to indicate weakening economic conditions in the future (Estrella *et al*., 2003:631).

There are rather a number of channels through which the forecasting power of the term structure of interest rates may manifest, as a result, the variety of literature proposes that the relationship that exists between the term structure of interest rates and economic activity is, to a certain extent, robust (Estrella & Trubin, 2006:2). Accordingly, a channel that is not active at a certain time usually implies that other channels may slack (Estrella & Trubin, 2006:2).

2.5.3   Criticism of the Term Structure as a Predictor of Business Cycles

Contrary to the evidence that supports the relationship between the forecasting power of the term structure of interest rates and variables of economic activity, there are studies such as that of Estrella *et al*. (2003); Giacomini and Rossi (2005) that have found the term structure's predictive ability tending to weaken from the 1980's in some developed countries. An observation made in Germany and the United States cautions that forecasting models of the term structure spread when used should be applied with a certain degree of confidence in the models' reliability over time (Estrella *et al*., 2003:641). The forecasting ability of the models that use the term structure spread to predict either inflation or economic activity indicates that the predictive ability of these models is subject to the stability of the models (Estrella *et al*., 2003). Moreover, the observation made by Estrella *et al*. (2003) checks for structural breaks using an econometric technique known as the generalized-method-of-moments, conversely, no significant break is found in the relationship between the term structure and the recession dummy in the study. The results clearly show that most of the predictive relationships examined are to a certain extent close. However, the theoretical motivations propose that these relationships may not have continued stability.

2.6   THE FINANCIAL CRISIS AND EH

Even though research that has been done up until this point clearly shows how useful the term structure has been at predicting future changes in interest rates and possible economic cycles, not much is known about the effect that the financial crisis may have had on the term structure's ability to forecast, and on the possible shift in monetary policy caused by the financial crisis.

The economies of developed countries underwent major financial disruptions when the US financial system failed leading to the recent financial crisis (The Economist, 2013).

Conventionally, dated as a phenomenon that took place between August 2007 and June 2009, the financial crisis has since been regarded as the worst disruption since the Great Depression of 1929-1933 (Guidolin & Tam, 2013:18). Prior to the financial crisis, the central bank's main task was to implement a policy that was intended to stabilize price and reduce inflation in the US economy (Bernanke, 2004). Consequently, low short term interest rates in developed countries pulled down the long term interest rate resulting into low long term interest rates. This encourage various market participants to take on securities that were much riskier in the hope of higher returns (The Economist, 2013). Treasury securities provide a safe-haven during times of uncertainty, financial events in the US and Europe appear to have increased the demand for these instruments, causing downward pressure on Treasury yields, thereby resulting to a low or negative term premium (Bernanke, 2013:7). The effects of the eventual collapse of what was a fragile economy spread to other parts of the world and are still present in many economies.

The financial crisis revealed the underlying weakness of the policy framework employed by the central bank consequently, causing a shift in monetary policy (Mishkin, 2012:2). The weakness of the central bank policy framework became evident when the economy was in a recession post the crisis. During this time, the central bank could not implement expansionary monetary policy as the instrument rate was in the zero bound (Svensson, 2000:1). Since interest rates in most developed (G7) countries were in the zero-bound, this meant that the interest rates in developing countries such as the BRICS countries became investment alternatives as they were higher. According to Bernanke (2013:7), the main driver of huge capital inflows in developing countries in recent years is largely triggered by the financial crisis and by the challenges in the euro area that followed after, causing global financial and economic pressure.

Moreover, the central bank was not able to use traditional monetary policy to stimulate the economy as they could not lower the interest rates further (Mishkin, 2012:8). This challenge saw the use of an alternative non-traditional monetary policy referred to as quantitative easing (Mishkin, 2012:9). Quantitative easing involves the purchase of government securities by the central bank in order to increase money supply in an economy and to reduce interest rates, thereby stimulating economic activity (Svensson, 2000:18). The implementation of QE in Europe and the U.S. illustrate that traditional policies and theories are quite limited when it comes to solving the challenges faced by modern economies in times of, and after a crisis. So where does this leave EHTS?

In assessing the effects of the financial crisis, it becomes clear that the effects will endure long after the crisis passed due to the adverse changes that took place from a policy perspective (Guidolin & Tam, 2013:37). Studies conducted by Guha and Hiris (2002), and Gilchrist *et al.*, (2009) reveal a business cycle phenomenon that is widely recognized, the tendency of bond yield spreads to expand shortly before a recession unfolds and to contract before a recovery. Although Guidolin and Tam (2013:19) assert that observing the financial crisis through the spread of data is an indirect manner of associating financial events to the developments of the business cycle.

Clearly, the advancement of the economies in the world carries with it various forms of risk. Shocks in the economy are unavoidable, and market institutions that are adversely affected by shocks may be indicative of deteriorating predictive ability of term structure spreads (Uesugi & Yamashiro, 2009). Hence the need to find out the relevance of EHTS in modern economies and the ability of these term structures to forecast future interest rate movements given the recent financial crisis. The theory suggests that there ought to be a long-run relationship between the two interest rates that are under observation. Failure of a long-run relationship would result in the rise of arbitrage opportunities. Arbitrageurs earn a profit by selling overpriced short bonds and buying bonds that are under-priced. This is known as yield curve arbitrage (Spaulding, 2016). Under normal economic conditions the shape of the yield curve is upward sloping. A deviation from the normal state would allow for arbitrage opportunities from the distortion in the yield curve (Spaulding, 2016).

2.7   EMPIRICAL LITERATURE

Developments in the testing procedures of EH have become sophisticated as the theory made progress over the years, making these procedures quite useful for research (Corte *et al.*, 2008:158).

Literature on the term structure's predictive ability uses different types of interest rates when assessing the spread between the interest rates. However, most studies make use of either the two year Treasury rate and the ten year Treasury rate or, the three month Treasury bill rate and the ten year government bond rate. The combination of the three month Treasury bill and the ten year bond has in previous studies provided accurate and robust recession forecasts in most developed countries such as the United States (US). In selecting the suitable rates, Estrella and Trubin (2006:3) point out that the consistency calculation of rates over time, risk premiums and the availability of historical data form part of the criteria

that should be considered. Treasury rates are often computed on a consistent basis, they are not subject to substantial credit risk premiums which are likely to change with maturity, and historical data is readily available (Estrella & Trubin, 2006:3). After this consideration, the authors further state that it is important to determine the most effective maturity groupings (Estrella & Trubin, 2006:3).

2.7.1 Empirical Studies from Developed Economies

The validity of the expectations hypothesis is central to the theory of the term structure of interest rates (Uesugi & Yamashiro, 2009:72). However, the expectations hypothesis has received considerable attention in the literature of term structure, and has been tested extensively using data from various economies at different time periods. Such studies include Bekaert *et al*. (2001), Campbell and Shiller (1991), Mishkin (1990) and, Sangvinatsos (2008). Despite all of this, there is still no overall consensus on the validity of the expectations hypothesis (Cargill, 1975:763). Applying cointegration methods on a sample of ten countries that became part of the European Union in 2004 Koukouritakis and Michelis (2008) assess the validity of EH of term structure and point out strong association between two countries. However, there was a weak association among the ten countries. Sangvinatsos (2008:14) employed US data in testing the validity of the expectations hypothesis, and concludes that the theory does not hold but it provides mixed results for data from outside the United States. A study done by Thornton (2006) provides similar evidence to that of Sangvinatsos (2008:14). The author argues that the expectations hypothesis gives misleading results as favourable outcomes are found even when the theory does not hold (Thornton, 2006). Research done by Mankiw and Miron (1986); Fama (1986), Cook and Hahn (1989), Lee (1995), MacDonald and Speight (1988), and that of Tzavalis and Wickens (1997) support this outcome. While those of Mankiw (1986), Mankiw and Summers (1984), Shiller *et al*. (1983), and Taylor (1992) reject the theory.

The term structure of US bond rates provides rather mixed evidence of the role played by EH as there is significant support for the theory in some cases and other cases it is rejected such as at the short end of the term structure (Shiller, 1979; Campbell & Shiller, 1987, 1988, 1991; Fama & Bliss, 1987). The UK and Japan also have no exception to this phenomenon. MacDonald and Speight (1988) found that long term bonds are in favour of the EH, whereas Taylor (1992) found evidence that rejects the EH when testing bonds of similar maturity. Empirical results of studies conducted in Japan have contrasting outcomes.

According to a study by Thornton (2004), Japan short maturity securities are in favour of the EH. Using varying maturities of Yen Eurobonds and Japanese government bonds Batten *et al*. (2003) studied the long-run equilibrium effects of EH of term structure and found evidence supporting the theory. The discovery is that as adjustments to long rate yields in the short rate yields occur, liquid long-term Japanese government bonds lean towards to driving the Yen Eurobond term structure.

2.7.2   Empirical Studies from Developing Economies

Research in Asia as conducted by Holmes *et al*. (2011:688) employed panel testing procedure and empirical results show that the EH holds for each of the countries observed. The implication of their study relates to efficiency of the financial market and that using monetary policy, the central banks are able to influence long term interest rates (Holmes *et al*., 2011:688). This suggests that the current long rate is an unbiased predictor of the future short rate and it cannot be enhanced through employing current information available. Shelile (2006) tests the ability of the South African term structure of interest rates to forecast economic activity and finds support for the term structure's predictive ability. The yield curve in South Africa was analysed by Khomo (2005) and the results support the ability of the yield curve to predict the developing recessions and the business cycle. Moreover, Clay and Keeton (2011:187) found empirical evidence that supports the ability of the yield curve to forecast future downturns in the economy, although the yield curve made a false prediction in 2002 to 2003, it was able to correctly predict the recession that occurred in South Africa between 2008 and 2009.

On the hand, owing to structural changes in South Africa and India, a shift to inflation targeting and robust capital flows in South Africa after the apartheid era, Beechey *et al*. (2008) founds no evidence supporting EH. The author further noted that the lower long rates found in these countries may have some correlation to the lack of support for the theory (Beechey *et al*., 2008). A study on the term structure of interest rates in India by Panigrahi (1997:2664) showed that the underdeveloped state of the market led to no relation between interest rates and the slope of the term structure in the short-run. Tabak and Andrade (2001) analysed the EH of term structure of interest in Brazil with maturities between two months and 12 months employing single equations and their results do not show support for the EH. In India the EH is found to be able to predict future interest rate movements in a study

conducted by Shivam and Jayadev (2003), thereby supporting the notion of market participants being able to use the theory to forecast interest rates.

2.7.3 Empirical Support and Criticism

The predictability of the term structure of interest rates has also shown relative inconsistency in the past as indicated by Campbell and Shiller (1991). The authors find that for the short term change in the rates on long term bonds, the slope of the term structure gives a prediction in the wrong direction (Campbell & Shiller, 1991). However, for long term changes on short term rates the slope of the term structure gives a prediction in the correct direction (Campbell & Shiller, 1991). Furthermore, Hardouvelis (1994) points out that the prediction in the wrong direction of the long term interest rate forecast is as a result of large measurement errors. To minimise such errors in the analysis of the theory and to improve the forecast ability of the term structure, Peel and Ioannidis (2003:152) suggest the employment of structural breaks to allow for breaks in policy regime. In addition to this, the term structure is found to dominate other forecasting variables when it comes to forecasting coming recessions that are a few quarters ahead, its dominance escalates and its performance improves significantly as the horizon lengthens (Estrella & Mishkin, 1996:4).

A number of reasons have been given by researchers for the failure of the theory. The consensus is that, when single equations models are employed in the analysis of the informative content of the term structure, single equations models become unsuitable for analysing the expectations hypothesis (Modena, 2008:27). Accordingly, Modena (2008:27) affirms that non-linear models are able to provide appropriate analysis in this regard. Other studies indicate that the reasons behind the failure of the theory is mostly due to the time variation in the expected returns of securities (Sangvinatsos, 2008:14). More often, the failure of the theory to hold and the theory's inability to predict future changes in interest rate movements depends on the time horizon.

Rudebusch (1995) maintains that the forecasting power of the term structure is greater at periods that are longer than two years. Furthermore, prediction of future movements in rates that are shorter than one month also tend to give accurate predictions (Rudebusch, 1995). In some instances, it has been suggested that the overreaction of long term rates to the expected changes on the short term interest rates are the source of the theory's empirical failure (Campbell and Shiller, 1991; Hardouvelis, 1994).

In assessing the predictability of the term structure of interest rates, some of the empirical work done in literature examines predictability across various maturities (Uesugi & Yamashiro, 2009:72). In this area of research, the finding is that the term structure does a better job predicting the future interest rate at shorter horizons of up to three months, and long horizons of two years or more than horizons that are in between (Uesugi & Yamashiro, 2009:72). Sarno, *et al*. (2007:82) further emphasizes this notion by putting forward the grounds for EH rejection. The author's findings conclude that at maturity longer than 24 months, EH for the long term rate is not rejected, while it is always rejected for the maturity of 24 months or less (Sarno *et al*., 2007:82).

The term structure has been found in empirical literature to indicate a significantly positive relationship between the short and the long term interest rates (Estrella & Hardouvelis, 1991). Bekaert *et al*. (1997) indicate that some tests of the expectations hypothesis can give results that are overly favourable to the theory when it is valid. Campbell and Shiller (1991), for instance, examined post-war term structure data in the United States and found that a high yield spread between long and short term interest rates predicts rising shorter term interest rates over the long term.

2.8   SUMMARY

The advancement of the economies in the world allows for greater international integration and also greater exposure to various forms of risk. Most of this risk exposure is, in some way or another, linked to interest rate risk. Managing this risk requires forecasting future economic trends and future economic variable expectations. This chapter explored one of the underlying theories of interest rates, the expectations hypothesis in particular the relation of this theory to the predictability of the term structure.

Monetary policy authorities have direct influence over the short term interest rates in an economy as changes in the official interest rate are quickly reflected in the short term rates. However, the implementation of monetary policy is considered effective only when it is able to affect a wide range of interest rates, from the short term interest rate to the long term interest rate. Also, the positive relationship that exists between long term interest rates and the budget deficit, which imply that the long term rate has a direct bearing on economic activity and growth. Making it essential for monetary policy to be able to influence the long term rate via the direct control of the short term rate and the management of future expectations. Central banks across the world are able to affect a country's economic activity

and inflation rate by changing the short term interest rate, and by influencing the expectations of market participants regarding the future direction of the monetary policy rate. The central bank mainly affects the economy through indirect channels, precisely through influencing the expectations of market participants, especially those of the private sector, thereby influencing the long term interest rates.

Though the expectations hypothesis is an old theory, still there is no overall consensus regarding its validity which is quite central to the predictability of the term structure. Central banks and market participants form a notable part of economic growth and changes as indicated by the linkages of the expectations hypothesis theory to the long term interest rate and the economic cycle. EH is likely to fit the data better where there is low frequency in the variation of interest rate expectations as monetary policy reacts to shifts in economic conditions

The forecasting power of the term structure is found to outperform other leading economic and financial indicators, making the term structure a valuable tool for forecasting. The theory's ability to predict future interest rate movements and its links to monetary policy, the long term rate, the economic cycle and financial crisis provide a build up to the capability being explored. The theory's link to the long term rate, makes a compelling case for the ability of the term structure to forecast future interest rates and economic activity.

The monetary policy authority's ability to influence the long term interest rate depends on the validity of the EH of term structure of interest rates. The role of the long rates in monetary policy transmission is a significant one, and it is one in which the link between expectation and observed or announced policy is not completely understood. The long rate channel is directly linked to bond rates, these rates comprise future policy rate expectations of bond traders. This link between expectations and observed or announced policy essentially points out to the dependence of monetary policy effectiveness on the bond market's policy perceptions.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

The central objective of the study is to assess the EH of term structure of interest rates in two economic groups, BRICS and G7 data. The study examines and compares the predictive ability of the term structure in light of the recent financial crisis. The purpose of the analysis is to assess how this event may have affected the conduct of monetary policy and the validity of the EH of term structure of interest rates. The validity of the EH forms the basis of the term structure's ability to predict future interest rate movements, a feature that is beneficial to policymakers and market participants alike if found to be true. This is due to the significant role that the expectations about future policy have in the determination of the shape of the term structure (Walsh, 2003:465). The validity of the EH requires testing for the existence of a long-run relationship between the short rate and the long rate. As Corte *et al*. (2008:158) maintains that interest rates with varying maturities move together since the rates are connected by the EH. The EH is considered valid if there is long-run association between the observed variables. However, if there is no long-run association between the variables the theory then does not hold. Consequently, variables cannot be used to assess the term structure's predictability.

The validity of the theory and the predictability of the term structure were investigated in the developed and developing countries. The two groups were affected by the financial crisis in different ways, and one of the objectives is to therefore assess whether there is or no change in the behaviour of term structures due to the adverse effects of the financial crisis in each country.

The study also builds on some of the findings from various literature regarding the term structure's predictability of future economic variables, in particular, interest rates and economic cycle, both which are important to the central bank and ultimately financial markets. This is done in order to determine whether information in the term structure of interest rates is potentially useful for various market participants including the central banks; and also, to assess the predictive ability of the term structure at developed and developing country level. This is done by comparing the predictability of the term structure in the group of seven countries (G7) against BRICS countries. This chapter thus presents the

methods employed to assess the predictability of the term structure of interest rates and the validity of the EH, and is structured as follows. In model and estimation methods a model of EHTS is presented, followed by a review of the Autoregressive Distributed Lag (ARDL) model and the employment of the model in the study is justified. The chapter reviews the diagnostic tests used in the study, and a summary of the chapter is provided. Before considering the method employed to test whether the EH holds or not and the predictability of the term structure, this chapter begins with describing the data, sample period and variables.

3.2   DATA, SAMPLE PERIOD AND VARIABLES DESCRIPTION

The data employed comprises short term and long term interest rates from BRICS and G7 countries. For all countries, the 91-day Treasury bill rate is used as the short term rate, and 10 year government bond rate denotes the long term rate. The spread between the 91-day Treasury bill rate and the ten year government bond rate has been proven to be a powerful and valuable tool when it comes to the predictability of the future direction of the term structure of interest rates and for forecasting economic activity (Estrella & Mishkin, 1996). Compared to other bond rates, the bond rates employed in this study are default risk free, they are not subject to credit risk premiums which often change with maturity, making them suitable owing to the consistency in the calculation of these rates over time and the availability of historical data (Estrella & Trubin, 2006:3).

The sample period consist of 157 monthly observations from each country starting from May 2003 to May 2016. The selected sample period was mainly based on the availability of data. Obtaining data in the developing Asian countries was challenging especially data dated beyond 2003. It was either missing or not accessible. Data was obtained from the International Financial Statistics (IFS) and the Organisation for Economic Co-operation and Development (OECD).

The motivation behind the use of government rates is that they represent a measure of monetary policy that has less complex term premium effects (Wright, 2006:2). Also due to the assessment of how responsive the short rate and long rate (the Treasury bill and government bond rates respectively) are to the objectives of the study (Kozicki & Tinsley, 2008:72).

Table 3-1: Data Sources

	IFS		OECD stats	
	Long	**Short**	**Long**	**Short**
G7			✓	✓
Brazil		✓	✓	✓
Russia	✓	✓		
India	✓			✓
China	✓			✓
South Africa	✓	✓		

Source: Compiled by author

3.3   SAMPLES FROM DEVELOPED AND DEVELOPING ECONOMIES

The study sampled different states of the world to assess the predictability of term structure of countries that fall within two economic categories; developed economies represented by G7 countries and developing countries represented BRICS countries. The group of seven (G7) countries is a group of major industrialised countries that was formed in 1975-1976, and it represents a high level of policy making in the world and facilitates collective action (Global Policy Forum, 2016). The G7 bloc consists of the world's leading and most advanced economies which are; Canada, France, Germany, Italy, Japan, United Sates, and United Kingdom (Laub, 2015). The central banks and finance ministers of these countries meet on an annual basis to monitor and address economic developments, assess economic policies, commit to the implementation of fair trade, international security and global concerns (IMF, 2016). The major oil shock and the fall of the Bretton Woods fixed exchange rate system were some of the major economic challenges faced in the 1970's which saw the formation of the G7 in order to find ways of dealing with these challenges through consulting on global economic policy (Bundesregierung, 2016).

The BRICS bloc consists of five of the world's major emerging market economies, and together the economies of the BRICS countries account for about two-thirds of emerging market GDP (Global Macroeconomics Team, 2016). The BRICS countries are Brazil, Russia, India, China, and South Africa. These countries came together in year 2001 with South Africa joining in 2010 (Brown *et al*., 2015). The BRICS bloc represents a shift in global power balance as it seeks to increase influence among the developed nations through

financial cooperation (Shanming, 2013). The main intent of the BRICS bloc is to improve relations among the group of countries through addressing economic challenges faced by the countries. This is done through the combination of resources, trade agreements and the recent establishment of a BRICS bank, the New Development Bank (NDB) (Muzindutsi & Mposelwa, 2016:2). The NDB was established with the aim of addressing development challenges by providing infrastructure funding across borders (Brown *et al*., 2015). The BRICS is a cooperation forum that ensures countries are able to open trade opportunities, initially driven by the establishment of common areas within the member countries and collective action to address economic issues facing the group (Brown *et al*., 2015).

3.4   MODEL AND ESTIMATION METHODS

3.4.1   Modelling the Expectations Hypothesis of Term Structure (EHTS)

In assessing the relationship between the observed rates under the EHTS, the study followed a model by Campbell and Shiller (1991):

$$R_t^{(n)} = \frac{1}{q} \sum_{i=0}^{q-1} E_t R_{t+mi}^{(m)} + c \tag{3.1}$$

The single linear relationship of EHTS is explained by the association between the long rate $R_t^{(n)}$, and the short rate $R_t^{(m)}$, in Equation (1) where $n > m$. According to the theory of EH, investing in an *n*-period rate and in the *m*-period will yield equal expected returns in the future up to $n - m$ periods, including *c*, a constant risk premium where $q = n/m$. For that reason, it is possible to convey $R_t^{(n)}$ as a weighted-average of current and expected $R_t^{(m)}$, with the addition of a risk premium, *c*. Equation (2) is a fascinating restraint of stationarity and it is derived from Equation (1) by deducting $R_t^{(m)}$ in Equation (1) from both sides of the relationship:

$$R_t^{(n)} - R_t^{(m)} = \frac{1}{q} \sum_{i=0}^{q-1} \sum_{j=1}^{j=i} E_t [\Delta^{(m)} R_{t+jm}^{(m)}] + c \tag{3.2}$$

According to Campbell and Shiller (1998) interest rates are widely recognised as variables that are well defined as I(1) processes. Should the observed interest rates be (1) series, subsequently, $\Delta R_t^{(n)}$ and $\Delta R_t^{(m)}$ are considered stationary, I(0), by definition. Since *c* is constant it is also considered stationary. Consequently, should the theory hold, since the RHS of Equation 2 is stationary as *c* and $\Delta R_t^{(m)}$ are I(0), subsequently $R_t^{(n)} - R_t^{(m)}$ ought to

be stationary. Should this not be the case then the order of integration in the association of the RHS and the LHS in this equation would have discrepancies (Campbell & Shiller, 1991).

In general, $R_t^{(n)} - R_t^{(m)}$ is the spread between the *n*-period and the *m*-period rates, denoted by $S_t^{(n,m)}$ and is able to illustrate the slope of the term structure. Accordingly, the spread is considered stationary should the theory hold, therefore $R_t^{(n)}$ and $R_t^{(m)}$ would cointegrated with a cointegrating vector of $(1, -1)$ for $[R_t^{(n)}, R_t^{(m)}]$. As such, the rates are considered to have a common stochastic trend as there is a common integrating process in each rate (Gujarati & Porter, 2008:746). Thus, if the stochastic process behind the rates and the one period rate is the same, then there is cointegration between the interest rates and the one period rate as predicted by the theory.

It becomes important to check for stationarity prior to the cointegration test since Equation 3.2 implies a high probability of spurious regression when a single-equation standard regression is employed. This is due to the inability of standard regression techniques to handle nonstationary variables (Brooks, 2014:354).

3.4.2   Stationarity and Unit Root Tests

Before proceeding to the ARDL model the study tests for stationarity by conducting unit root tests. Detecting the existence of a unit root in time series models is generally an essential part as it is able to provide evidence on the stationarity or non-stationarity of the data (Perron, 1989). Apart from this, unit root tests are usually the first step in the process of analysing long-run equilibrium relationships among variables using cointegration methods (Gujarati & Porter, 2008:762).

The unit root test is a prerequisite for the ARDL model and the test is conducted to check for the order of integration as the ARDL model does not accommodate variables of I(2) integration. The conventional Augmented Dickey Fuller (ADF), Phillips-Perron (PP) (1988) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992) unit root tests are employed to conduct a stationarity test of the data. Moreover, the integration of markets and financial market liberalization of the countries under observation raises the need to conduct break-point unit root test as the observed variables may have been subject to structural breaks. The breakpoint unit root test is also significant in this study as the effect of financial crisis is a

major component that may have contributed to structural changes in the economies of the observed countries. The study employed the above mentioned techniques to determine the order of integration in the variables.

3.4.3 Augmented Dickey-Fuller (ADF)

The Augmented Dickey-Fuller (ADF) test is derived from the basic autoregressive unit root test of Dickey-Fuller (DF). The improvement as done by Said and Dickey (1984) is able to accommodate autoregressive moving average (ARMA) of order *p,q* where the orders are unknown. The test is based on a regression that is estimated as follows:

$$\Delta y_t = \alpha \, y_{t-1} + \delta x_t + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \ldots + \beta_n \Delta y_{t-n} + u_t \tag{3.3}$$

In the above equation (3.3) optional exogenous regressors are represented by x_t and are likely to entail a constant, or both a constant and a trend. The parameters to be estimated are represented by δ and β, while u_t denotes white noise. Based on this equation, the ADF unit root test hypothesis is set as:

$H_0 \colon \alpha = 0$

$H_1 \colon \alpha < 0$

The rejection of the null hypothesis occurs when the coefficient is less than zero suggesting that the variables consist of a unit root implying non-stationarity. The alternative hypothesis is true when the coefficient is less than zero; then it can be concluded that the variable has no unit root, implying that it is stationary. Failing to reject the null hypothesis on the other hand occurs when the coefficient is equal to zero, suggesting that the variable consists of a unit root thus implying that it is not stationary. The process is repeated for non-stationary variables, these variables are differenced until they become stationary.

3.4.4 Phillips and Peron (PP) Unit Root Test

The Phillips and Perron (1988) unit root test is much like the ADF unit root test. However, the two tests differ in terms of how they deal with serial correlation in the errors; although both tests often reach similar results. The PP test estimates a non-augmented Dickey Fuller test equation, proposing the use of nonparametric statistical method. The method controls serial correlation in the errors and it does not add lagged difference terms as the ADF unit root does (Gujarati & Porter, 2008:758). Furthermore, the PP unit root test employs the

Newey–West (1987) to address serial correlation. The PP unit root test is better than the ADF test as it is able to test for a unit root in variables that may reflect structural changes in the economy (Phillips & Perron, 1988). The PP procedure is presented as follows:

$$y_t = \alpha \, y_{t-1} + \delta x_t + u_t \tag{3.4}$$

$$\Delta y_t = \theta_0 + \delta y_{t-1} + u_t \text{ (PP test equation)} \tag{3.5}$$

In equation (3.5) the constant and the trend is denoted by θ_0 and t respectively, with the following set hypothesis:

$$H_0: \delta = 0$$

$$H_1: \delta < 0$$

Under the null hypothesis $\delta = 0$ indicates that the variable consists of a unit root, implying that it is non-stationary. The alternative hypothesis $\delta < 0$, indicates that the variable has no unit root, implying that the variable is generated by a stationary process.

There is, however, criticism when it comes to the use of the ADF and the PP unit root tests in research. The first relates to the low power that these tests are known to have against the alternative hypothesis that the series is stationary or trend stationary (DeJong *et al.*, 1992). The second relates to size, as the ADF and the P unit root tests tend to distort the size when the series contains a large negative moving average root, often distorting the size towards over-rejecting the null hypothesis (Schwert, 1989). Therefore, the study employed the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test to confirm the results of the ADF and the PP unit root test.

3.4.5   Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Stationarity Test

The KPSS test was employed in the study as an alternative test procedure that attempts to resolve the power and the size issues related to the ADF and the PP tests. The KPSS test is not the same as the ADF and the PP tests as under the null hypothesis the series y_t is assumed to be stationary or trend stationary (Brooks, 2014:365). The results from the KPSS test are compared to the ADF and PP test results to see if the same conclusion is reached.

$$y_t = \beta' D_t + \mu_t + u_t \tag{3.6}$$

$$\mu_t = \mu_{t-1} + \varepsilon_t, \, \varepsilon_t \sim WN \, (0, \sigma_\varepsilon^2) \tag{3.7}$$

Where D_t denotes a constant or a constant with a trend, trend is denoted by t. The symbol μ_t is a random walk with an innovation variance of σ_ε^2, while u_t is integrated of order zero I(0) and may be heteroscedastic and WN (0, σ_ε^2) represents white noise with mean zero and variance σ_ε^2. The KPSS employs the Lagrange multiplier as a test statistic with the hypothesis set as follows:

H_0: $\sigma_\varepsilon^2 = 0$

H_1: $\sigma_\varepsilon^2 > 0$

The LM statistic tests the null hypothesis $\sigma_\varepsilon^2 = 0$ that states that the variance is zero, which implies that μ_t the random walk is constant against the alternative hypothesis that $\sigma_\varepsilon^2 > 0$ where the variance is greater than zero, thus indicates the presence of a unit root making the variable non-stationary.

3.4.6   Break-Point Unit Root Test

Often time-series data may contain a structural break or may be trend stationary, and in such instances, Perron (1989) cautions researchers about a bias towards a false rejection of null hypothesis that traditional unit root tests tend to lead to due to power issues. The presence of a structural break in the intercept or trend using traditional unit root tests may appear non-stationary when the series is stationary. Hence the study employs break-point unit root test by running an ordinary least squares (OLS) regression suggested by Perron (1989) as follows:

$$y_t = a_0 + a_1 y_{t-1} + a_2 t + \mu_2 D_L + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$$
$$(3.8)$$

Where y_t is the series under consideration, a and β denote changes in the parameter for the period of the time break $t = T_B + 1$. The dummy variable is denoted by D. The hypothesis is set as follows:

H_0: $y_t = a_0 + y_{t-1} + \mu_1 D_P + a_t$ \hfill (3.9)

H_0: $y_t = a_0 + y_2 t + \mu_2 D_L + a_t$ \hfill (3.10)

The null hypothesis states that y_t has a unit root and in consequence, confirms no presence of a structural break. The alternative hypothesis on the other hand states that y_t is trending stationary confirming a structural break.

As previously mentioned, the validity of EH forms the basis for investigating the predictability of the term structure, and the test of whether EHTS holds or not is conducted by testing for cointegration between variables. In this study, cointegration is tested using the ARDL model.

3.4.7   Autoregressive Distributed Lag (ARDL)

The cointegration test is conducted using a number of methods. The method chosen for the study is the Autoregressive Distributed Lag (ARDL) bounds testing model, a model; endorsed by Pesaran and Pesaran (1997), Pesaran and Smith (1998), Pesaran and Shin (1999), and Pesaran *et al*. (2001).

The ARDL model is employed in the test for long-run association between the short rate and the long rate as the properties of the model make it favourable in the context of this study compared to other cointegration techniques. Compared to other cointegration methods, the model can be employed for testing mutually integrated variables, or a mixture of series that are integrated of order I(0) or I(1) (Dube & Zhou, 2013:203). Whereas other cointegration methods require that variables are of the same order of integration. However, it is not possible to interpret the F-statistic values when the variables are I(2). The ARDL approach does not require large data samples as it is robust in small samples (Pattichis, 1999). In addition the technique permits the use of varying optimal lags, the model employs a general-to-specific modelling approach through accommodating a sufficient number of lags in order to ensure the validity of the data generating process (Harvey, 1981).

Upon selecting the lag order, the ARDL model allows for OLS estimation of the cointegration relationship. Moreover, the model is able to differentiate between the dependent and independent variable thereby reducing issues related to endogeneity and the presence of autocorrelation (Mobin & Masih, 2014:15). The use of system equations is common in traditional cointegration methods, while the ARDL uses a single equation set up thus making it easy to implement. The ARDL model offers unbiased and efficient estimation of the short-run and long-run relationship, meaning that an error correction model (ECM) can be retrieved from the model (Sezgin & Yildirim, 2003). Cointegrated

variables imply that there exists an ECM that incorporates the short-run adjustments with the long-run equilibrium whilst still holding the content in the long-run (Pesaran & Shin, 1999).

The study begins by selecting the optimal number of lags for the model through the use of information criteria such as the Schwarz Bayesian (SBIC), Akaike (AIC), and Hannan–Quinn (HQIC) (Brooks, 2014). To obtain the optimal lag length $(p + 1)^k$ a number of regressions are estimated for each variable. In the equation, the maximum number of lags is represented by p, and the number of variables is represented by k.

In the bounds testing using the F-statistic, the cointegration analysis involves testing the null hypothesis of no cointegration against the alternative of cointegration between the variables. Pesaran *et al*. (2001) makes available two sets of critical value bounds for classifying regressors into mutually integrated, purely I(0) or purely I(1). EH holds if the estimated F-statistic is greater than the upper bound I(1). This is followed by the assessment of the long-run equations for the countries found with cointegrating variables, and short-run adjustment to equilibrium using the ECM. The ECM should be statistically significant and have a negative sign.

The following ARDL model is estimated to assess the relationship between the long and short rate:

$$\Delta LR_t = c + B_i \sum_{i=0}^{n} \Delta LR_{t-i} + \phi_i \sum_{i=0}^{n} \Delta SR_{t-i} + \alpha_1 LR_{t-1} + \alpha_2 SR_{t-1} + e_t \qquad (3.11)$$

Where ΔLR_t denotes the change in the long rate at time t, and ΔSR_t denotes the short rate at time t. c represents the intercept, n denotes the number of lags and e_t is the white noise error term.

The ARDL model encompasses error correction estimation for the long rate and its determinant. The short-run dynamics of the model are denoted by B_i and ϕ_i, long-run coefficients are represented by α_1 and α_2. For each of the countries Equation (3.11) is estimated to test for cointegration under the following set hypothesis:

$H_0: \alpha_1 = \alpha_2 = 0.$

$H_1: \alpha_1 \neq \alpha_2 \neq 0.$

The null hypothesis (H_0) states that there is no cointegration, while the alternative hypothesis (H_1) states that there is cointegration between the variables. This is done by conducting a bounds test in which the estimated F-statistic is compared to upper and lower bound critical values found in the Pesaran *et al.* (2001) table. Cointegration is evident when the F-statistic is greater than the upper bound of the critical values, thereby indicating the rejection of the null hypothesis in favour of the alternative hypothesis and also indicating the validity of the EH. Cointegration suggests that there is a long-run relationship between the variables. Furthermore, the model in this instance is able to rule out arbitrage opportunities between varying interest rates (Ang *et al.*, 2006:359). Conversely, an F-statistic that is lower than the critical values is a sign of no cointegration as null hypothesis in this case is not rejected. An F-statistic that falls in between the critical bound values results in inconclusive findings without further information (Dube & Zhou, 2013:203). Subsequent to the outcome of cointegration, an ECM is estimated using Equation (3.12) which is derived from Equation (3.11) as follows:

$$\Delta LR_t = c + B_i \sum_{i=0}^{n} \Delta LR_{t-i} + \phi_i \sum_{i=0}^{n} \Delta SR_{t-i} + ECT_{t-1} + e_t \qquad (3.12)$$

The ECM corrects disequilibrium and it is used to measure the speed of adjustment back to equilibrium in the short-run, thereby linking the short-run dynamics of the dependent variable to its long-run value. The short-run dynamics are also used as predictors of future interest rates in the study.

3.4.8   Diagnostic tests

To ensure the reliability of the employed data the study conducts diagnostic tests. These tests include parameter stability, a test for the presence of serial correlation and heteroscedasticity. The parameter test stability is assessed by applying the cumulative sum of recursive residuals (CUSUM) (Pesaran & Pesaran, 1997). Parameter stability is a visual presentation of the CUSUM test and it measures the stability of the variables under the null hypothesis of perfect parameter stability which is shown by a statistic lying within two sets of critical bands (Brooks, 2014:232). The alternative hypothesis is shown by a statistic line that falls outside the two sets of bands indicating instability of the variables.

Moreover, the study tests the variables for the likelihood of undesirable features in the data that could lead to misleading results, namely, serial correlation and heteroscedasticity. Serial correlation as defined by Tintner (1965) as lag correlation between two different

series where the set null hypothesis has no serial correlation versus the alternative hypothesis of serial correlation which is undesirable. Rejecting null hypothesis would imply that the disturbance term is serially correlated. Thus, a lagged dependent variable results into invalid estimated standard errors, biased and inconsistent estimated coefficients (EViews, 2016).

The Breusch-Godfrey serial correlation Lagrange Multiplier (LM) test is used in the study because it can be applied whether the dependent variables are lagged or not (EViews, 2016). On the other hand, the Breusch-Pagan-Godfrey heteroscedasticity test is set with the null hypothesis of homoscedasticity, an outcome that is desirable for the variables in the study as it indicates that the variance of the disturbance term is the same regardless of the value of the dependent variable (Gujarati & Porter, 2008:65). The alternative hypothesis indicates that the model is heteroscedastic suggesting that the variance of errors is not constant.

3.5   PANEL ESTIMATION

In an effort to compare the two economic groups the study employed the panel ARDL model also known as Pooled Mean Group (PMG) econometric technique proposed by Pesaran *et al*. (1999). Similar to the methods used for the analysis of individual countries unit root test precedes cointegration test. For panel estimation methods, this section explains panel unit root and the panel ARDL model.

3.5.1   Panel Unit Root Testing

Panel data is tested for stationarity under two assumptions: the common unit root assumption (homogenous) where a common autoregressive (AR) structure is assumed, and under the assumption of individual unit root (heterogeneous). For the homogenous test Levin, Lin, and Chu (LLC) (2002), and Breitung (2000) unit root methods are employed. The heterogeneous test employs unit root methods such as the Im, Pesaran and Shin (IPS) (2003), the Fisher ADF and Fisher PP proposed by Maddala and Wu (1999). A general panel unit root procedure employed for most tests is represented as follows:

$$\Delta y_{it} = p_i y_{i,t-1} + \sum_{l=1}^{p_i} \phi_{i,l} \Delta y_{i,t-l} + \alpha_i d_{it} + \varepsilon_{it} \tag{3.13}$$

Deterministic components are denoted by d_{it}. The *y* process consists of a unit root for individual *i* when $p_i = 0$, conversely, $p_i < 0$, implies that around the deterministic part the process is stationary.

The LLC test allow the lag order across individual countries to vary making the null hypothesis restrictive, nonetheless, the test method proposes the following hypotheses:

H_0: Each time series consists of a unit root

H_1: Each time series is stationary

The Breitung test follows similar hypotheses as LLC however suggests alternative test procedure and differs from the LLC in that it excludes the deterministic terms (Nell & Zimmermann, 2011:4).

The IPS test on the other hand permits heterogeneous coefficients and is not restrictive as the LLC, p_i in the case of IPS (2003) can vary and some individuals may consist of a unit root. The IPS test proposes the following hypothesis:

H_0: All individual countries follow a unit root process

H_1: Some of the individual countries have unit roots

The Fisher tests for each cross-section employs the probability values from unit root tests, and according to Nell and Zimmermann (2011:4) the test possess advantages such as the ability to deal with unbalanced panels, and permits for variation in the lag lengths of the ADF test. Panels in these tests consists of a unit root under the null hypothesis, the alternative is stationarity (Choi, 2001).

3.5.2 Panel ARDL estimation

There are three precondition for conducting panel ARDL cointegration; the variables are all integrated of order one I(0), variables are all integrated of order one I(1), or mixture of I(0) and I(1) variables and no second order of cointegration. The study employs PMG econometric method that is proposed by Pesaran *et al.* (1999), assuming an ARDL that is presented as follows:

$$y_{it} = \sum_{j=1}^{p} \phi_{ij} + \sum_{j=0}^{q} \delta_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (3.14)$$

Where y_{it} denotes the dependent variable, the number of countries is $i = 1, 2,... n$; the periods under observation $t = 1, 2,...,$T; k x 1 vector of independent variables is denoted by X_{it}; k x 1 coefficient vectors are denoted by δ_{ij}; the ϕ_{ij} symbolise the scalars while the

48

country specific effect μ_i and $\text{var}(\varepsilon_{it}) = \sigma_i^2$. The cointegration of variables and I(1) process in (3.14), then for all i the error term is I(0) process. Similar to the method used in testing the individual country interest rates, the cointegrated variables are assessed for their adjustment back to equilibrium. Before this assessment is conducted, the error correction term (ECT) should be significant and negative. If the ECT does not hold this condition then, there is no support for long-run association between the variables.

3.6   SUMMARY

The central objective of the study is to test the EH of term structure of interest rates in two economic groups, BRICS and G7 data and, also to examine and compare the predictability of the term structure in light of the recent financial crisis. The validity of the EH forms the basis of the term structure's ability to predict future interest rate movements. The validity of the EHTS requires testing for the existence of long-run association between the short rate and long rate.

The chapter presented methods used to assess the predictability of the term structure and the validity of the EH; a brief background is given on the BRICS and G7 groups, the data and sample period is described and a model of EH presented. A review of the various unit root tests and justification for the use of the models is explained. This was followed by a review of the ARDL model and justification of the model for the analysis of the relationship between the short rate and the long rate in the observed countries. The ARDL approach was chosen owing to its flexible features compared to other traditional cointegration methods. The cointegration of variables in this study indicate the validity of the EH. The ARDL model is employed to test for the long-run association between the short rate and the long rate in each of the BRICS and G7 countries. The chapter also reviewed the diagnostic tests applied in the study. The chapter also explained the panel data and econometric methods employed in the analysis.

CHAPTER 4: EMPIRICAL RESULTS

4.1 INTRODUCTION

The chapter presents the results of the study based on the ARDL model of cointegration. The empirical analysis begins by illustrating graphical movements of the observed rates in the different countries over the sample period. The descriptive statistics and correlation analysis is conducted to assess the features contained in the data sampled. This is followed by the unit root test where the variables are tested for stationarity and most importantly for determining the order of integration which is essential for the test of cointegration using the ARDL approach. Upon conducting the cointegration test, the variables found with long-run association are assessed for their ability to predict future interest rate movements and are also compared to the outcome of the panel cointegration test. The diagnostics tests are also conducted to assess goodness of fit, followed by a discussion of the results and finally conclusion.

4.2 GRAPHICAL ANALYSIS

The ultimate goal of the study is to test for long-run association between each country's short and long rates in order to determine the validity of the expectations hypothesis, and to compare the results of the two economic groups, namely developing and developed nations. It is important to first conduct preliminary investigation by way of graphical analysis for each country in the groups. This investigation will be able to give an overview of how long and short rates performed during the sample period.

Figure 2 consists of the graphical analysis of a series of interest rates from the developing (BRICS) countries. The graphical analysis depicts that each of the developing countries was affected by the financial crisis in a unique way. As such, the term spreads in each country follow different trends, if any trend at all. Overall, the interest rate spreads seem to have reacted mostly in the period just before and during the financial crisis. This is evident in all the countries under observation with the exception of China. The interest rate spread in China is extremely wide with a relatively small period of the short rate exceeding the long rate. Apart from these minor deviations, the Chinese yield curve is normal. The short rate of China has been close to zero post the financial crisis, and of the five developing countries, the long rate is the lowest at less than 5 percent in the observed period (IMF, 2016:4). Post the financial crisis credit growth increased to as high as 34.4 percent, however, stringent

regulation in China's financial institutions led to a slowdown in 2015 to 12.4 percent (IMF, 2015:5-6).

Figure 2: Interest Rates in Developing Countries (BRICS)
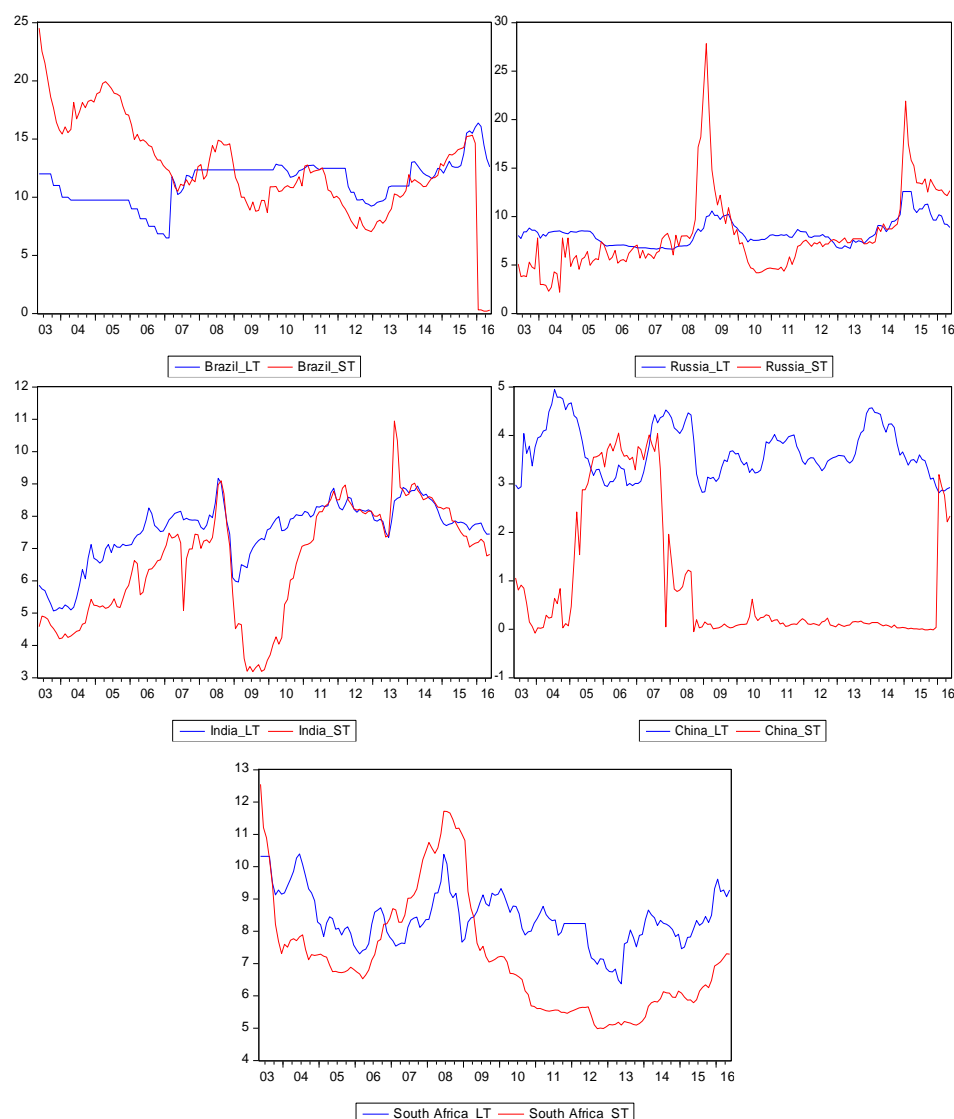
Source: Compiled by author

From the analysis China and India seem to have been insulated from the effects of the financial crisis, while the South African economy may have experienced a downturn as indicated by the inverted yield curve from 2006 to 2009. An inverted yield curve occurs when the short rate is higher than the long rate, thus causing the yield curve to slope downwards. China and South Africa may have experienced notable expansions, that is, rapid growth in the economies of the specified countries before and after the financial crisis. While the economies of Brazil, Russia and India may have experienced relative expansion

periods; the short rate in Brazil and Russia is remarkably volatile. Also, the short rate in Russia rose quite dramatically compared to the country's long rate which had a marginal increase and was relatively stable. Both Brazil and Russia have flat yield curves with notable downturns in both economies. The flat yield curves are indicated by the rates that have remained the same for quite long periods as observed in the economies of the two countries. A depressionary state is reflected by the downward sloping spread especially in the long rate of Russia (Mishkin, 1990b). The long rate is below the short rate.

The decline in the price of oil and the sanctions imposed on Russia contribute to the lower export levels experienced by Russia in recent years (World Bank, 2015:9). Consequently, the central bank of Russia tightened monetary policy in order to help stabilise its national currency and to limit the effect that a weak national currency would have on the economy (Tanas & Andianova, 2014). Most of the observed developing countries export commodities to other parts of the world, and according to a study by the World Bank (2009:6), the decline of commodity prices from mid-2008 due to a sluggish growth globally began months ahead of the financial crisis. The full blown crisis amplified this process. The term structures of developing countries show that the economies suffered from the effects of the financial crisis as a result of lower demand from the developed countries that they export to.

Most developing countries have issued bonds greatly in the international market, and experienced portfolio inflows owing to low interest rates in the more developed parts of the world after the financial crisis (World Bank, 2015:20). Brazil experienced strong portfolio inflows as a result of its more attractive interest rates compared to those of developed countries (IMF, 2015:10). This was followed by a wave of monetary policy tightening of 125 basis points between 2014 and 2015 to help stabilize the national currency and the expected hikes in regulated prices (IMF, 2015:12). Consequently, credit growth declined across financial institutions and in 2015, Brazil suffered drastic recessions (World Bank, 2016:4).

In relation to the theory, a long rate that is high compared to a short rate indicates the expectation of a rise in future interest rates and is illustrated by an upward sloping yield curve (Spaulding, 2016). This is evident in the term structures of South Africa, China and India in certain periods. An inverted yield curve is evident partially in Brazil, Canada, France, Germany, United Kingdom and the United States where the short rate is higher than the long rate, thus indicating an expectation of a decline in future interest rates which

eventually followed. For developed countries, it is possible that the economies experienced a rather depressed economy due to lenders being more cautious following the financial crisis.

The interest rate spreads in developed (G7) countries are marked by a downward trend particularly after the financial crisis as depicted in Figure 3. There are wide interest rate spreads prior to the financial crisis, narrow spreads between the two interest rates during the financial crisis with short rates becoming higher than the long rates with the exception of Japan and the UK. In addition, all these countries except Japan saw a sharp decline in the short rate and a decline of the long term rate over time, particularly after the financial crisis as the economies seem to have gone through recessions as depicted by the graphical analysis.

During economic downturns, central banks attempt to stimulate the economies by reducing the short term interest rate and implement other stimulatory programmes (Bernanke, 2013:7). The US economy was the worst hit by the financial crisis as this is where the financial crisis began, short rates reached the zero bound meaning that the central bank could no longer make use of traditional methods for economic stimulations (Bernanke, 2013:7). The US economy began seeing a recovery in early 2016 and a slight increase in the short rate from the zero bound level. Strengthening momentum in the Euro area and Japan partially contribute to the slow growth in the US and the UK (World Bank, 2016:2).

Movements in the rates of Canada, France, UK and Germany seem to be rather correlated or to show quite strong similarity. The similarity in interest rate movement of these countries may be due to how integrated world economies are, particularly in developed parts of the world, and to the similar monetary policy approach implemented by each central bank in the various business cycles (Bernanke, 2013:1). It is also noteworthy to point out the latent factor behind the similarity found in France, Germany and the United Kingdom as being the integration of markets in Europe and the United Kingdom or the establishment of a common market after the formation of the European Economic Community (European Union, 2016). In addition to this, a sovereign debt crisis took place in Europe between 2009 and 2011 which led to the use of unconventional monetary policy where the European Central Bank (ECB) employed methods that include negative interest rates, the purchase of bonds and quantitative easing in an attempt to restore stability (McBride & Alessi, 2015).

Figure 3: Interest Rates in Developed Countries (G7)
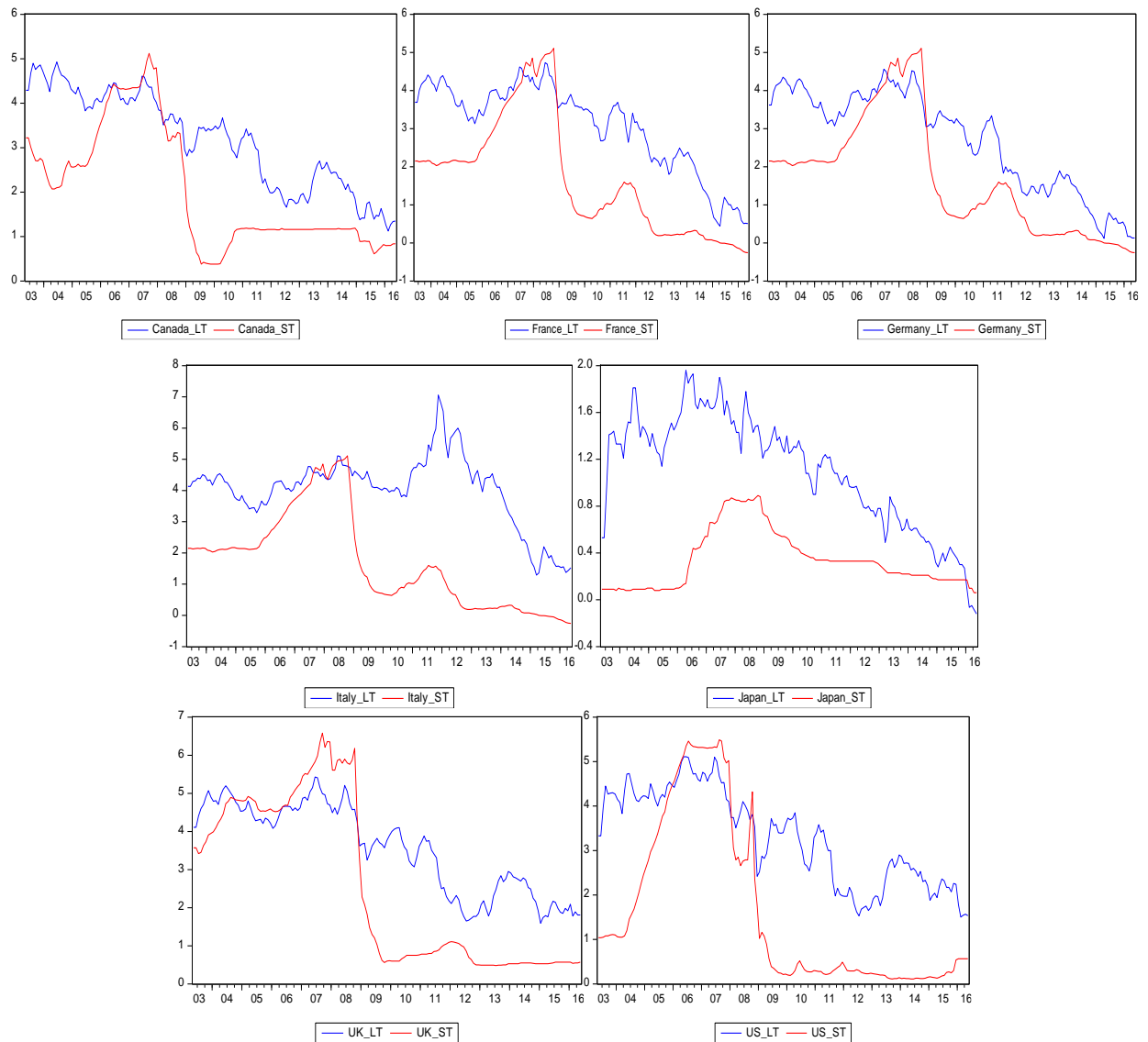
Source: Compiled by author

Following the outcome of the graphical analysis, there is an indication of a significant amount of volatility over the observed period. This is not surprising with the much observed spikes on the graphs, signifying the need to conduct the break-point unit root test. Furthermore, there seems to be a sharp contrast in the behaviour of the term structures of the two groups. The term structures of interest rates in the developing countries clearly indicate that the countries were not as severely affected by the financial crisis as developed countries. The term structure of interest rates in developed countries show the effect of the financial crisis and the attempt by central banks in G7 countries to restore economic activity by reducing their short term interest rates.

4.3 DESCRIPTIVE STATISTICS AND CORRELATION ANALYSIS

Descriptive statistics are conducted in order to provide some of the features contained in the data sample.

Table 4-1: Developing Countries' Descriptive Statistics

Country	Rate	Count	Min	Max	Mean	Std. Dev	Skewness
Brazil	Long Rate	157	6.5	16.36	11.33	1.84	-0.24
	Short Rate	157	0.19	24.52	12.51	4.16	-0.22
Russia	Long Rate	157	6.63	12.58	8.29	1.31	1.16
	Short Rate	157	2.2	27.83	7.99	4.06	1.95
India	Long Rate	157	5.06	9.17	7.55	0.95	-1.06
	Short Rate	157	3.18	10.94	6.65	1.73	-0.29
China	Long Rate	157	2.81	4.95	3.67	0.53	0.38
	Short Rate	157	-0.08	4.05	0.97	1.38	1.24
SA	Long Rate	157	6.37	10.39	8.40	0.82	0.31
	Short Rate	157	4.98	12.55	7.18	1.81	1.06

Table 4-2: Developed Countries' Descriptive Statistics

Country	Rate	Count	Min	Max	Mean	Std. Dev	Skewness
Canada	Long Rate	157	1.12	4.93	3.17	1.08	-0.20
	Short Rate	157	0.38	5.12	2.02	1.34	0.73
France	Long Rate	157	0.44	4.73	3.07	1.15	-0.81
	Short Rate	157	-0.25	5.11	1.68	1.52	0.73
Germany	Long Rate	157	0.12	4.56	2.70	1.31	-0.46
	Short Rate	157	-0.25	5.11	1.68	1.52	0.73
Italy	Long Rate	157	1.29	7.06	4.03	1.12	-0.64
	Short Rate	157	-0.25	5.11	1.68	1.52	0.73
Japan	Long Rate	157	-0.12	1.96	1.10	0.49	-0.48
	Short Rate	157	0.06	0.89	0.34	0.24	0.93
UK	Long Rate	157	1.59	5.43	3.55	1.17	-0.24
	Short Rate	157	0.48	6.58	2.55	2.17	0.41
US	Long Rate	157	1.50	5.11	3.29	1.05	-0.05
	Short Rate	157	0.11	5.49	1.63	1.88	1.02

A summary of descriptive statistics calculated from the long and short rates of developing countries are reported on Table 4-1, followed by a summary of calculations done on the rates of developed countries on Table 4-2. Each of the observed countries has a total of 157 variables.

The gap between the minimum and maximum values indicates that the long rates for each country have a higher value compared to that of the short rate. This is expected since the long rate has a higher return owing to the higher risk which long term investors are compensated for. Also, in relation to the theory, this is considered a normal state of the term structure of interest rates. The minimum and maximum gap values between the interest rates of most of the observed countries are not as wide as those of Brazil and Russia. This could be a reflection of the perceived lower risk especially on the part of developed countries and, the effect of the financial crisis that led to a rapid decline in interest rates in those countries as depicted by the graphical analysis.

The mean values indicate that, on average, interest rates in developing countries are higher than interest rates in developed countries, except for China. The long rate in China remained relatively high even after the sharp decline of the short rate as illustrated on the graphical analysis. This is also indicated by the average of the long and short rate observed in country. The possible explanation for the higher average of interest rates in developing countries compared to developed countries may be due to the perceived high risk in developing countries, volatile interest rate movements, and also interest rates in developing countries were not directly affected by the financial crisis. The long rates in all observed countries except for Brazil are on average, higher than the short rates. This finding is consistent with that of Modena (2008:7). The author found that the average of the spread between long and short rates rises with maturity. With longer term maturity securities the mean tends to be higher compared to those of a shorter maturity. The short rates in Brazil and Russia seem to have wider spreads as measured by the standard deviation. This suggests that the short rates in these countries are much more volatile than all the observed countries. The long rate consists of data that is negatively skewed in all the developing countries, including Brazil and India. The short rate on the other hand is positively skewed in developing countries, including Russia, China and South Africa.

Correlation analysis on Table 4-3 indicates that most of the developed (G7) countries have correlation coefficients that are close to one that is, nearly indicating a perfect positive

association between the long rate and the short rate. The interest rates under observation in France, Germany and the United Kingdom have association that is strongly positive. Italy has positive association however; it is the weakest in the group of the developed countries, with the second weakest association evident in the interest rates of Japan. The relationship between interest rates in the United States and Canada are positively correlated, however, not to the extent of the countries with strong correlation.

Table 4-3: Correlation Analysis

Country	Coefficient	Country	Coefficient	Country	Coefficient
Brazil	-0.286	**Germany**	0.827	**Russia**	0.650
Canada	0.705	**India**	0.773	**South**	0.541
China	-0.245	**Italy**	0.390	**UK**	0.852
France	0.802	**Japan**	0.434	**US**	0.776

The developing countries have a mixture of positive and negative correlation coefficients. Brazil and China have interest rates that are negatively correlated, suggesting that an increase in the short rate will lead to a decline in the long rate. South Africa has the weakest form of positively associated interest rates of the three countries with positively correlated interest rates. The positive correlation that exists between the interest rates of India and Russia is less strong compared to that of the developed countries found with strong positive correlation.

4.4 UNIT ROOT TEST RESULTS

The employment of the unit root test in research has become an increasingly essential part of analysis. The unit root test is essential for this study in order to check whether none of the observed variables are I(2) given the selected ARDL approach to cointegration. To determine this, the Augmented Dickey Fuller (ADF), Phillips-Perron (PP), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests are employed. The following section is a summary of unit root tests conducted for each of the two economic categories starting with the developing countries.

4.4.1 Augmented Dickey Fuller Unit Root Test Results

Table 4-4 is a summary of results for the ADF unit root test for each of the developing (BRICS) countries. The inclusion of an intercept in the equation at level results in the null hypothesis (H_0) of a unit root not being rejected at 0.05 significance level for both interest rates, implies that the variables are non-stationary at levels except for the long rate of South Africa. The null hypothesis is rejected at both 0.01 and 0.05 significance levels when the there is an intercept with no trend included in the equation for the South African long rate, making it a variable that is of I(0) order of integration. There is no rejection of the null hypothesis after first differencing with the intercept included in the equation. The null hypothesis is not rejected when the ADF unit root is tested at level with the intercept and trend included in the equation for all developing countries' short rate, suggesting that the variables consist of a unit root. However, at first difference the null hypothesis is rejected in favour of the alternative hypothesis (H_a). Thus the rates in developing countries become stationary at first difference indicating that the variables are integrated of order one I(1), with the inclusion of the intercept and trend.

Table 4-4: ADF Unit Root Test – Developing Countries

	Level with intercept & without trend		Level with intercept & trend		First Difference without trend		First Difference with intercept & Trend		Order of Integration
	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	
B-LT	1.996	0.2881	2.674	0.2487	0.236	0.5996	11.232	0.0000	I(1)
R-LT	2.217	0.2011	2.430	0.3623	0.1459	0.6318	10.383	0.0000	I(1)
I-LT	2.673	0.0809	2.853	0.1808	0.094	0.7113	9.114	0.0000	I(1)
C-LT	2.868	0.0515	3.036	0.1259	0.369	0.5501	10.341	0.0000	I(1)
S-LT	3.513	0.0089	3.349	0.0623	0.518	0.4908	9.682	0.0000	I(0)
B-ST	2.019	0.2782	2.805	0.1975	2.013	0.0425	11.778	0.0000	I(1)
R-ST	2.554	0.1049	2.9766	0.1422	0.8162	0.3609	11.650	0.0000	I(1)
I-ST	2.143	0.2280	2.483	0.3361	0.2733	0.5861	10.046	0.0000	I(1)
C-ST	1.878	0.3417	1.849	0.6756	1.4043	0.1487	13.787	0.0000	I(1)
S-ST	2.010	0.2820	1.781	0.7091	0.9277	0.3132	7.946	0.0000	I(1)

H_0: a series has a unit root and H_a: a series has no unit root, stationary. *B = Brazil, R = Russia, I = India, C = China, S = South Africa *LT = Long term rate, ST = Short term rate

Table 4-5: ADF Unit Root Test – Developed Countries

	Level with intercept		Level with intercept & trend		First Difference with intercept & without trend		First Difference with intercept & Trend		Order of Integration
	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	
C-LT	0.752	0.8290	3.893	0.0145	1.3673	0.1588	9.7570	0.0000	I(0)
F-LT	0.255	0.9273	2.5142	0.3210	1.1480	0.2280	9.1716	0.0000	I(1)
G-LT	0.293	0.9219	2.9373	0.1538	1.2329	0.1992	8.9586	0.0000	I(1)
I-LT	0.872	0.7948	1.3540	0.8703	0.9109	0.3202	9.8690	0.0000	I(1)
J-LT	0.542	0.8783	4.3927	0.0030	0.6479	0.4352	10.4991	0.0000	I(0)
UK-LT	0.881	0.7919	3.3930	0.0560	1.0065	0.2811	8.9996	0.0000	I(1)
US-LT	1.225	0.6629	3.9942	0.0108	0.8609	0.3415	9.8336	0.0000	I(0)
C-ST	2.880	0.5546	1.9372	0.6302	1.3153	0.1737	5.6077	0.0000	I(1)
F-ST	1.355	0.6025	2.3796	0.3887	1.2751	0.1858	5.0510	0.0003	I(1)
G-ST	1.355	0.6025	2.3796	0.3887	1.2751	0.1858	5.0510	0.0003	I(1)
I-ST	1.355	0.6025	2.3796	0.3887	1.2751	0.1858	5.0510	0.0003	I(1)
J-ST	1.155	0.6928	1.0606	0.9313	0.7268	0.4003	8.4638	0.0000	I(1)
UK-ST	0.903	0.7849	2.0038	0.5943	1.0837	0.2514	7.4448	0.0000	I(1)
US-ST	1.026	0.7430	1.8916	0.6541	0.8497	0.3464	9.3220	0.0000	I(1)

*C = Canada, F = France, G = Germany, I = Italy, J = Japan, UK = United Kingdom, US = United States *LT = Long term rate, ST = Short term rate.

It is important to highlight the outcome of this ADF unit root test as it is key to the analysis of the cointegration of the rates under observation. Furthermore, the results are consistent with that of Brooks (2014:364) who states that financial time series in practice contain a single unit root and no more. So far, these results suggest that the two variables from each country may be cointegrated; thus permit for the estimation of a cointegration test to assess the co-movement between the variables in the long run.

Table 4-5 is a summary of results from each of the developed (G7) countries. There is a mixture of I(0) and I(1) variables as the null hypothesis of a unit root is rejected at level in countries like Canada, Japan and the United States when the intercept and trend is included, meaning that the variables are I(0). For France, Germany, Italy and the United Kingdom the null hypothesis is not rejected at level with the intercept and at level with the trend. However, the variables only become stationary at first difference with the intercept and trend are included, suggesting that the variables are I(1). The short rates in developed countries have results that indicate that all the short rates are of first order of integration I(1) as the null hypothesis is rejected at level and become stationary at first difference. Overall,

there is a similar pattern in the interest rates of the two groups in the sense that the null hypothesis is not rejected at level with both the intercept and trend, and also at first difference with just intercept. Interest rates are all stationary after first differencing with the intercept and trend included in the equation at 0.01 and 0.05 significance levels.

4.4.2 Phillips-Perron (PP) Unit Root Test results

In addition to the ADF unit root tests, the Phillips-Perron (PP) unit root test is employed to supplement the ADF unit root test. The test is conducted at a 0.05 significance level using Newey-West procedure and the results are presented on Table 6 for the developing countries and Table 4-7 for developed countries. The null hypothesis for the PP unit root test is that the variable has a unit root, while the alternative is that the variable is stationary.

The results on Table 4-6 show the PP unit root test results for the developing countries and suggests that the variables are non-stationary at level, with the exception of the South African rates. Four of the five developing countries' variables are integrated of order one I(1) as the variables have a unit root at level becoming stationary at first difference except for the South African rates.

Table 4-6: Phillips-Perron (PP) Unit Root Test results – Developing Countries

	Level with intercept & without trend		Level with intercept & trend		First Difference without trend		First Difference with intercept & Trend		Order of Integration
	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	
B-LT	2.145	0.2272	2.825	0.1903	11.265	0.0000	11.240	0.0000	I(1)
R-LT	1.823	0.3680	2.063	0.5613	10.403	0.0000	10.367	0.0000	I(1)
I-LT	2.319	0.1672	2.399	0.3786	9.126	0.0000	9.072	0.0000	I(1)
C-LT	2.840	0.0550	2.959	0.1472	10.276	0.0000	10316	0.0000	I(1)
S-LT	3.135	0.0260	2.912	0.1613	9.552	0.0000	9.584	0.0000	I(0)
B-ST	2.280	0.1798	3.277	0.0738	11.814	0.0000	11.778	0.0000	I(1)
R-ST	2.774	0.0643	3.292	0.0714	11.794	0.0000	11.746	0.0000	I(1)
I-ST	2.000	0.2866	2.166	0.5043	9.965	0.0000	9.941	0.0000	I(1)
C-ST	1.769	0.3944	1.734	0.7313	13.850	0.0000	13.821	0.0000	I(1)
S-ST	3.057	0.0320	2.682	0.2452	7.906	0.0000	7.928	0.0000	I(0)

*B = Brazil, R = Russia, I = India, C = China, S = South Africa *LT = Long term rate *ST = Short term rate

Table 4-7: Phillips-Perron (PP) Unit Root Test results – Developed Countries

	Level with intercept		Level with intercept & trend		First Difference with intercept & without trend		First Difference with intercept & Trend		Order of Integration
	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	t-stat.	p-value	
C-LT	0.539	0.8789	3.435	0.0504	9.615	0.0000	9.601	0.0000	I(0)
F-LT	0.151	0.9686	2.141	0.5183	8.956	0.0000	9.020	0.0000	I(1)
G-LT	0.097	0.9467	2.673	0.2491	8.862	0.0000	8.986	0.0000	I(1)
I-LT	0.590	0.8682	1.105	0.9241	9.591	0.0000	9.647	0.0000	I(1)
J-LT	0.536	0.8795	4.390	0.0030	10.908	0.0000	11.407	0.0000	I(0)
UK-LT	0.744	0.8311	3.109	0.1078	9.003	0.0000	9.015	0.0000	I(1)
US-LT	0.765	0.8255	3.525	0.0402	9.683	0.0000	9.714	0.0000	I(0)
C-ST	1.269	0.6432	1.713	0.7410	5.657	0.0000	5.640	0.0000	I(1)
F-ST	0.999	0.7529	1.975	0.6097	5.137	0.0000	5.153	0.0002	I(1)
G-ST	0.999	0.7529	1.975	0.6097	5.137	0.0000	5.153	0.0002	I(1)
I-ST	0.999	0.7529	1.975	0.6097	5.137	0.0000	5.153	0.0002	I(1)
J-ST	1.170	0.6864	1.193	0.9079	8.910	0.0000	9.153	0.0000	I(1)
UK-ST	0.887	0.7900	1.979	0.6073	7.540	0.0000	7.526	0.0000	I(1)
US-ST	0.996	0.7537	1.829	0.6858	9.271	0.0000	9.280	0.0000	I(1)

*C = Canada, F = France, G = Germany, I = Italy, J = Japan, UK = United Kingdom, US = United States

*LT = Long term rate, ST = Short term rate.

The PP and ADF unit root results have similar outcomes, the only difference is that with the PP unit root test it is both the South African short and long rate that are of I(0) order of integration at level with intercept. At level with intercept and trend all the variables consist of a unit root. After first differencing with and without the trend, all the variables become stationary.

Table 4-7 represents the PP unit root test for the developed countries. The outcome from the ADF and PP unit root test for developed countries shows some consistency with regards to the order of integration. The long rates of Canada, Japan and the United States reject the null hypothesis of a unit root at level with the intercept and trend included, while the exclusion of a trend at level results in all variables consisting of a unit root. However, variables become stationary after first differencing. There are no changes in the unit root test conducted on short rates, making the PP unit root test similar to that of the ADF test.

4.4.3 Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test results

The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for the unit root is conducted in order to compare the outcome of results with that of the ADF unit root test. With the KPSS unit root test, under the null hypothesis the series is stationary, while under the alternative hypothesis the series has a unit root and therefore is not stationary.

Table 4-8 shows the KPSS results of developing countries, while results of developed countries are on Table 4-9. The KPSS results of both country groups indicate that the outcome of some variables are consistent with that of the ADF unit root test results. There are a few inconsistencies though, in Table 8 the long rates of Russia and China are stationary at level with the inclusion of an intercept while the other country rates have a unit root. In addition, the long rate of South Africa under the KPSS test has a unit root. Furthermore, most country rates are stationary at level with the intercept and trend included in the equation.

This KPSS outcome at level with intercept is consistent with the ADF test for the Brazil rates, short rate for Russia, India rates and the short rates for China and South Africa. Apart from some of the inconsistencies between the unit root tests, the KPSS unit root test with and without the trend after first difference, variables are stationary.

Table 4-8: Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test results – Developing Countries

	At level with intercept			Level with intercept &			First Difference without			First Difference with		
	LM-Stat	Crit. Value	Outcome	LM-Stat	Crit. Value	Outcome	LM-Stat	Crit. Value	Outcome	LM-Stat	Crit. Value	Outcome
B-LT	0.577	0.463	Unit Root	0.092	0.146	Stationary	0.070	0.463	Stationary	0.054	0.146	Stationary
B-ST	1.123	0.463	Unit Root	0.167	0.146	Unit Root	0.089	0.463	Stationary	0.090	0.146	Stationary
R-LT	0.393	0.463	Stationary	0.114	0.146	Stationary	0.052	0.463	Stationary	0.048	0.146	Stationary
R-ST	0.494	0.463	Unit Root	0.103	0.146	Stationary	0.042	0.463	Stationary	0.040	0.146	Stationary
I-LT	0.844	0.463	Unit Root	0.183	0.146	Unit Root	0.104	0.463	Stationary	0.030	0.146	Stationary
I-ST	0.739	0.463	Unit Root	0.073	0.146	Stationary	0.076	0.463	Stationary	0.054	0.146	Stationary
C-LT	0.082	0.463	Stationary	0.049	0.146	Stationary	0.097	0.463	Stationary	0.048	0.146	Stationary
C-ST	1.123	0.463	Unit Root	0.131	0.146	Stationary	0.089	0.463	Stationary	0.095	0.146	Stationary
S-LT	0.406	0.463	Unit Root	0.102	0.146	Stationary	0.143	0.463	Stationary	0.047	0.146	Stationary
S-ST	0.661	0.463	Unit Root	0.126	0.146	Stationary	0.233	0.463	Stationary	0.107	0.146	Stationary

*B = Brazil, R = Russia, I = India, C = China, S = South Africa *ST = Short term rate

Table 4-9: Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test results – Developed Countries

	At level with intercept			Level with intercept &			First Difference			First Difference with		
	LM-Stat	Crit. Value	Outcome	LM-Stat	Crit. Value	Outcome	LM-Stat	Crit. Value	Outcome	LM-Stat	Crit. Value	Outcome
C-LT	1.443	0.463	Unit Root	0.079	0.146	Stationary	0.059	0.463	Stationary	0.033	0.146	Stationary
C-ST	0.857	0.463	Unit Root	0.123	0.146	Stationary	0.088	0.463	Stationary	0.088	0.146	Stationary
F-LT	1.240	0.463	Unit Root	0.310	0.146	Unit Root	0.225	0.463	Stationary	0.034	0.146	Stationary
F-ST	0.910	0.463	Unit Root	0.169	0.146	Unit Root	0.121	0.463	Stationary	0.074	0.146	Stationary
G-LT	1.359	0.463	Unit Root	0.288	0.146	Unit Root	0.158	0.463	Stationary	0.032	0.146	Stationary
G-ST	0.910	0.463	Unit Root	0.169	0.146	Unit Root	0.121	0.463	Stationary	0.074	0.146	Stationary
I-LT	0.381	0.463	Stationary	0.244	0.146	Unit Root	0.254	0.463	Stationary	0.080	0.146	Stationary
I-ST	0.910	0.463	Unit Root	0.169	0.146	Unit Root	0.121	0.463	Stationary	0.074	0.146	Stationary
J-LT	1.241	0.463	Unit Root	0.348	0.146	Unit Root	0.055	0.463	Stationary	0.096	0.146	Stationary
J-ST	0.289	0.463	Stationary	0.277	0.146	Unit Root	0.363	0.463	Stationary	0.101	0.146	Stationary
UK-	1.331	0.463	Unit Root	0.156	0.146	Unit Root	0.103	0.463	Stationary	0.055	0.146	Stationary
UK-	1.122	0.463	Unit Root	0.139	0.146	Stationary	0.132	0.463	Stationary	0.122	0.146	Unit Root
US-	1.289	0.463	Unit Root	0.134	0.146	Stationary	0.127	0.463	Stationary	0.057	0.146	Stationary
US-	0.780	0.463	Unit Root	0.156	0.146	Unit Root	0.253	0.463	Stationary	0.208	0.146	Unit Root

*C = Canada, F = France, G = Germany, I = Italy, J = Japan, UK = United Kingdom, US = United States *LT = Long term rate
*ST = Short term rate. At 0.05 significance level

4.4.4 Break-point Unit Root Test

It is common in the modelling and testing of macroeconomic time series variables to come across structural breaks which may have occurred due to changes in the regulations of financial markets, the financial crisis and other major changes that have a significant impact on the economy (Pahlavani & Wilson, 2005:135). The existence of a structural break in macroeconomic time series variables can be determined using a process by Perron (1989) which allows for a complete sample instead of two sub-samples for use (Pahlavani & Wilson, 2005:135). The study by Perron (1989) indicates that a unit root test which does not allow for the likelihood of a sharp movement or jump in the process of data generation is often biased towards not rejecting the null hypothesis of the presence of a unit root.

The unit root test with a break point is able to conduct the modified Dickey-Fuller tests which allow for levels and trends that differ across a single break date assuming an innovation outlier break. The innovation outlier model allows for changes in the series to take place gradually (Pahlavani & Wilson, 2005:136). The breakpoint unit root test is conducted with intercept and the breakpoint selection of Dickey-Fuller min-t., at level and

at first difference to identify a break in the unit root. The breakpoint unit root test of both the economic groups is then accompanied by the Dickey Fuller t-statistics graph in the Appendix which clearly indicates the likely break date for the observed country rates. Also, the test is conducted with a trend and intercept included in the equation at level and first difference. The null hypothesis suggests the presence of a unit root, thus making the variable non-stationary. The alternative hypothesis suggests that the series is trending stationary making the series stationary around a deterministic trend. This kind of series confirms the presence of a structural break at level on either the intercept or the growth of the trend (MathWorks, 2016).

Table 4-10 and 4-11 represent the breakpoint unit root results for developing countries. Table 4-10 is the outcome of a breakpoint unit root test with the intercept included in the equation. The results show that the interest rates in each of the developing countries become trend stationary after first differencing. These results are almost consistent with the ADF unit root test with the exception of the long rate in South Africa which in the breakpoint unit root test consists of a unit root at level. The reported break dates for long term rates are around the early stages of the financial crisis for Brazil (2007M03), India (2008M12) and China (2008M10), while India and China have very close break dates. Some of the breaks may be linked to other financial or economic events that were specific to that particular country and indicate the need to employ dummy variables. Moreover, the eruption of the financial crisis may have led to interest and liquidity related risk to spread across sectors and countries. Russia (2014M12) and South Africa (2013M06) on the other hand indicate the presence of a break post the financial crisis, suggesting that the long rates in these countries were affected by global weakness that followed financial crisis.

The proposed break dates for the short term rates of developing countries occur mostly after the financial crisis for Brazil (2016M01), India (2013M08) and China (2016M01), while for Russia (2009M03) and South Africa (2009M02) the break dates occur during the period of the financial crisis. Russia and South Africa mainly export commodities, energy and mineral commodities respectively, and both countries saw a heavy decline in prices over recent years after the commodity boom that occurred between 2000 and 2010 which may have affected currencies and the short rate (IMF, 2015:65).

Table 4-11 tests for a breakpoint unit root with a trend and intercept and it presents similar results to the outcome in Table 4-10, with the long rate that consists of a unit root at level

becoming stationary at first difference. There are no changes observed when comparing the long rate results for Brazil (2007M03) and Russia (2014M12) from Table 4-10 to Table 4-11.

The break dates for India (2008M12), China (2008M10) and South Africa (2008M08) took place during the peak period of the financial crisis. The graphical analysis shows that the long term rate during the suggested break dates dropped immensely.

When compared to the outcome on table 10, the break dates for India and China are the same, while the break date for South Africa moves from 2013M06 to 2008M08. Changes in the suggested break dates for short rates are also evident for Russia (2009M03) and China (2016M01) when comparing the two tables. However, the rest of the countries remain unchanged. The break dates for both the short and the long term rate are consistent with the finding in the graphical analysis.

The breakpoint unit root test with trend and intercept for developing countries is shown in Table 4-11 and it indicates that the long rates consist of a unit root at level, however, becoming trend stationary at first difference. The short rate has a mixture of variables, the short rates of Russia and South Africa are trend stationary at level, and the remaining short rates consist of a unit root at level and become trend stationary at first difference.

The outcome of the break unit root test with the inclusion of the intercept is on Table 4-12 for developed countries, and it shows similar results as the outcome for developing countries as shown on Table 4-10. The long rate consists of a unit root at level becoming trend stationary at first difference. However, the short rate has a mixture of variables with most of the countries becoming stationary at level except for Canada and Japan. Canada and Japan short rates fail to reject the null hypothesis of unit root in the series, nevertheless, they become stationary at first difference.

Table 4-10: Breakpoint Unit Root Test for Developing Countries with Intercept

	At Level with Intercept					**First Difference with Intercept**				
	Time of Break	Lags	T-stat.	P-value	Result	Time of Break	Lags	T-stat.	P-value	Result
B-LT	2007M02	0	4.083	0.1296	Unit Root	2007M03	0	16.042	< 0.01	Stationary
R-LT	2013M10	1	3.287	0.5101	Unit Root	2014M12	0	12.875	< 0.01	Stationary
I-LT	2004M09	1	3.933	0.1795	Unit Root	2008M12	1	10.114	< 0.01	Stationary
C-LT	2005M03	1	3.650	0.3067	Unit Root	2008M10	0	11.125	< 0.01	Stationary
S-LT	2008M06	1	4.018	0.1509	Unit Root	2013M06	0	10.132	< 0.01	Stationary
B-ST	2015M11	0	4.395	0.0573	Unit Root	2016M01	0	21.668	< 0.01	Stationary
R-ST	2009M01	0	3.331	0.4858	Unit Root	2009M03	0	12.746	< 0.01	Stationary
I-ST	2010M04	1	3.454	0.4116	Unit Root	2013M08	0	11.931	< 0.01	Stationary
C-ST	2007M08	0	3.277	0.5178	Unit Root	2016M01	0	16.455	< 0.01	Stationary
S-ST	2008M11	1	3.442	0.4180	Unit Root	2009M02	0	9.548	< 0.01	Stationary

*B = Brazil, R = Russia, I = India, C = China, S = South Africa *ST = Short term rate

Table 4-11: Breakpoint Unit Root Test for Developing Countries with Trend and Intercept

	At Level with Trend and Intercept					**First Difference with Trend and Intercept**				
	Time of Break	Lags	T-stat.	P-value	Result	Time of Break	Lags	T-stat.	P-value	Result
B-LT	2007M02	0	4.552	0.2143	Unit Root	2007M03	0	15.844	< 0.01	Stationary
R-LT	2014M10	1	3.326	0.8864	Unit Root	2014M12	0	12.497	< 0.01	Stationary
I-LT	2008M07	1	4.470	0.2503	Unit Root	2008M12	1	10.294	< 0.01	Stationary
C-LT	2013M06	1	3.877	0.6014	Unit Root	2008M10	0	11.164	< 0.01	Stationary
S-LT	2012M05	1	4.502	0.2359	Unit Root	2008M08	0	10.263	< 0.01	Stationary
B-ST	2015M02	0	3.904	0.5853	Unit Root	2016M01	0	16.712	< 0.01	Stationary
R-ST	2009M01	0	5.456	0.0235	Stationary	2009M01	0	13.178	< 0.01	Stationary
I-ST	2008M08	1	3.467	0.8289	Unit Root	2013M08	0	11.814	< 0.01	Stationary
C-ST	2007M08	0	4.989	0.0797	Unit Root	2015M12	0	16.772	< 0.01	Stationary
S-ST	2009M01	1	5.580	0.0165	Stationary	2009M02	0	9.971	< 0.01	Stationary

*B = Brazil, R = Russia, I = India, C = China, S = South Africa *ST = Short term rate

Table 4-12: Breakpoint Unit Root Test for Developed Countries with Intercept

	At Level with Intercept					First Difference with Intercept				
	Time of Break	Lags	T-stat.	P-value	Results	Time of Break	Lags	T-stat.	P-value	Result
C-LT	2011M04	1	2.738	0.8153	Unit Root	2008M12	0	10.371	< 0.01	Stationary
F-LT	2011M11	1	2.609	0.8655	Unit Root	2011M11	0	9.555	< 0.01	Stationary
G-LT	2011M04	1	3.204	0.5640	Unit Root	2008M12	0	9.371	< 0.01	Stationary
I-LT	2013M12	1	3.305	0.5005	Unit Root	2011M11	0	11.613	< 0.01	Stationary
J-LT	2011M04	0	3.317	0.4940	Unit Root	2006M04	1	10.819	< 0.01	Stationary
UK-LT	2008M06	1	3.385	0.4512	Unit Root	2008M12	0	9.652	< 0.01	Stationary
US-LT	2010M04	1	3.691	0.2871	Unit Root	2008M12	0	11.0417	< 0.01	Stationary
C-ST	2008M07	2	4.188	0.1013	Unit Root	2009M01	0	6.926	< 0.01	Stationary
F-ST	2008M10	1	5.065	< 0.01	Stationary	2008M11	0	6.406	< 0.01	Stationary
G-ST	2008M10	1	5.065	< 0.01	Stationary	2008M11	0	6.406	< 0.01	Stationary
I-ST	2008M10	1	5.065	< 0.01	Stationary	2008M11	0	6.406	< 0.01	Stationary
J-ST	2012M10	2	1.615	> 0.99	Unit Root	2008M12	0	10.397	< 0.01	Stationary
UK-ST	2008M10	1	10.926	< 0.01	Stationary	2008M11	0	10.451	< 0.01	Stationary
US-ST	2008M10	0	4.785	0.0185	Stationary	2008M01	0	10.367	< 0.01	Stationary

*C = Canada, F = France, G = Germany, I = Italy, J = Japan, UK = United Kingdom, US = United States *LT = Long term rate
*ST = Short term rate.

Table 4-13: Breakpoint Unit Root Test for Developed Countries with Trend and Intercept

	At Level with Trend and Intercept					First Difference with Trend and Intercept				
	Time of Break	Lags	T-stat.	P-value	Results	Time of Break	Lags	t-stat.	p-value	Result
C-LT	2011M04	1	4.615	0.1865	Unit Root	2008M12	0	10.353	< 0.01	Stationary
F-LT	2011M11	1	4.707	0.1551	Unit Root	2011M11	0	9.522	< 0.01	Stationary
G-LT	2006M01	1	4.917	0.0941	Unit Root	2008M12	0	9.360	< 0.01	Stationary
I-LT	2011M06	1	5.157	0.0528	Unit Root	2012M02	0	11.071	< 0.01	Stationary
J-LT	2006M02	1	8.246	< 0.01	Stationary	2005M06	1	10.970	< 0.01	Stationary
UK-LT	2011M04	1	4.379	0.2953	Unit Root	2008M12	0	9.665	< 0.01	Stationary
US-LT	2011M04	1	4.703	0.1562	Unit Root	2008M12	0	11.234	< 0.01	Stationary
C-ST	2008M10	2	5.641	0.0136	Stationary	2009M01	0	6.958	< 0.01	Stationary
F-ST	2008M10	1	10.237	< 0.01	Stationary	2008M11	0	6.216	< 0.01	Stationary
G-ST	2008M10	1	10.237	< 0.01	Stationary	2008M11	0	6.216	< 0.01	Stationary
I-ST	2008M10	1	10.237	< 0.01	Stationary	2008M11	0	6.216	< 0.01	Stationary
J-ST	2006M04	1	5.662	0.0126	Stationary	2007M08	0	10.627	< 0.01	Stationary
UK-ST	2008M10	1	15.516	< 0.01	Stationary	2008M11	0	10.158	< 0.01	Stationary
US-ST	2007M12	0	4.440	0.2648	Unit Root	2008M10	0	10.706	< 0.01	Stationary

*C = Canada, F = France, G = Germany, I = Italy, J = Japan, UK = United Kingdom, US = United States *LT = Long term rate
*ST = Short term rate.

The breakpoint unit root test with trend and intercept for developing countries is shown on Table 4-13 and it indicates that the long rates consist of a unit root at level however, become trend stationary at first difference. Only Italy and Japan have different break dates when comparing Table 4-12 and 4-13. Italy changes from 2011M11 when break date is determined with the inclusion of an intercept to 2012M02. Japan's break date moves from 2006M04 to 2005M06. For the short rate, four out of the seven countries are trend stationary at level in both developed country tables. However, the break dates for Canada, Japan and the United States vary.

There is a notable pattern with the break dates in most countries, once the variables become trend stationary the suggested break dates occur during and after the time of the financial crisis. This outcome may be consistent with the disruption caused by the financial crisis.

It appears that all of the country rates are trend stationary. That is, the country interest rates appear to be trending series. In addition, each country has a break date. This confirms the global ramifications of the financial crisis which may have had an impact on interest rates in most of the countries considered for this study. The breakpoint unit root test conducted for each country rate at level and first difference with the inclusion of the intercept is supported by a Dickey-Fuller t-statistics graphical illustration in the Appendix. The graphs clearly indicate the likely break point that was selected with the corresponding lag length using the Schwarz information criterion. The graphs for developing countries have varying trends and break point dates at level, almost becoming steady after first difference. The rates for developed countries show similarity especially after first differencing, with a similar break date.

The breakpoint unit root test assists in estimating an appropriate model. Failing to include an appropriate trend in a trending data series may lead to capturing results that omit important information (Pahlavani & Wilson, 2005:138). Furthermore, failing to include a break when the data series contains a break is likely to lower the ability to reject the null hypothesis of no break as the inclusion of a trend leads to an increase in critical values (Pahlavani & Wilson, 2005:138). In this study, the results of the breakpoint unit root test assist in adding breaks and trend in the ARDL analysis which is done by employing appropriate dummy variables in the ARDL model.

4.5   ARDL RESULTS

The unit root tests conducted in the previous section indicate that there is a mixture of I(0) and I(1) order of integration, and none of the series are I(2) . The outcome of the unit root tests clearly suggest that the Auto-Regressive Distributed Lag model (ARDL) is suitable for the cointegration test. The ARDL is thus employed to verify whether there is a long-run relationship between the long rate and the short rate in each country, moreover, for the assessment of the predictability of future interest rate movements.

4.5.1   ARDL Model Selection

To identify the most suitable model for the ARDL estimation, optimum lags were selected and tested for each model. The consideration of the most suitable model involved the selection of a model that is homoscedastic and has no serial correlation from the model selection summary of the criteria graph generated by using EViews 9.

Table 4-14: Selected model for each country

Country	Trend Specification	Selected Model	R-Squared
Brazil	Constant Level	(3,0)	90.08%
Russia	Linear Trend	(7,0)	93.00%
India	Constant Level	(2,5)	95.40%
China	Constant Level	(3,0)	88.10%
South Africa	Constant Level	(2,0)	87.42%
Canada	Linear Trend	(2,1)	98.30%
France	Linear Trend	(2,1)	98.40%
Germany	Linear Trend	(2,1)	98.80%
Italy	Linear Trend	(3,12)	96.40%
Japan	Linear Trend	(1,5)	96.20%
United Kingdom	Linear Trend	(2,1)	98.20%
United States	Linear Trend	(2,4)	97.00%

The appropriate models were selected using the Schwarz Bayesian information criterion (SBIC). The selected models are at linear trend and constant level as shown in Table 4-14 with relevant R-squared values. It is not unusual to have high R-squared values in EHTS, a study by Casalin (2007:26) on the EHTS and that of Engle and Granger (1987) used high R-squared values. The R-squared values of the model for each of the countries indicate that

the model is able to explain high variability between the short and long rate. Apart from the R-squared values' ability to indicate variability between the two interest rates, in the case of EHTS, it has another use. At times the R-squared value is used to measure the variability of interest rates, with a low value interpreted as not being able to determine variation in an observed rate (Shiller, 1979:1212).

4.5.2   Bound Cointegration Results: Long-Run Relationships

Table 4-15 and Table 4-16 consist of the ARDL cointegration test results at different significance levels, upper and lower bound critical values with the corresponding F-statistic. The ARDL cointegration test determines the existence of a long-run relationship between the two observed variables in each country. The estimated F-statistic values for developing countries are 5.987, 6.074, and 6.921. These values exceed the upper bound critical value at both 10 percent and 5 percent significance levels and represent the interest rates of India, China and South Africa respectively. An F-statistic that exceeds the upper bound critical values results in the rejection of the null hypothesis which states that there is no cointegration between the long and the short rate. This implies that there is co-movement between the rates in the long-run and also suggests the validity of the EH in these economies. However, the F-statistic of 2.289 and 4.898 for Brazil and Russia is less than the lower bound critical value at both significance levels, thus failing to reject the null hypothesis of no cointegration. Therefore, this makes Brazil and Russia the only countries in the group of developing countries that have no evidence of the EH.

Table 4-15: Results of the Cointegration Test - Developing Countries

Country	Brazil		Russia		India		China		South Africa	
Bounds	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
10%	4.04	4.78	5.59	6.26	4.04	4.78	4.04	4.78	4.04	4.78
5%	4.94	5.73	6.56	7.3	4.94	5.73	4.94	5.73	4.94	5.73
F-stat.	2.289		4.898		5.987**		6.074**		6.921**	

I(0) and I(1) refer to lower and upper bounds, respectively;

(*), (**) indicate significance at 10% level and 5% level respectively.

Table 4-16: Results of the Cointegration Test - Developed Countries

Country	Canada		France		Germany		Italy		Japan		UK		US	
Bounds	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
10%	5.59	6.26	5.59	6.26	5.59	6.26	5.59	6.26	5.59	6.56	5.59	6.26	5.59	6.26
5%	6.56	7.3	6.56	7.3	6.56	7.3	6.56	7.3	6.26	7.3	6.56	7.3	6.56	7.3
F-stat.	10.141**		9.709**		10.615**		1.888		4.145		6.134		5.890	

(*) and (**) indicate significance at 10% level and 5% level respectively.

On the other hand, long-run co-movement between the long and short rates in developed countries is found in Canada, France and Germany as for each of these countries the F-statistic is 10.141, 9.709, and 10.615 respectively. The F-statistic value for each of these countries exceeds the upper bound critical value as represented in Table 4-16, at 5 percent and 10 percent significance levels suggesting that there is cointegration between variables. Also, there is evidence that supports the validity of the EH in these countries.

Although the F-statistic value in the United Kingdom and the United States were 6.134 and 5.890 respectively, both the values lie in between the lower and upper critical value bounds resulting in the test outcome being inconclusive. While the interest rates in Italy and Japan indicate that there is no cointegration in the observed variables since the F-statistic value in these countries falls below the lower bound critical value.

There exists a long-run relationship between the observed variables in the countries found with cointegrating variables. The ARDL test indicates that there is a long-run relationship from the short to the long rate of most of the observed countries, suggesting that the Error Correction Model (ECM) should be estimated. Before the estimation of the ECM, the corresponding long-run equations for the countries with cointegrating variables are shown in equations 4.1 – 4.6.

The long-run equation for India indicates that the independent variable, which is the short rate, has a positive effect on the dependent variable – the long rate evident in Equation 4.1. Accordingly, a rise in the short rate will result in an increase in the long rate of 21.82 percent. The dummy variable is negative and insignificant, and when compared to the pre-crisis period, which is the period without the dummy variable. It is clear that the structural break suggested for India does not have a major effect on the variables, if the dummy was significant it would decrease the long rate by 30.88 percent in the long-run. India has experienced a surge of capital inflows post the financial crisis. Moreover, the formal adoption of the flexible inflation targeting regime in February 2015 improved policy

formulation and in the same year the central bank cut the key interest rate by 125 basis points (IMF, 2016:12). The relationship between the interest rates of India seem to have a similar pattern throughout the observed period, much like a study done by Mankiw (1986:109) in which interest rates were unaffected by significant changes. The most evident change in the country post the adoption of inflation targeting is an increase of 1.7 percent in the credit growth (IMF, 2016:12). The change in monetary policy regime may influence the market's expectations in terms of the likely direction that the short term rate of India may take (Mankiw, 1986:109).

$$India_{LT} = 6.0395 + 0.2182 India_{ST} - 0.3088 DUMMY \qquad (4.1)$$

$$China_{LT} = 1.7640 - 0.0255 China_{ST} \qquad (4.2)$$

$$South\ Africa_{LT} = 7.0727 + 0.1793 South\ Africa_{ST} \qquad (4.3)$$

$$Canada_{LT} = 4.9486 - 0.0339 Canada_{ST} + 0.4826 Dummy01 - 0.0234@TREND \qquad (4.4)$$

$$France_{LT} = 4.3895 + 0.0963 France_{ST} + 1.5737 DUMMY01 - 0.0337@TREND \qquad (4.5)$$

$$Germany_{LT} = 4.8739 - 0.1441 Germany_{ST} + 1.5104 DUMMY - 0.0288@TREND \qquad (4.6)$$

Equation 4.2 is the corresponding long-run equation for China. The long-run equation indicates that there is a negative relationship between the two observed rates, implying that a rise in the short rate leads to a decline in the long rate of 2.55 percent in the long-run. The monetary policy framework of China is rather complex, the country has had a fixed exchange rate system and is still in the process of a shift to a free floating system (Kwan, 2015). The finding of long-run association under such a framework is consistent with a closely linked study by Gerlach and Smets (1998), the authors note the EH validity is common in fixed exchange rate systems.

Equation 4.3 is the long-run equation of the South African rates. The equation indicates that there exists a positive relationship between the observed rates, thus suggesting that in the long-run, a rise in the short rate leads to an increase of 17.93 percent in the long rate.

The long-run equation for Canada is found in equation 4.4 and it indicates that there is negative association between the long rate and the short rate. Changes in the short rate have an inverse effect on the long rate. Therefore, an increase in the short rate is followed by a decline in the long rate of 3.39 percent. The dummy variable has a weak effect on the short

rate since it is significant at 10 percent. Nonetheless, post the financial crisis the dummy increases the long rate by 48.26 percent, thus suggesting that the financial crisis has a weak effect in the long-run. The central bank of Canada has kept the short rate at 1 percent between 2010 through to 2014 evident on the graphical analysis. Moreover, in the long-run there is strong evidence of a negative trend supported by a 0.01 significance level causing a decline of 0.35 percent on the term structure.

Equation 4.5 is the long-run equation of interest rates in France. The short rate has a positive relationship with the long rate, thus a rise in the short rate will in the long-run lead to an increase in the long rate of 9.63 percent. There is also strong evidence of a negative trend over the observed period. Furthermore, the statistical significance of the dummy coefficient implies that post the financial crisis the inclusion of a dummy results in an increase in the long rate of 1.57. Furthermore, Equation 4.6 indicates that there is a negative relationship between the variables, from the short rate to the long rate in Germany. An increase in the short rate is followed by a decrease in the long rate by 14.41 percent. There is also strong statistical evidence supporting the negative trend over the observed period, while the statistical significance of the dummy coefficient is indicative of an increase in the long rate post the crisis over the long-run.

The central banks of France and Germany conduct monetary policy independently. Both the countries are members of the European System of Central Banks and as such, changes in interest rates seem to have co-movement (IMF, 2014:4). Post the crisis the interest rates in both countries were very low, the long rate fell from 4.7 percent in 2008 to 0.05 percent in the second quarter of 2016 subsequently supporting economic recovery (IMF, 2016:36).

The findings in this study in relation to the long rates of France, Canada and Germany are similar to a study conducted by Hardouvelis (1994:281). The author finds that the long rate of France follows the correct path as predicted by EH, an increase in the short rate is followed by an increase in the long rate. Furthermore, in Canada and Germany the long rate takes the opposite path, possibly due to white noise deviation of the long rate from a level projected by EH. However, owing to cumulative changes in the short rate and the lagged response between the long and the short rates, the size of the white noise is not economically significant, as the content on the term structure is not affected (Hardouvelis, 1994:281).

4.5.3   Error Correction Model (ECM) Results

The countries with cointegrating interest rates propose that in the long-run there is equilibrium between the two rates. However, in this section the use of ECM in part corrects disequilibrium that may have occurred in the previous period, that is, disequilibrium in the short-run (Gujarati & Porter, 2008:764). In essence the model is able to record the speed of adjustment from the previous period back to equilibrium if the ECM is negative and significant. Thus strictly speaking, the model measures how long it takes for the discrepancy in the last period between the two rates to be restored back to equilibrium (Brooks, 2014:376). The ECM adjusts deviations from the equilibrium of variables and serves to estimate the speed of adjustment of the observed variables. The table below consists of output from the countries found with cointegrating variables. Here ECM is employed to capture the short-run effects in each country's interest rates.

Table 4-17: ECM results for India

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INDIA_LT(-1))	0.244287	0.080508	3.034308	0.0029
D(INDIA_ST)	0.277959	0.037492	7.413745	0.0000
D(INDIA_ST(-1))	-0.049923	0.063485	-0.786373	0.4330
D(INDIA_ST(-2))	0.079431	0.060843	1.305492	0.1938
D(INDIA_ST(-3))	-0.051573	0.059073	-0.873034	0.3841
D(INDIA_ST(-4))	0.014246	0.037340	0.381526	0.7034
D(DUMMY)	0.030517	0.037014	0.824472	0.4111
ECT(-1)	-0.098819	0.031085	-3.178966	0.0018

Table 4-18: ECM results for China

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CHINA_LT(-1))	0.195346	0.078689	2.482499	0.0142
D(CHINA_LT(-2))	0.226447	0.080100	2.827053	0.0053
D(CHINA_ST)	-0.005799	0.011025	-0.525954	0.5997
ECT(-1)	-0.227414	0.030840	-7.373873	0.0000

Table 4-19: ECM results for South Africa

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SOUTH_AFRICA_LT(-1))	0.294619	0.076699	3.841254	0.0002
D(SOUTH_AFRICA_ST)	0.022803	0.015452	1.475775	0.1421
ECT (-1)	-0.127150	0.033639	-3.779782	0.0002

Table 4-20: ECM results for Canada

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CANADA_LT(-1))	0.260536	0.076888	3.388504	0.0009
D(CANADA_ST)	0.270802	0.093226	2.904780	0.0042
D(DUMMY01)	0.073046	0.039179	1.864410	0.0642
D(@TREND())	-0.003549	0.000811	-4.374484	0.0000
ECT(-1)	-0.151367	0.035051	-4.318431	0.0000

Table 4-21: ECM results for France

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FRANCE_LT(-1))	0.325438	0.076202	4.270721	0.0000
D(FRANCE_ST)	0.194973	0.079369	2.456555	0.0152
D(DUMMY01)	0.236384	0.068077	3.472323	0.0007
D(@TREND())	-0.005056	0.001192	-4.240156	0.0000
ECT(-1)	-0.150213	0.034228	-4.388599	0.0000

Table 4-22: ECM results for Germany

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GERMANY_LT(-1))	0.301958	0.074839	4.034767	0.0001
D(GERMANY_ST)	0.280701	0.080732	3.476925	0.0007
D(DUMMY)	0.175255	0.055943	3.132754	0.0021
D(@TREND())	-0.003336	0.000734	-4.548370	0.0000
ECT(-1)	-0.116036	0.029247	-3.967470	0.0001

Short-Run Relationship for India

The ECM for India is on Table 4-17 and it shows that there is a short-run relationship between the long rate and the short rate as the error correction term (ECT) is negative and significant at 0.01 level. In the short-run the long rate is responsive to adjustments towards equilibrium correcting approximately by 9.88 percent of its previous period disequilibrium, with changes in the short rate taking 10.11 months (1/0.098819) to fully affect the long rate, thus there is a relatively slow adjustment. The short-run coefficient lag of the long rate is significant at 0.01 level indicating that there is a strong short-run relationship, thus changes in the short rate affect the long rate. However, the lagged short rate coefficients do not

respond to changes in the long rate. The strong significance of the short rate of India at 0.01level indicates that changes in the long rate in the short-run are able to influence changes in the short rate.

Short-Run Relationship for China

Table 4-18 represents the ECM results for Chinese interest rates. The error correction coefficient is negative and significant as desired, implying that approximately 22.74 percent of disequilibrium between the long and the short rate is corrected every month. This means that changes in the short rate take approximately 4.39 months (1/0.227414) to have a full effect on the long rate, suggesting that there is quick adjustment to equilibrium in the model. The model also has significant coefficient lags at 0.01 level signifying that there is strong short-run association between rates, with the long rate responding to changes in the short rate however, not the other way around, given that the coefficient of the short rate is insignificant.

Short-Run Relationship for South Africa

Table 4-19 represents the ECM for interest rates in South Africa. There is an indication of short-run association between the variables shown by the negative and significant error correction coefficient. This implies that the dependent variable is responsive to adjustments towards short-run equilibrium and that the system corrects 12.71 percent of disequilibrium between variables from the previous period. It therefore takes approximately 7.86 months (1/0.127150) for a change in the independent variable to have a full effect on the dependent variable. The speed of adjustment back to equilibrium is quite moderate in this case. There is also strong short-run equilibrium between the variables as indicated by the coefficient of the long rate that is significant at 0.01. The disequilibrium of the previous period is corrected at a speed of 29.4 percent. The long rate responds to changes in the short rate. On the other hand, it seems like changes in the long rate do not affect the short rate as indicated by the short rate's insignificant coefficient.

Short-Run Relationship for Canada

Table 4-20 is the ECM for Canada. The ECT is negative and significant as desired, implying that disequilibrium of 15.13 percent is eliminated every month. This means that changes in the short rate will take approximately 6.61 months (1/0.151367) to restore the system back to equilibrium which is a relatively quick adjustment. There is a strong short-run

relationship as indicated by the statistically significant coefficient lag of the long rate at 0.01 significance level, meaning that disequilibrium is corrected at a speed of 26.0 percent in the short-run. The short rate and the trend coefficients are statistically significant at 0.01 level suggesting that there is strong association in the short-run between these variables and the long rate. Also, 27.0 percent of disequilibrium in the short rate is corrected and a strong downward trend of 0.3 percent is present in the system in the short-run. Moreover, the dummy coefficient has rather weak association with the long rate as indicated by the 10 percent significance level. The results indicate that both rates influence each other, meaning the long rate responds to changes in the short rate and the other way around in the short-run. The dummy has a positive and weak effect on the long rate of 7.3 percent in the short-run.

Short-Run Relationship for France

Restoration from shocks back to the equilibrium position of France are shown in Table 4-21. The error correction coefficient is negative and significant as desired, thus signalling the existence of long-run association between the observed variables. It takes approximately 6.66 months (1/0.150213) for restoration back to equilibrium after a shock to the system, this adjustment is relatively quick. Although the statistical significance at 0.05 level of the variables' coefficient lags suggests that there is a strong short-run relationship between the variables and the dependent variable. In the short-run, changes in the dummy correct disequilibrium in the system at a rate of 23.6 percent, also, the significance at 0.01 of this coefficient is indicative of a robust adjustment. The trend coefficient is negative and significant at 0.01 meaning that the term structure has a downward trend as it restores back to equilibrium in the short-run.

Short-Run Relationship for Germany

Table 4-22 represents the ECM of Germany. The error correction coefficient provides evidence of a short-run relationship between the short rate and the long rate, as indicated by the negative and statistically significant coefficient at 5 percent. The speed of adjustment back to equilibrium is moderate at approximately 8.61 months (1/0.116036). A short-run equilibrium between the dependent and independent variables is indicated by the 0.01 significance level of the short-run coefficients. The short rate strongly responds to previous changes in the long rate, adjusting at 28.0 percent as signalled by the significance level at 0.01. The disequilibrium of the previous period is corrected at a rate of 30.1 percent, thus the long rate strongly responds to changes in the short-run as implied by the 0.01

significance level. In the short-run, changes in the dummy respond to disequilibrium in the system at a rate of 17.5 percent. Moreover, the significance at 0.01 of this coefficient is indicative of a robust adjustment. The trend coefficient is negative and significant at 1 percent meaning that the term structure has a downward trend as it restores back to equilibrium in the short-run.

4.6   RESIDUAL DIAGNOSTICS

The residual diagnostics played a significant role in selecting the appropriate model for each country. The process involves considering a model that has stable parameters, with no serial correlation, and is homoscedastic. The residual diagnostic tests for each country indicate that there is no heteroscedasticity present and no serial correlation in the models. The residual tests for developing countries are on Table 4-23, followed by the residual tests of developed countries on Table 4-24. The null hypothesis for serial correlation states that there is no serial correlation should the probability value be greater than the 0.05 significance level, while the alternative is the presence of serial correlation which is not desirable and this occurs when the probability value is less than 0.05 significance level.

The test for heteroscedasticity involves a null hypothesis of homoscedasticity and an alternative hypothesis of heteroscedasticity. The rejection of null hypothesis is not desirable as it suggests that the model is heteroskedastic suggesting that the variance of errors is not constant. The developing and developed countries all have passed the residual diagnostic tests apart from Russia which has heteroscedasticity even with the inclusion of a dummy variable.

Table 4-23: Serial Correlation and Heteroskedasticity Test – Developing Countries

	Breusch-Godfrey Serial Correlation Test			Breusch-Pagan-Godfrey Heteroskedasticity Test	
	F-Stat.	Prob. F	Prob. χ^2	F-Stat.	Prob. χ^2
Brazil	1.3138598	0.2707	0.2527	1.435095	0.2023
Russia	0.814367	0.4451	0.4143		
India	1.822985	0.1654	0.1453	1.855700	0.0670
China	0.460489	0.6319	0.6191	0.586446	0.6650
South Africa	2.272899	0.1066	0.1008	1.878013	0.1342

Table 4-24: Serial Correlation Test and Heteroskedasticity – Developed Countries

	Breusch-Godfrey Serial Correlation Test			Breusch-Pagan-Godfrey Heteroskedasticity Test	
	F-Stat.	Prob. F	Prob. χ^2	F-Stat.	Prob. χ^2
Canada	0.666653	0.5150	0.4959	1.164347	0.3221
France	2.080785	0.1285	0.1167	0.839532	0.5308
Germany	0.772304	0.4638	0.4443	0.327276	0.9170
Italy	2.486470	0.0873	0.0611	1.516702	0.1039
Japan	2.534183	0.0829	0.0716	1.915199	0.0650
UK	0.120188	0.8868	0.8804	1.539439	0.1677
US	0.684742	0.5059	0.4791	1.453774	0.1707

The parameter stability is assessed using the CUSUM test which gives a visual representation of stability in the observed variables through the CUSUM test graph (Brooks, 2014:232). The null hypothesis states that there is perfect parameter stability. Visually, this is given by a statistic lying within the two sets of bands (Brooks, 2014:232). The outcome of the parameter stability tests for each of the countries indicates that the variables in each country after running the ARDL model are stable. The statistic line is well within the two sets of bands indicating that the null hypothesis is not rejected.

4.7 PANEL DATA ANALYSIS

To get an understanding of how the two economic groups compare, the individual countries are pooled together and a long-run relationship is tested using panel data methods. The employment of panel data methods brings both cross-sectional and time series elements to the analysis. Moreover, the individual analysis of the countries seems to indicate co-movement among the various term structures, suggesting that there is financial integration across domestic term structures. Similar to a study conducted by Holmes *et al.* (2011:682), the association of domestic term structures internationally heightens the use of the panel data approach.

4.7.1 Panel Unit Root Test results

Panel unit root tests are similar to unit root tests of time series data, the null hypothesis tests for the presence of a unit root against the alternative of at minimum one stationarity series. However, the difference is that the panel unit root test is conducted jointly. The panel unit

root tests are conducted using the Schwarz information criterion with automatic lag length selection. Table 4-25 and Table 4-26 report the unit root test conducted at level and at first difference of the developing countries. Table 4-25 reports the unit root test of the long rate, with the intercept and with both the intercept and trend included in the equation.

Table 4-25: Long Rate Unit Root Test – Developing Countries

	Intercept		Intercept and Trend	
	At Level	First Difference	At Level	First Difference
Method	**P-value**	**P-value**	**P-value**	**P-value**
Null: Unit root (assumes common unit root process)				
LLC	0.1636	0.0000	0.3410	0.0000
Breitung			0.1090	0.0000
Null: Unit root (assumes individual unit root process)				
IP & SW-stat	0.0018	0.0000	0.0234	0.0000
ADF-Fisher χ^2	0.0036	0.0000	0.0561	0.0000
PP-Fisher χ^2	0.0170	0.0000	0.1778	0.0000

Table 4-26: Short Rate panel Unit Root Test – Developing Countries

	Intercept		Intercept and Trend	
	At Level	First Difference	At Level	First Difference
Method	**P-value**	**P-value**	**P-value**	**P-value**
Null: Unit root (assumes common unit root process)				
LLC	0.3747	0.0000	0.8363	0.0000
Breitung			0.5558	0.0000
Null: Unit root (assumes individual unit root process)				
IP & SW-stat	0.0624	0.0000	0.2803	0.0000
ADF-Fisher χ^2	0.1432	0.0000	0.3735	0.0000
PP-Fisher χ^2	0.0277	0.0000	0.1215	0.0000

The long rate unit root tests under the two different equations give different results. While there seems to be a common unit root process assumed when the intercept is included in the test equation at level, this null hypothesis is rejected at first difference. This also occurs when both the intercept and trend are included in the equation under different tests, thus implying that the long rates of the developing countries are I(1) variables. Under the common unit root process, all series assume common Autoregressive (AR) coefficients

(EViews, 2016). Series under the assumption of individual unit root process take on different AR coefficients.

However, under the individual unit root assumption the null hypothesis is strongly rejected at 0.01 and 0.05 significance levels when the intercept is included in the equation. The inclusion of the trend on the other hand has mixed results, with only one out of the three unit root tests failing to reject the null. The PP-Fisher chi-square is the only exception as it suggests that the series is I(1). In both equations, the null hypothesis of individual unit root process is strongly rejected at first difference.

The short rate unit root test is reported on Table 4-26. The results show that at level there is a common unit root process assumption under the two inclusions in the equation. Apart from the PP-Fisher chi-square method which rejects the null hypothesis of individual unit root process when intercept is included, the series are non-stationary at level. The assumption of individual unit root process cannot be rejected at 0.05 significance level for the IP and SW-stat and the ADF Fisher chi-square methods. The short rate becomes stationary at first difference as shown on Table 4-26. The null hypothesis of a common unit root and the null hypothesis of individual unit root are both rejected making the short rate an I(1) variable.

Table 4-27: Long Rate panel Unit Root Test - Developed Countries

	Intercept		Intercept and Trend	
	At Level	First Difference	At Level	First Difference
Method	**P-value**	**P-value**	**P-value**	**P-value**
Null: Unit root (assumes common unit root process)				
LLC	0.9951	0.0000	0.0074	0.0000
Breitung			0.1475	0.0000
Null: Unit root (assumes individual unit root process)				
IP & SW-stat	0.9951	0.0000	0.0002	0.0000
ADF-Fisher χ^2	0.9995	0.0000	0.0002	0.0000
PP-Fisher χ^2	1.0000	0.0000	0.0032	0.0000

Table 4-28: Short Rate Panel Unit Root Test - Developed Countries

	Intercept		Intercept and Trend	
	At Level	First Difference	At Level	First Difference
Method	**P-value**	**P-value**	**P-value**	**P-value**
Null: Unit root (assumes common unit root process)				
LLC	0.4819	0.0000	0.1594	0.0000
Breitung			0.0538	0.0000
Null: Unit root (assumes individual unit root process)				
IP & SW-stat	0.8194	0.0000	0.7235	0.0000
ADF-Fisher χ^2	0.9657	0.0000	0.8543	0.0000
PP-Fisher χ^2	0.9928	0.0000	0.9773	0.0000

The unit root test with the inclusion of an intercept clearly indicates that the long rate for developed countries is I(1) as it becomes stationary at first difference, shown on Table 4-27. While on the other hand, the inclusion of the intercept and trend has the probability values that show a mixed outcome for the long rate at level. All methods excluding Breitung that test for individual unit root process imply stationarity at level, under the Breitung method however, the long rate becomes stationary at first difference.

The short rate is non-stationary at level when the intercept is included, becoming stationary at first difference both at the common unit root assumption and the individual unit root assumption. The inclusion of an intercept and trend in the equation results in the majority of the methods failing to reject null hypothesis, while the Breitung has weak rejection of null hypothesis at 10 percent. The variable becomes stationary at first difference, with a strong rejection of null hypothesis at 0.01 significance level.

4.7.2   Panel Cointegration Results

The cointegration test for developing countries is on Table 4-29, followed by developed country cointegration test on Table 4-30. Table 29 presents an ARDL cointegration test that is estimated at constant level and the selected model is (3,1). The Akaike Information Criterion (AIC) is used for optimal lag selection for developing countries as it has the lowest value, which is desirable. The results provide enough evidence of cointegration between the long and short rate of the developing countries.

Table 4-29: Panel ARDL results – Developing Countries

	Long Run Equation			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
SHORT_RATE	0.197749	0.059292	3.335183	0.0009

	Short Run Equation			
ECT	-0.076853	0.010511	-7.311376	0.0000
D(LONG_RATE(-1))	0.191369	0.033092	5.782943	0.0000
D(LONG_RATE(-2))	0.001976	0.060697	0.032548	0.9740
D(SHORT_RATE)	0.085873	0.053129	1.616322	0.1064
C	0.489535	0.085646	5.715775	0.0000

Table 4-30: Panel ARDL results – Developed Countries

	Long Run Equation			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
SHORT_RATE	0.473285	0.110753	4.273350	0.0000

	Short Run Equation			
ECT	-0.024825	0.004826	-5.144154	0.0000
D(LONG_RATE(-1))	0.239125	0.022343	10.70266	0.0000
D(SHORT_RATE)	0.170271	0.011293	15.07716	0.0000
C	0.048698	0.014765	3.298271	0.0010

The long-run equation is given by the statistically significant short rate coefficient of 0.197749, thus implying there exists a positive long-run relationship between the variables in the pooled developing countries. A change in the short rate will lead to a rise in the long rate of 19.77 percent in the long-run. Furthermore, disequilibrium in the long-run will take approximately 5.05 months (1/0.197749) to restore the deviations back to equilibrium which is relatively quick.

Once again the ECT is used to measure the speed of error correction. The error correction term is negative and significant as desired, implying that there is short-run correction between the variables. The coefficient of -0.076853 implies that there is an error correction of 7.68 percent back to equilibrium each month. Accordingly, it takes about 13.01 (1/0.076853) months for changes in the short rate to have a full effect on the long rate and

thus restore the deviation back to equilibrium state. This adjustment is rather lengthy, and it also suggests that the short-run relationship between the long rate and the short rate is not strong. Furthermore, the short rate coefficient of 0.085873 indicates that a change in the short rate leads to a positive change in the long rate in the short-run. However, this coefficient is statistically insignificant.

Thus, when the developed countries are pooled together, only the long rate lagged once responds to changes in the short rate as suggested by the statistical significance at 1 percent. Conversely, the strong statistical insignificance of the short rate implies that in the short-run the short rate does not respond to changes in the long rate; an outcome that is consistent with the individual country tests. Thus, an increase in the short rate in the short-run positively influences the long rate and a change in the short rate in the short-run leads to a 19.13 percent increase in the long rate. The long rate that is lagged twice on the other hand is statistically insignificant.

For developed countries the Schwarz Information Criterion (SIC) is used for optimal lag selection as it has the lowest value, which is desirable. The ARDL cointegration test is estimated at constant level and the selected model is (2,1) and the outcome is presented on Table 4-30.

The long-run equation of the developed countries implies that there is a strong positive relationship between the observed variables in the long-run as the short rate coefficient is statistically significant at 1 percent. An increase in the short rate will lead to a rise in the long rate of 47.32 percent in the long-run. The increase is larger than that of developing countries. Deviations in the long-run take 2.11 months (1/0.473285) to adjust back to equilibrium, thus the adjustment is quick.

The short-run equation indicates that there is correction back to equilibrium in the short-run as the ECT is negative and statistically significant as desired. The coefficient of -0.024825 means that roughly, 2.48 percent of deviations from equilibrium are corrected every month. Thus, changes in the short rate take 40.28 months (1/0.024825) to have a full effect on the long rate. This suggests that the adjustment towards equilibrium is sluggish. The short-run relationship between the short rate and the long rate is therefore weak. Moreover, in the short-run, changes in the short rate do not immediately affect the long rate, rather, the lagged long rate strongly responds to changes in the short rate at 0.01 significance level. A change in the short rate leads to an increase in the lagged long rate of 23.91 percent in the

short-run. Also, the short rate responds strongly to changes in the long rate as shown by the statistically significant short rate coefficient. This implies that a change in the lagged long rate leads to a change in the short rate of 17.02 percent in the short-run. Approximately, 17 percent of deviations in the short-run are corrected each month. The results are similar to the individual developed countries in the sense that both the long and the short rate are able to influence each other in the short-run.

4.8   DISCUSSION

Evidence from the graphical analysis suggests that there is no uniform effect of the financial crisis on the term structures of developing countries. The spreads indicate reaction prior the financial crisis, suggesting that developing countries during this period were mostly affected by the decline in commodity prices and the global economic slowdown. In addition to this, the term structure seems volatile during the financial crisis, suggesting that the term structures were reacting to the spread in risk and liquidity as the crisis erupted. Moreover, the slowdown in the economies of developing countries as indicated by the lower interest rates during this period may be as a result of lenders being more cautious following the financial crisis. On the other hand, post the financial crisis interest rate spreads in developed countries are marked by a downward trend. Apart from Japan, the developed countries seem to have undergone a recession as there is a sharp decline in the short rate and in the long rate over time. The expectation of a rise in the future interest rates is illustrated by an upward sloping yield curve as the long rate is higher than the short rate, evident in the term structures of South Africa, China and India in certain periods. Conversely, there is partial evidence of an inverted yield curve in Brazil, Canada, France, Germany, United Kingdom and the United States. An inverted yield curve indicates the expectation of a decline in future interest rates, which eventually becomes evident in these term structures.

The integration of markets is also evident in Canada, France, UK and Germany as the interest rates seem to show strong similarity in movement. The overall finding, however, is that the behaviour of the term structure in the two groups is indicative of a sharp contrast.

The unit root test results indicate the presence of a single unit root in some of the rates which is common in financial time series as highlighted by Brooks (2014:364). Thus outcome of the results enhance the need to employ the ARDL model in assessing the existence of a long-run relationship as the variables are a mixture of I(0) and I(1), and none are I(2) order of integration. The presence of structural breaks in the early stages of the

financial crisis in the long rate of developing countries such as Brazil, India and China point out to the spread of risk across sectors and across countries. Furthermore, post financial crisis structural breaks in Russia and South Africa indicate the effect of the lacklustre global economic growth. The break date in short rates occurs after the financial crisis, thus suggesting that the countries were not directly affected by the financial crisis, rather by the effects of the financial crisis such as the global slow-down.

Developed countries are directly affected as evident in the break dates of most of the short rates, as the suggested break dates are in line with the actual crisis event. Post the financial crisis there is a large degree of interest rate interdependence and with regards to the long rate it is more consistent across countries (Caceres *et al*., 2016:3).

The slope of the term structure of interest rates in a single country took on a few shapes during the observed period. In most cases, the shape of the term structure is able to give a good indication of the future direction of the short rate. So far changes in the slope of the term structure of interest rates have correctly reflected the interest rate outlook (Shiller *et al*., 1983:174). An indication in the preliminary results of the prediction of the future direction of interest rates is evident in Brazil, India, China, South Africa, Canada, France, Germany, United Kingdom and the United States. However, upon conducting tests to assess the validity of the EH, the term structure of interest rates in India, China, South Africa, Canada, France, Germany are the only countries where EH holds. There is no long-run cointegration found in the case of Russia, Italy and Japan. On the other hand, the results for the United Kingdom and the United States are inconclusive, possibly owing to the rapid decline in interest rates over the period during and after the financial crisis (Cuthbertson, 1996).

The lack of support for the EH implies that no long-run relationship can be estimated from these Russia, Italy, Japan, United Kingdom and the United States, possibly indicating that a shift in monetary policy occurred. Moreover, the short rate in Brazil and in Russia is remarkably volatile in the observed sample period, with a dramatic rise in the short rate for Russia especially when compared to its long rate which has a marginal increase and remained relatively stable. Furthermore, Brazil and Russia have flat yield curves with notable downturns. The flat yield curves are indicated by the rates that have remained the same for quite long periods as observed in the economies of the two countries. The long and short rate data out of Brazil and Russia are characterised by wide minimum and maximum

gap values compared to other developing countries. At the same time, the interest rates of Italy and Japan displayed different behaviour compared to most of the developed countries. The data out of Italy and Japan is characterised by weak form of association, the weakest in the group of developed countries. Japan has experienced long-lived economic stagnation which saw the use of drastic policy measures in an attempt to encourage an economic recovery prior 2003 (Svensson, 2003:30). The Bank of Japan (BOJ) has carried out quantitative easing on longer term rates in Japan following the zero bound interest rate situation that dates as far back as 1999 (Oda & Ueda, 2005). While the interest rates in Italy saw a dramatic decline post the financial crisis as illustrated in the graphical analysis. These may be some of the reasons why there is no cointegration in the interest rates of Brazil, Russia, Italy and Japan. However, the results in this study for Italy are inconsistent to that of Musti and D'Ecclesia (2008) who find that interest rates in Italy support the validity of the EH, thus able to predict future movements. What is noteworthy with regards to the inconsistency found for Italy is that the study by Musti and D'Ecclesia (2008) was conducted before the financial crisis, consequently the finding in this study supports the notion that the financial crisis and its effects affected the term structure of interest rates in Italy. To further stress the impact of the financial crisis on the validity of EH and on the term structures of the countries where EH did not hold, a study by Brown *et al.* (2008) finds that the theory holds in an environment with less volatile interest rates. Interest rates in the countries where EH does not hold show a great amount of volatility compared to the countries where EH holds as illustrated in the graphical analysis.

The ARDL test outcome indicates that there is a long-run relationship from the short to the long term interest rate of the countries found with cointegrating variables. The key feature in equation (4.1), (4.3) and (4.5) is the positive association between the interest rates, implying that changes in the long rate follow the correct direction in India, South Africa and France as predicted by the EH. While (4.2), (4.4) and (4.6) indicate that there is an inverse relationship between the interest rates, meaning that in the long-run the long rate moves in the opposite direction, thus making EH controversial. As pointed out by Hardouvelis (1994:281), the inverse relationship may be due to white noise error, however, regardless of the size of the error it has no material effect in the information on the term structure.

The long-run equation of India has a dummy variable that is negative and insignificant, and when compared to the pre-crisis period, which is the period without the dummy variable. It is clear that the structural break suggested for India does not have a major effect on the

variables. Furthermore, the relationship between the interest rates of India seem to have a similar pattern throughout the observed period, much like a study done by Mankiw (1986:109) in which interest rates were unaffected by significant changes. There appears to be a positive relationship between the short rate and the long rate in two out of three developing countries in the long-run, as a change in the short term interest rate leads to a change in the same direction of the long term interest rate.

China is the only exception since there is a negative relationship in the long-run, possibly due to the country's fixed exchange rate regime which possibly links China's interest rate system to developments in the country it is pegged with. Apart from France, the interest rates in Canada and Germany also behave in a similar manner as those of China with a rise in the short rate resulting in a decline in the long rate in the long-run. On the other hand, there is a positive relationship between the interest rates in France, as an increase in the short rate is followed by an increase in the long rate in the long-run. The finding is similar to the interest rates of India and South Africa. It also supports the finding by Estrella and Trubin (2006:6), where a rise in the short term rate is often followed by a relatively small rise in the long term rate.

The authors' findings also support the outcome of the negative relationship in the case of China, Canada and Germany, stating that the long rate can move in a different direction without any coinciding movement in the short term interest rates (Estrella & Trubin, 2006:6).

The short-run disequilibrium adjustment as given by the ECM in India, China, and South Africa is strong and corrected at a slow, quick and moderate speed respectively. Furthermore, the short rate is able to influence the long rate in the short-run, thus enabling the prediction of the long rate. However, for all three developing countries, movements of the long rate in the short-run are not able to influence the short rate. The implication is that it is only the long rate that adjusts to restore the system back to equilibrium. The behaviour of these term structures allude to the asymmetric nature of the adjustment process that is common in economic time series variables. These findings are consistent with evidence found by Enders and Granger (1998:311). Canada, France and Germany have similar robust adjustments as those of developing countries with the process relatively quicker in Canada and France and fairly moderate in Germany. Although the long rate responds to changes in the short rate, the finding in these developed countries is that the short rate responds to

previous changes in the long rate in the short-run. The implication here is that both the interest rates adjust to restore equilibrium, however, at differing periods. Also, post the financial crisis, there is a common downward trend in response to a positive change in the long rate in developed countries. The dummy variable in each of the developed countries adjusts to a previous change in the long rate, with a robust adjustment occurring in France and Germany, and a weak adjustment in Canada.

All adjustments back to equilibrium respond to a positive discrepancy between the long rate and the short rate. The outcome of the ECM is consistent with a study done by Estrella and Trubin (2006:6) in the sense that the variables depict evidence of the direct influence that monetary policy has on the short term interest rate. A rise in the short term rate is followed by a rise in a lagged long term rate. Thus, the long rate does not react rapidly to changes made in the short rate. This confirms the findings by Modena (2008:2) and also the indirect influence monetary policy has on the long rate. However, in contrast with the finding of Estrella and Trubin (2006:6), the observed G7 and BRICS countries where EH is valid the long rate seems to move in the same direction as the short rate in the short-run.

Overall, the finding is that the short rate is a dominant determinant in the long rate due to its ability to influence movement in the long rate both in the long-run and in the short-run. The notion is similar to a study by Hurn *et al*. (1995:418). This finding is in line with a study by Tabak *et al*. (2009) as the short rate is an imperative component within the system of interest rate, consistent with EH. Therefore, the short rate is able to predict future movements of the long rate, implying that the relationship between the long and the short rate as implied by the expectations hypothesis would mean that monetary policy has substantial influence on the spread of the term structure. More precisely, the central bank is able to influence the long rate, making the implementation of monetary policy significant as it is able to affect interest rates of different maturities. Moreover, the central bank is able to influence the market's future expectations and economic activity for some time, making the predictability of the term structure of interest rates a valuable forecasting tool consistent with Estrella and Mishkin (1996:1) and Thornton (2014:205). The possible implication of the lagged long term rate is that the long term interest rate is generally driven by the market and indirectly influenced by monetary policy (Modena, 2008:2). Furthermore, the long rate is affected by more than one factor; its movement is influenced by economic activity and long term expectations of inflation (Estrella & Mishkin, 1997:1376). The findings also support the emphasis of the EH of term structure on the ability of monetary policy to affect

the long rate simply by influencing the short rates, which monetary policy is able to control, and also by altering market expectations of future short rates (Walsh, 2003:465).

The outcome of the panel cointegration test has similar results to that of the individual country cointegration tests. Cointegration for both groups is confirmed by the significant coefficient in the long-run equation for both of the country groups. The short-run effects on the other hand differ between the two groups. The lagged long rate responds to changes in the short rate when developing countries are pooled together in the short-run. However, the short rate does not respond to changes in the long rate, an outcome that is similar to the results of the individual developing country interest rates. The short-run effects in the pooled developed countries mirror the results of the individual tests, the short rate responds to changes in the long rate, and the long rate responds to changes in the short rate.

There is a vast amount of difference in the ECT and its behaviour between the two groups. The ECT in the pooled developing countries corrects 7.68 percent of deviations, and the adjustment at 13.01 months is relatively lengthy, however, faster than that of developed countries. The short-run relationship is thus considered to be a moderate one. The ECT in pooled developed countries corrects deviations in smaller portions compared to the developing countries at 2.48 percent. Furthermore, adjustment back to equilibrium is sluggish at 40.28 months. Thus, the adjustment back to equilibrium in the short-run is considered weak.

Given the backdrop of global financial interdependence in the markets, overall the results indicate that there is co-movement in the term structure of interest rates among developed countries. This outcome is not surprising given the integration of financial markets and central banks particularly in Europe. Major events in developed countries have led to a shift in the conduct of monetary policy, with the employment of non-conventional monetary policy methods. Zero bound and negative interest rates in the United States and Euro area respectively led to the inflow of capital in developing countries since interest rates remained relatively higher in developing countries compared to developed countries.

Developing countries on the other hand are not immune to the major events that occurred in developed countries, the term structure of interest rates in developing countries seem to have merely reacted to the effects of the financial crisis. Moreover, there is great volatility in the short rates of developing countries, possibly due to slow global economic growth, lower demand for exports and the decline in the price of commodities. The results indicate

the impact of global financial integration in the markets on the observed countries' term structures. There is significant evidence suggesting that domestic term structures of interest rates are influenced by foreign monetary policy and foreign term structures as a consequence of integration and liberalization of financial markets (Holmes *et al*., 2011:680). Since long term government bonds provide a safe-haven for investors in times of uncertainty in financial markets (Bernanke, 2013:7), the capital inflows that surged in developing countries post the financial crisis following the uncertainty in the developed countries provide evidence of this feature.

4.9   SUMMARY

This chapter presented results that support the predictability of the term structure of interest rate on the basis of the validity of expectations hypothesis. By employing the 91-day Treasury bill rate as the short rate and the 10-year government bond rate as the long rate, the validity of the expectations hypothesis is tested in the individual BRICS and G7 countries and in pooled panels of both country groups.

The short rate is found to be a dominant determinant in the long rate as the short rate is able to influence movement in the long rate in the short-run and in the long-run. The short rate is thus able to predict future movements of the long rate in India, China, South Africa, Canada, France and Germany. The implication is that monetary policy in these countries is able to exert influence on the long rate, thereby able to influence economic activity and the spread of the term structure.

The individual country tests and the pooled tests produce somewhat similar results. A comparison between the two groups indicates contrasting results as for pooled developed countries, the short and the long rate are able to influence each other in the short-run. An outcome that is not true for developing countries. While a long-run relationship is present for both groups, the short-run adjustment to equilibrium indicates that a weak short-run relationship exists between the long and the short rate in pooled group of developed countries. The developed countries' group has a sluggish adjustment back to equilibrium, correcting a small percentage adjustment in the short-run. The developing countries' group has a moderate short-run relationship, correcting a relatively larger percentage while the adjustment back to equilibrium is relatively faster than the developed countries.

CHAPTER 5: CONCLUSION

5.1   SUMMARY OF FINDINGS

The study was set out to assess the predictability of the term structure by testing the expectations hypothesis in a sample of BRICS and G7 countries using monthly data from 2003 to 2016. To capture the validity of EH, a comparison of the effect of the financial crisis on the observed country term structures was assessed. More importantly, the study explains the usefulness of the theory in relation to the predictability of interest rates and the significance of the ability to predict future movements of this economic variable to policymakers and market participants.

The first chapter gave a background of the study, as part of establishing the validity of EH and its predictive ability in different economic categories. The literature review in chapter two explained the role of the monetary policy, establishing the background for the importance of the short rate and the long rate and the relation between the two rates in the economy. Substantive findings are provided from contributions made in studies related to monetary policy, the EH, the term structure of interest rates and links to the business cycle. The chapter provides a graphical representation of the different shapes of the yield curve, and reviews the financial crisis in relation to its implication to the term structure and reviews empirical studies on EH of the term structure of interest rates. The methodology chapter reviewed and justified primarily the use of the ARDL approach to cointegration by Pesaran *et al.* (2001). In the chapter also, the estimation methods used to achieve the set empirical objectives were reviewed and justified. The sample period is selected based on the availability of data and the sources of the data are disclosed. The research findings in chapter four uncovered results that are significant and meaningful to market participants and the central bank. A preliminary investigation of the behaviour of the term structure of interest rates in the observed countries is given by way of graphical analysis. The preliminary investigation showed a sharp contrast between the term structures of the developing and developed countries. The unit root tests provided a mixture of results, strongly justifying the need to employ the ARDL approach to cointegration. Only six countries were found to have long run relationships, with significant long-run and short-run relationships. The panel results mirrored the results of the individual country test. The findings are discussed in relation to the contributions of previous studies and theories.

5.2 THEORETICAL OBJECTIVES

To achieve objectives, the study reviewed the theoretical concepts of the expectations hypothesis of term structure and explained the theory in relation to monetary policy, the yield curve, the term structure, economic cycle and the financial crisis. The link between the EH of term structure and monetary policy provided the setting for the significance of the role of the theory throughout the economy as the validity of EH. This implied that monetary policy is able to influence a range of interest rates, thereby influencing decision making in the economy. The study explains the EH in relation to the term structure and the yield curve, and provides evidence from previous studies regarding the reliability of the term structure as a predictor of future interest rate movements. A review of the theory in relation to the business cycle describes how the theory can be used to predict future economic activity using the term structure of interest rates. Furthermore, the relation between the financial crisis and the EH is explained, including the effect of the crisis on monetary policy. Empirical studies provided mixed conclusions regarding the validity of the theory, although in the past it has been found to be valid in most developed and developing countries.

5.3 EMPIRICAL OBJECTIVES

In accordance with the primary objective, the study determined the relationship between the observed variables, as the existence of this relationship formed the basis for further achieving the other empirical objectives. The results from testing the individual countries using the ARDL cointegration model indicate that the individual countries offer mixed support for the EH. Six of the 12 observed developing and developed countries have cointegrating variables. That is, only six countries had rates with a long-run relationship. These countries include China, India and South Africa out of the BRICS or developing countries, and from the G7 or developed countries Canada, France and Germany. All six countries were also found to predict the future direction of the long rate in the short-run. While a comparison of the developed and developing countries regarding the validity of the theory showed somewhat similar results, but varied in the rate that the term structure is able to predict. Developing country rates indicate that only the short rate is able to predict the long rate and, on the other hand, the rates in developed countries show that both the short rate and the long rate are able to predict each other in the short-run. Also, the significance of the dummy variable in Canada, France and Germany implied a change in period, a period where the financial crisis affected the term structures of these countries.

The countries in which the theory holds, such as in developed countries, the finding reveals that there is co-movement between interest rates of different term structures, while in developing countries there is an indirect reaction to the effects of the financial crisis and these are reflected on the interest rate movements. These are partly owing to the liberalization and interdependence of financial markets, thereby consistent with the findings of Holmes *et al*. (2011:680).

The countries are pooled together according to each of the two country groups and both are found to have co-integrating long and short rates. The outcome in pooled developing countries is similar to the finding in individual developing countries that had co-integrating variables. In the short-run, changes in the short rate have influence on the long rate in the next (lagged) period. However, the long rate on the other hand does not have an effect on the short rate. The short-run dynamics of pooled developed countries indicates that both rates are able to influence each other, though the effect of the short rate on the long rate is delayed and not immediate. The pooled results of developed countries mirror those of the individual developed countries. Therefore, in the short-run the implication is that changes in the long rate are able to influence movement in the short rate in G7 countries.

5.4   KEY CONCLUDING REMARKS

The short rate is a dominant determinant of the long rate. This is a feature that is common in all the countries that have long-run association between the two observed variables. Movements in the short rate are able to determine the future direction of the long rate. The implication is that monetary policy is able to influence the long rate, thereby influence the economy. This finding was revealed in both the individual country analysis and in the panel analysis.

Central banks in countries with cointegrating variables are able to effectuate their economies since a change in the short rate is able to influence change in long rate; implying that the implementation of monetary policy in these countries is effective and consistent with previous studies of Bonga-Bonga (2012:3955), Thornton (2014:205) and Walsh (2003:465). The validity of the expectations hypothesis in the analysis also proved that the theory is still valuable for the analysis of interest rates. It is able to assist market participants predict the future direction of interest rates using the yield curve.

The similarity in the term structures of developed countries and the indirect influence of the financial crisis on the developing countries' term structures makes compelling support for the effect of the interdependence of financial markets, more precisely, the term structures. This is in agreement with the studies of Holmes *et al*. (2011) where domestic term structures of interest rates are influenced by foreign monetary policy and foreign term structures as a consequence of integration and liberalization of financial markets.

5.5   THE LIMITATIONS TO THE STUDY

The consideration of the monetary policy regime and consideration of a change in the policy of each country may have produced different results.

5.6   RECOMMENDATION

An interesting area for future research is further analysis in the term structures of the countries where there is no long-run relationship between variables. Also, application of an alternative methodology when analysing the term structures of these countries is recommended. The investigation on the effects of the financial crisis within different periods of time and change in the monetary policy framework need to be carried out. Finally, research in the term structure of interest rates of less developed countries may portray different results.

Appendix: Dickey-Fuller T-Statistics Graph

Dickey-Fuller t-statistics

Brazil Long Rate at Level

Dickey-Fuller t-statistics

Brazil Long Rate at First Difference

Dickey-Fuller t-statistics

Brazil Short Rate at Level

Dickey-Fuller t-statistics

Brazil Short Rate at First Difference

Dickey-Fuller autoregressive coefficients

Russia Long Rate at Level

Dickey-Fuller t-statistics

Russia Long Rate at First Difference

Dickey-Fuller t-statistics

Russia Short Rate at Level

Dickey-Fuller t-statistics

Russia Short Rate at First Difference

Dickey-Fuller t-statistics

India Long Rate at Level

Dickey-Fuller t-statistics

India Long Rate at First Difference

Dickey-Fuller t-statistics

India Short Rate at Level

Dickey-Fuller t-statistics

India Short Rate at First Difference

Dickey-Fuller t-statistics

China Long Rate at Level

Dickey-Fuller t-statistics

China Long Rate at First Difference

Dickey-Fuller t-statistics

China Short Rate at Level

Dickey-Fuller t-statistics

China Long Rate at First Difference

Dickey-Fuller t-statistics

South Africa Long Rate at Level

Dickey-Fuller t-statistics

South Africa Long Rate at First Difference

98

Dickey-Fuller t-statistics

South Africa Short Rate at Level

Dickey-Fuller t-statistics

South Africa Short Rate at First Difference

Dickey-Fuller t-statistics

Canada Long Rate at Level

Dickey-Fuller t-statistics

Canada Long Rate at First Difference

Dickey-Fuller t-statistics

Canada Short Rate at Level

Dickey-Fuller t-statistics

Canada Long Rate at First Difference

Dickey-Fuller t-statistics

France Long Rate at Level

Dickey-Fuller t-statistics

France Long Rate at First Difference

Dickey-Fuller t-statistics

France Short Rate at Level

Dickey-Fuller t-statistics

France Short Rate at First Difference

Dickey-Fuller t-statistics

Germany Long Rate at Level

Dickey-Fuller t-statistics

Germany Long Rate at First Difference

Dickey-Fuller t-statistics

Germany Short Rate at Level

Dickey-Fuller t-statistics

Germany Short Rate at First Difference

Dickey-Fuller t-statistics

Italy Long Rate at Level

Dickey-Fuller t-statistics

Italy Long Rate at First Difference

Dickey-Fuller t-statistics

Italy Short Rate at Level

Dickey-Fuller t-statistics

Italy Short Rate at First Difference

Dickey-Fuller t-statistics

Japan Long Rate at Level

Dickey-Fuller t-statistics

Japan Long Rate at First Difference

Dickey-Fuller t-statistics

Japan Short Rate at Level

Dickey-Fuller t-statistics

Japan Short Rate at First Difference

Dickey-Fuller t-statistics

United Kingdom Long Rate at Level

Dickey-Fuller t-statistics

United Kingdom Long Rate at First Difference

Dickey-Fuller t-statistics — United Kingdom Short Rate at Level

Dickey-Fuller t-statistics — United Kingdom Short Rate at First Difference

Dickey-Fuller t-statistics — United States Short Rate at Level

Dickey-Fuller t-statistics — United States Short Rate at First Difference

.

BIBLIOGRAPHY

Ang, A. & Piazzesi, M. 2003. A No-Arbitrage Vector Autoregression of Term Structure Dynamics with Macroeconomic and Latent Variables. *Journal of Monetary Economics*, 50(4):745-787.

Ang, A., Piazzesi, M. & Wei, M. 2006. What Does the Yield Curve Tell Us About GDP Growth? *Journal of Econometrics*, 131(1):359-403.

Ang, A., Hodrick, R.J., Xing, Y. & Zhang, X. 2006. The Cross-Section of Volatility and Expected Returns. *The Journal of Finance*, 61(1):259-299.

Andersen, T.G. & Lund, J. 1997. Estimating Continuous-Time stochastic Volatility Models of the Short-Term Interest Rate. *Journal of Econometrics*, 77(2):343-377.

Assenmacher-Wesche, K & Gerlach, S. 2008. The Term Structure of Interest Rates across Frequencies. European Central Bank, Working Paper Series 976.

Balduzzi, P., Bertola, G. & Foresi, S. 1997. A Model of Target Changes and the Term Structure of Interest Rates. *Journal of Monetary Economics*, 39(2):223-249.

Batten, J., In, F. & Kim, S. 2003. What Drives the Term and Risk Structure of Japanese Bonds?. *The Quarterly Review of Economics and Finance*, 43(3):518-541.

Beechey, M., Hjalmarsson, E. & Österholm, P. 2009. Testing the Expectations Hypothesis When Interest Rates Are Near Integrated. *Journal of Banking & Finance*, 33(5):934-943.

Beenstock, M. & Longbottom, J.A. 1981. The Term Structure of Interest Rates in a Small Open Economy. *Journal of Money, Credit and Banking*, 13(1):44-59.

Bekaert, G., Hodrick, R.J. & Marshall, D.A. 1997. On Biases in Tests of the Expectations Hypothesis of the Term Structure of Interest Rates. *Journal of Financial Economics*, 44(3):309-348.

Bekaert, G., Hodrick, R.J. & Marshall, D.A. 2001. Peso Problem Explanations for Term Structure Anomalies. *Journal of Monetary Economics*, 48(2):241-270.

Bekaert, G. & Hodrick, R.J. 2001. Expectations Hypotheses Tests. *The Journal of Finance*, 56(4):1357-1394.

Bernanke, B. 2004. The Logic of Monetary Policy. 2 Dec. http://www.federalreserve.gov/boarddocs/speeches/2004/20041202/default.htm. Date of Access: 21 Feb. 2016. (Speech).

Bernanke, B.S. 2013. Long-Term Interest Rates. 1 Mar. Annual Monetary/Macroeconomics Conference: The Past and Future of Monetary Policy. San Francisco, California.

Bernanke, B.S. & Blinder, A.S. 1992. The Federal Funds Rate and the Channels of Monetary Transmission. *The American Economic Review*, 82(4):901-921.

Bliss, R. 1997a. Movements in the Term Structure of Interest Rates. *Economic Review*, 82(4):16-33. Federal Reserve Bank of Atlanta.

Bliss, R. 1997b. Testing Term Structure Estimation Methods. *Advances in Futures and Options Research*, 9:197-231.

Bonga-Bonga, L. 2010. Monetary Policy and Long Term Interest Rates in South Africa. *International Business & Economics Research Journal (IBER)*, 9(10):43-54.

Bonga-Bonga, L. 2012. Budget Deficit and Long-Term Interest Rates in South Africa. *African Journal of Business Management*, 6(11):3954-3961.

Breitung, J. 2000. Nonstationary Panels, Panel Cointegration, and Dynamic Panels. *Advances in Econometrics*, 15(2):161-178.

Brooks, C. 2014. Introductory Econometrics for Finance. 3rd Ed. Cambridge: Cambridge University Press.

Brown, C.R., Cyree, K.B., Griffiths, D.B. & Winters, M.D. 2008. Further Analysis of the Expectations Hypothesis Using Very Short-Term Rates. *Journal of Banking and Finance*, 32(4):600-613.

Brown, N., Padayachee, A., Ndlovu, K., Naidoo, K., Mdluli, M. & Phillips, R. 2015. The South African Retail Sector and the BRICS Trading Bloc – An Analysis of Opportunities. Wholesale and Retail SETA.

Bundesregierung. 2016. G7 Summit. https://www.g7germany.de/Content/EN/StatischeSeiten/G7_elmau_en/texte_en/2014-11-05-geschichte-g8.html. Date of Access: 4 Oct. 2016.

Caceres, L., Carrière-Swallow, Y., Demir, I. & Gruss, B. 2016. U.S. Monetary Policy Normalization and Global Interest Rates. IMF Working Paper 16.

Campa, J. & Chang, P.K. 1995. Testing the Expectations Hypothesis on the Term Structure of Volatilities in Foreign Exchange Options. *The Journal of Finance*, 50(2):529-547.

Campbell, J.Y. 1995. Some Lessons from the Yield Curve. *Journal of Economic Perspectives,* 9(3):129-152.

Campbell, J.Y., & Cochrane, J.H. 1999. By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behaviour. *The Journal of Political Economy*, 107(2):205–251.

Campbell, J.Y., & Hamao, Y. 1991. Monetary Policy and the Term Structure of Interest Rates in Japan. CJEB Working Paper no. 53. Columbia University.

Campbell, J.Y. & Shiller, R.J. 1987. Cointegration and Tests of Present Value Models. *Journal of Political Economy*, 95(5):1062-1088.

Campbell, J.Y., & Shiller, R. 1988. Interpreting Cointegrated Models. *Journal of Economic Dynamics and Control*, 12(2-3):505-522.

Campbell, J.Y., & Shiller, R. 1991. Yield Spreads and Interest Rate Movements: A Bird's Eye View. *Review of Economic Studies*, 58(3):495-514.

Cargil, T.F. 1975. The Term Structure of Interest Rates: A Test of the Expectations Hypothesis. *The Journal of Finance*, 30(3):761-771.

Carriero, A., Favero, C.A. & Kaminska, I. 2003. Financial Factors, Macroeconomic Information and the Expectations Theory of the Term Structure of Interest Rates. Unpublished manuscript.

Casalin, F. 2007. The Expectations Hypothesis of Term Structure of Interest Rates Revisited. University of Millan – Bicocca. Working Paper Series No. 128.

Choi, I. 2001. Unit Root Tests for Panel Data. *Journal of International Money and Finance*, 20(2):249–272.

Clarida, R.H., Sarno, L., Taylor, M.P. & Valente, G. 2006. The Role of Asymmetries and Regime Shifts in the Term Structure of Interest Rates. *The Journal of Business*, 79(3):1193-1224.

Clay, R. & Keeton, G. 2011. The South African Yield Curve as a Predictor of Economic Downturns: An Update. *African Review of Economics and Finance*, 2(2):165-170.

Cochrane, J.H. 2015. The Decline in Long-Term Interest Rates. http://johnhcochrane.blogspot.co.za/2015/08/the-decline-in-long-term-interest-rates.html. Date of Access: 13 Feb. 2016.

Cook, T. & Hahn, T. 1989. The Effect of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s. *Journal of Monetary Economics*, 24(3):331-351.

Corte, P.D., Sarno, L. & Thornton, D.L. 2008. The Expectation Hypothesis of the Term Structure of Very Short-Term Rates: Statistical Tests and Economic Value. *Journal of Financial Economics*, 89(1):158–174.

Cox, J.C., Ingersoll, J.E. & Ross, S.A. 1985. A Theory of the Term Structure of Interest Rates. *Econometrica*, 53(2):385-407.

Cuthbertson, K. 1996. The Expectations Hypothesis of the Term Structure: The UK Interbank Market. *The Economic Journal*, 106(436):578.592.

Dai, Q. & Singleton, K.J., 2000. Specification Analysis of Affine Term Structure Models. *The Journal of Finance*, 55(5):1943-1978.

Danthine, J.P. 2012. A World of Low Interest Rates. 22 March. Swiss National Bank, Zurich. (Speech).

DeJong, D.N., Nankervis, J.C., Savin, N.E. & Whiteman, C.H. 1992. The Power Problems of Unit Root Test in Time Series with Autoregressive Errors. *Journal of Econometrics*, 53(1-3):323-343.

Diebold, F.X. & Li, C. 2006. Forecasting the term structure of government bond yields. *Journal of Econometrics*, 130(2):337–364.

Diebold, F.X., Rudebusch, G.D. & Aruoba, S.B. 2006. The Macroeconomy and the Yield Curve: A Dynamic Latent Factor Approach. *Journal of Econometrics*, 131(1):309-338.

Diebold, F.X., Li, C. & Yue, V.Z. 2008. Global Yield Curve Dynamics and Interactions: A Dynamic Nelson-Siegel Approach. *Journal of Econometrics*, 146(2):351-363

Druck, P., Magud, N.E., & Mariscal, R. 2015. Collateral Damage: Dollar Strength and Emerging Markets' Growth. IMF Working Paper, 15.

Dube, S. & Zhou, Y. 2013. The Repo Rate Pass-Through to the Prime Rate in South Africa: Evidence from ARDL and FMLS Models. *Journal of Business Theory and Practice*, 1(2):199-213.

Dueker, M.J. 1997. Strengthening the Case for the Yield Curve as a Predictor of U.S. Recessions. Federal Reserve Bank of St. Louis. *Review*, 79:41-51.

Duffee, G.R. 2002. Term Premia and Interest Rate Forecasts in Affine Models. *The Journal of Finance*, 57(1):405-443.

Enders, W. and Granger, C.W.J., 1998. Unit-Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates. *Journal of Business & Economic Statistics*, 16(3):304-311.

Engle, R.F. and Granger, C.W., 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Engsted, T. 1993. Cointegration and Cagan's Model of Hyperinflation under Rational Expectations. *Journal of Money, Credit and Banking*, 25(3):350-360.

Engted, T. 1993. The Term Structure of Interest Rates in Denmark 1982-89: Testing the Rational Expectations/Constant Liquidity Premium Theory. *Bulletin of Economic Research*, 45.

Engsted, T. & Tanggaard, C. 1992. Cointegration and the US Term Structure. *Journal of Banking and Finance*, 18(1):167-181.

Estrella, A. & Hardouvelis, G.A. 1991. The Term Structure as a Predictor of Real Economic Activity. *The Journal of Finance*, 46(2):555-576.

Estrella, A & Mishkin, F.S. 1996. The Yield Curve as a Predictor of U.S. Recessions. *Current Issues in Economics and Finance*, 2(7):1-6.

Estrella, A. & Mishkin, F.S. 1997. The Predictive Power of the Term Structure of Interest Rates in Europe and the United States: Implications for the European Central Bank. *European Economic Review*, 41(7):1375-1401.

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

Estrella, A., Rodrigues, A.P. & Schich, S. 2003. How Stable Is The Predictive Power Of The Yield Curve? Evidence from Germany and the United States. *The Review of Economics and Statistics*, 85(3): 629–644.

Estrella, A. & Trubin, M.R. 2006. The Yield Curve as a Leading Indicator: Some Practical Issues. *Current Issues in Economics and Finance*, 12(5):1-7.

European Union. 2016. EU Member Countries. https://europa.eu/european-union/about-eu/countries/member-countries_en. Date of Access: 28 Oct. 2016.

EViews. 2016. Panel Unit Root Testing. http://www.eviews.com/help/helpintro.html#page/content/advtimeser-Panel_Unit_Root_Testing.html. Date of Access: 28 Sept. 2016

EViews. 2016. Residual Diagnostics. http://www.eviews.com/help/helpintro.html#page/content/testing-Residual_Diagnostics.html#ww182888. Date of Access: 28 Sept. 2016.

Fama, E.F. 1984. The Information in the Term Structure. *Journal of Financial Economics*, 13(4):509-528.

Fama, E.F. 1986. Term Premiums and Default Premiums in Money Markets. *Journal of Financial Economics*, 17(1):175-196.

Fama, E.F. & Bliss, R.R. 1987. The Information in Long-Maturity Forward Rates. *The American Economic Review*, 680-692.

Fisher, I. 1896. Appreciation and Interest: A Study of the Influence of Monetary Appreciation and Depreciation on the Rate of Interest with Applications to the Bimetallic Controversy and the Theory of Interest. *American Economic Association*, 11(4):331-442.

Frankel, J.A. & Froot, K.A. 1987. Short-Term and Long-Term Expectations of the Yen/Dollar Exchange Rate: Evidence from Survey Data. *Journal of the Japanese and International Economies*, 1(3):249-274.

Gerlach, S. & Smets, F. 1998. Output Gaps and Monetary Policy in the EMU Area. *European Economic Review*, 43(4):801-812.

Ghazali, N.A. & Low, S.W. 2010. The Expectation Hypothesis in Emerging Financial Markets: The Case of Malaysia. *Applied Economics*, 34(9):1147-1156.

Giacomini, R. & Rossi, B. 2006. How stable is the Forecasting Performance of the Yield Curve for Output Growth? *Oxford Bulletin of Economics and Statistics*, 68(s1):783-795.

Gilchrist, S., Yankov, V. & Zakrajšek, E. 2009. Credit Market Shocks and Economic Fluctuations: Evidence from Corporate Bond and Stock Markets. *Journal of Monetary Economics*, 56(4):471-493.

Global Macroeconomics Team. 2016. Global Weekly: Sources of the Growth Slowdown in BRICS. 1 Apr. *https*://blogs.worldbank.org/prospects/global-weekly-sources-growth-slowdown-brics. Date of Access: 26 Apr. 2016.

Global Policy Forum. 2016. Group of Seven / Group of Eight / Group of Twenty. https://www.globalpolicy.org/social-and-economic-policy/the-three-sisters-and-other-institutions/group-of-seven-group-of-eight-group-of-twenty.html. Date of Access: 31 Oct. 2016.

Guha, D. & Hiris, L. 2002. The Aggregate Credit Spread and the Business Cycle. *International Review of Financial Analysis*, 11(2):219-227.

Guidolin, M. & Tam, Y.M. 2013. A Yield Spread Perspective on the Great Financial Crisis: Break-Point Test Evidence. *International Review of Financial Analysis,* 26:18-39.

Guidolin, M., & Thornton, D.L. 2008. Predictions of Short-Term Rates and the Expectations Hypothesis of the Term Structure of Interest Rates. European Central Bank. Working Paper Series, No. 977.

Gujarati, D.N. & Porter, D.C. 2008. Basic Econometrics. 5th Ed. Boston: McGraw-Hill Irwin.

Guney, P.O. 2013. The Term Structure of Interest Rates: A Cointegration Analysis in the Non-Linear STAR Framework. *Journal of Economics and Behavioural Studies*, 5(12):851-860.

Gurkaynak, R.S., & Wright, J.S. 2012. Macroeconomics and the Term Structure. *Journal of Economic Literature*, 50(2):331-367.

Hackworth, J.F. 2008. Uncertainty and the Yield Curve. *Economics Letters*, 98(3):259–268.

Hardouvelis, G.A. 1994. The Term Structure Spread and Future Changes in Long and Short Rates in the G7 Countries: Is There a Puzzle? *Journal of Monetary Economics*, 33(2):255-283.

Harvey, A.C. 1981. Time Series Models. 2nd Ed. Cambridge: MIT Press.

Holmes, M.J. & Pentecost, E.J. 1997. The Term Structure of Interest Rates and Financial Integration in the ERM. *International Journal of Finance & Economics*, 2(3):237-247.

Holmes, M.J., Otero, J. & Panagiotidis, T. 2011. The Term Structure of Interest Rates, the Expectations Hypothesis and International Financial Integration: Evidence from Asian Economies. *International Review of Economics and Finance*, 20(4):679-689.

Hurn, A.S., Moody, T. & Muscatelli, V.A. 1995. The Term Structure of Interest Rates in the London Interbank Market. *Oxford Economic Papers*, 47(3):418-436.

Im, K.S., Pesaran, M.H. & Shin, Y. 2003. Testing for Unit Roots in Heterogenous Panels. *Journal of Econometrics*, 115(1):53–74.

International Monetary Fund (IMF). 2014. France. 2014 Article IV Consultation—Staff Report; Press Release; and Statement by the Executive Director for France. July. IMF Country Report No. 14/182. http://www.imf.org/external/pubs/ft/scr/2014/cr14182.pdf. Date of Access: 24 Aug. 2016.

International Monetary Fund (IMF). 2015. Brazil: 2014 Article IV Consultation-Staff Report; Press Release; and Statement by the Executive Director for Brazil. 12 May. http://www.imf.org/external/pubs/ft/scr/2015/cr15121.pdf. Date of Access: 24 Aug. 2016.

International Monetary Fund (IMF). 2015. World Economic Outlook: Adjusting to Lower Commodity Prices. https://www.imf.org/external/pubs/ft/weo/2015/02/pdf/c2.pdf. Date of Access: 24 Aug. 2016.

International Monetary Fund (IMF). 2015. People's Republic of China: Staff Report for the 2015 Article IV Consultation. 14 Aug. http://www.imf.org/external/pubs/ft/scr/2015/cr15234.pdf. Date of Access: 17 Sept. 2016.

International Monetary Fund (IMF). 2015. South Africa: 2014 Article IV Consultation-Staff Report; Informational Annex; Debt Sustainability Analysis; Staff Statement; Press Release; and Statement by the Executive Director for South Africa. 11 Dec. http://www.imf.org/external/pubs/ft/scr/2014/cr14338.pdf. Date of Access: 17 Sept. 2016.

International Monetary Fund (IMF). 2015. World Economic Outlook: Adjusting to Lower Commodity Prices. https://www.imf.org/external/pubs/ft/weo/2015/02/pdf/c2.pdf. Date of Access: 24 Aug. 2016.

International Monetary Fund (IMF). 2016. France. 2016 Article IV Consultation—Press Release; Staff Report; and Statement by the Executive Director for France. July. IMF Country Report No. 16/227. http://www.imf.org/external/pubs/ft/scr/2016/cr16227.pdf. Date of Access: 24 Aug. 2016.

International Monetary Fund (IMF). 2016. India: 2016 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for India. 2 Mar. http://www.imf.org/external/pubs/ft/scr/2016/cr1675.pdf. Date of Access: 17 Sept. 2016.

International Monetary Fund (IMF). 2016. People's Republic of China—Hong Kong Special Administrative Region: 2015 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for People's Republic of China—Hong Kong Special Administrative Region. 19 Jan. http://www.imf.org/external/pubs/ft/scr/2016/cr1617.pdf. Date of Access: 13 Sept. 2016.

International Monetary Fund (IMF). 2016. A Guide to Committees Groups and Clubs. 26 Sept. http://www.imf.org/en/About/Factsheets/A-Guide-to-Committees-Groups-and-Clubs#G7. Date of Access: 17 Oct. 2016.

Khomo, M.M. 2005. The Yield Curve as a Forecasting Tool: Does the Yield Spread Predict Recessions in South Africa? Rhodes University. (M.Com Thesis).

Kohn, D. 2005. Monetary Perspectives on Risk Premiums in Financial Markets. Speech, July 21. http://www.federalreserve.gov/boarddocs/speeches/2005/. Date of Access: 13 Feb. 2016.

Koukouritakis, M. & Michelis, L. 2008. The Term Structure of Interest Rates in the 12 Newest EU Countries. *Applied Economies*, 40(4):479-490.

Koukouritakis, M. 2010. Structural Breaks and the Expectations Hypothesis of the Term Structure: Evidence from Central European countries. *Review of World Economics*, 145(4):757-774.

Kozicki, S. & Tinsley, P.A. 2008. Term Structure Transmission of Monetary Policy. *North American Journal of Economics and Finance*, 19(1):71-92.

Kwan, C.H. 2015. The Yuan's Shift to a Free Floating Exchange Rate System yet to be Completed. Research Institute of Economy, Trade and Industry. http://www.rieti.go.jp/en/china/15091001.html. Date of Access: 20 Sept. 2016.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. & Shin, Y. 1992. Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root: How sure are we that Economic Time Series Have a Unit Root? *Journal of Econometrics*, 54(1-3):159–178.

Laub, Z. 2016. The Group of Seven (G7). Council on Foreign Relations (CFR). 2 Jun. http://www.cfr.org/international-organizations-and-alliances/group-seven-g7/p32957. Date of Access: 12 Sept. 2016.

Lee, S.S. 1995. Macroeconomic Sources of Time-Varying Risk Premia in the Term Structure of Interest Rates. *The Journal of Money, Credit and Banking*, 27(2):549-569.

Levin, A., Lin, C. & Chu, C.J. 2002. Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties, *Journal of Econometrics*, 108(1):1–24.

Litterman, R. & Scheinkman, J. 1991. Common Factors Affecting Bond Returns. *The Journal of Fixed Income*, 1(1):54-61.

Longstaff, F.A. 2000. Arbitrage and the Expectations Hypothesis. *The Journal of Finance*, 55(2):989-994.

Macaulay, F.R. 1938. Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields, and Stock Prices in the United States since 1856. NBER Working Paper Series, New York.

MacDonald, R. & Speight, A.E. 1988. The Term Structure of Interest Rates in the UK. *Bulletin of Economic Research*, 40(4):287-300.

Maddala, G.S. & Wu, S. 1999. A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics*, 61(S1):631–652.

Magud, N., & Sosa, S. 2015. Investment in Emerging Markets: We Are Not in Kansas Anymore… Or Are We? IMF Working Paper, 15(77):4-26.

Malkiel, B.G. 1966. The Term Structure of Interest Rates. Princeton: Princeton University Press.

Mankiw, N.G. 1986. The Term Structure of Interest Rates Revisited. Brookings Papers on Economic Activity 1.

Mankiw, N.G., Goldfeld, S.M. & Shiller, R.J. 1986. The Term Structure of Interest Rates Revisited. *Brookings Papers on Economic Activity*, 1986(1):61-110.

Mankiw, N.J. & Miron, J.A. 1986. The Changing Behaviour of the Term Structure of Interest Rates. *The Quarterly Journal of Economics*, 101(2):211-228.

Mankiw, N.G. & Summers, L.H. 1984. Do Long-Term Interest Rates Overreact to Short-Term Rates? *Brookings Papers on Economic Activity*, 1984(1):223-242.

Mathai, K. 2012. Monetary Policy: Stabilizing Prices and Output. Finance and Development. 28 Mar. http://www.imf.org/external/pubs/ft/fandd/basics/monpol.htm. Date of Access: 19 Jul. 2016.

MathWorks. 2016. Cointegration, Stationarity and Error Correction Models. https://www.mathworks.com/help/econ/trend-stationary-vs-difference-stationary.html?requestedDomain=www.mathworks.com. Date of Access: 4 Oct. 2016.

McBride, J. & Alessi, C. 2015. The Eurozone in Crisis. 11 Feb. Council on Foreign Relations. http://www.cfr.org/eu/eurozone-crisis/p22055. Date of Access: 27 Aug. 2016.

Mishkin, F.S. 1988. The Information in the Term Structure: Some Further Results. NBER Working Paper 2575.

Mishkin, F. 1990a. What Does the Term Structure Tell Us about Future Inflation? *Journal of Monetary Economics*, 25(1):77-95.

Mishkin, F. 1990b. The Information in the Longer Maturity Term Structure about Future Inflation. *Quarterly Journal of Economics,* 105(3):815-828.

Mishkin, F.S. 1991. A Multi-Country Study of the Information in the Term Structure about Future Inflation. *Journal of International Money and Finance*, 10(1):2-22.

Mishkin, F. S. 1995. Symposium on the Monetary Transmission Mechanism. *Journal of Economic Perspective*, 9(3):3-10.

Mishkin, F.S. & Eakins, S.G. 2006. Financial Markets and Institutions. Pearson Education India.

Mishkin, F.S. 2012. Central Banking after the Crisis. *National Bureau of Economic Research*, 1-45.

Mobin, M.A. & Masih, M. 2014. Do the Macroeconomic Variables Have Any Impact on the Islamic Bank Deposits? An Application of ARDL Approach to the Malaysian Market. *Munich Personal RePEc Archive*, MPRA Paper No. 62342.

Modena, M. 2008. The Term Structure and the Expectations Hypothesis: a Threshold Model.

Mollentze, S. 2000. Monetary Policy in South Africa on the Threshold of a New Era. *South African Journal of Economic and Management Sciences*, SS(2):1-50.

Musti, S. & D'Ecclesia, R.L. 2008. Term Structure of Interest Rates and the Expectation Hypothesis: The Euro Area. *European Journal of Operational Research*, 185(3):1596–1606.

Muzindutsi, P.F. & Mposelwa, S. 2016. Testing the Expectations Hypothesis of the Term Structure of Interest Rates in BRICS Countries: A Multivariate Co-integration Approach. *Œconomica*, 12(4):289-304.

Nel, H. 1996. The Term Structure of Interest Rates and Economic Activity in South Africa. *The South African Journal of Economics*, 64(3):161-174.

Nell, C. & Zimmermann, S. 2011. Summary Based on Chapter 12 of Baltagi: Panel Unit Root Tests. Vienna: University of Vienna. (Course – PhD).

Newey, W.K. & West, K.D., 1987. Hypothesis Testing With Efficient Method of Moments Estimation. *International Economic Review*, 777-787.

Oda, N. & Ueda, K. 2005. The Effects of the Bank of Japan's Zero Interest Rate Commitment and Quantitative Monetary Easing on the Yield Curve: A Macro-Finance Approach. Bank of Japan Working Paper Series No. 05-E-6.

Pahlavani, M & Wilson, E. 2005. Structural Breaks, Unit Roots and Postwar Slowdowns in Iranian Economy. *Proceedings of the International Conference in Economics and Finance (ICEF)*, 135-140.

Panigrahi, M.S. 1997. Term Structure and Economic Activity. *Economic and Political Weekly*, 32(42):2661-2666.

Pattichis, C. A. 1999. Price and Income Elasticities of Disaggregated Import Demand: Results from UECMS and an Application. *Applied Economics*, 31(9):1061–1071.

Peel, D.A. & Ioannidis, C. 2003. Empirical Evidence on the Relationship between the Term Structure of Interest Rates and Future Real Output Changes When There Are Changes in Policy Regimes. *Economics Letters*, 78(2):147–152.

Peel, D.A. & Taylor, M.P. 1998. The Slope of the Yield Curve and Real Economic Activity: Tracing the Transmission Mechanism. *Economics Letters*, 59(3):353-360.

Perron, P. 1989. The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica: Journal of the Econometric Society*, 1361-1401.

Pesaran, M.H. & Pesaran, B. 1997. Microfit 4.0: Interactive Econometric Analysis. Oxford: Oxford University Press.

Pesaran, M. H., & Shin, Y. 1999. An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. *Econometric Society Monographs*, 31:371-413.

Pesaran, M.H. & Smith, R.P. 1998. Structural Analysis of Cointegrating VARs. *Journal of Economic Surveys*, 12(5):471-505.

Pesaran, M.H., Shin, Y. & Smith, R.P. 1999. Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, 94(446):621-634.

Pesaran, M.H., Shin, Y. & Smith, R.J. 2001. Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16(3):289–326.

Philippon, T. 2009. The Bond Market's q. *Quarterly Journal of Economics*, 124(3):1011-1056.

Phillips, P.C.B., Perron, P. 1988. Testing for a Unit Root in Time Series Regression. *Biometrika*, 75(2):335–346

Roley, V.V. & Sellon Jr, G.H. 1995. Monetary Policy Actions and Long-Term Interest Rates. *Economic Review-Federal Reserve Bank of Kansas City*, 80(4):73.

Roll, R. 1970. The Behaviour of Interest Rates: An Application of the Efficient Market Model to US Treasury Bills. New York: Basic Books.

Rose, P.S. & Hudgins, S.C. 2013. Bank Management and Financial Services. 9th Ed. Singapore: McGraw Hill.

Rudebusch, G.D. 1995. Federal Reserve Interest Rate Targeting, Rational Expectations, and the Term Structure. *Journal of Monetary Economics*, 35(2):245-274.

Said, S.E. & D. Dickey. 1984. Testing for Unit Roots in Autoregressive Moving-Average Models with Unknown Order. *Biometrika*, 71(3):599-607.

Sangvinatsos, A. 2008. The Expectations Hypothesis. University of Southern California.

Sarno, L., Thornton, D.L. & Valente, G. 2007. The Empirical Failure of the Expectations Hypothesis of the Term Structure of Bond Yields. *The Journal of Financial and Quantitative Analysis*, 42(1):81-100.

Schwert, W. 1989. Tests for Unit Roots: A Monte Carlo Investigation. *Journal of Business and Economic Statistics*, 20(1):5-17.

Sezgin, S. & Yildirim, J. 2003. Military Expenditure and Unemployment in Turkey. *Defence and Peace Economics*, 14(2):129-139.

Shanming, Q. 2013. Financial Integration within the BRICS. *CRI English*, 10 Apr. http://english.cri.cn/7146/2013/04/10/3381s758725.htm. Date of Access: 16 Jul. 2016.

Shelile, T. 2006. The Term Structure of Interest rates and Economic Activity in South Africa. Rhodes University. (M.Com Thesis).

Shiller, R.J., 1979. The Volatility of Long-Term Interest Rates and Expectations Models of the Term Structure. *The Journal of Political Economy*, 87(6):1190-1219.

Shiller, R.J. 1990. The Term Structure of Interest Rates. *Handbook of Monetary Economics*, 1:627-722.

Shiller, R.J., Campbell, J.Y., Schoenholtz, K.L. & Weiss, L. 1983. Forward Rates and Future Policy: Interpreting the Term Structure of Interest Rates. *Brookings Papers on Economic Activity*, 1983(1):173-217.

Soderlind, P. & Svensson, L. 1997. New Techniques to Extract Market Expectations from Financial Instruments. *Journal of Monetary Economist*, 40(2):383-429.

Spaulding, W. 2016. Term Structure of Interest Rates. 3 Mar. http://thismatter.com/money/bonds/term-structure-of-interest-rates.htm. Date of Access: 12 Apr. 2016.

Stambaugh, R.F. 1988. The Information in Forward Rates: Implications for Models of the Term Structure. *Journal of Financial Economics*, 21(1):41-70.

Stojanovic, D. & Vaughan, M.D. 1997. Yielding Clues about Recessions: The Yield Curve as a Forecasting Tool. https://www.stlouisfed.org/publications/regional-economist/october-1997/yielding-clues-about-recessions-the-yield-curve-as-a-forecasting-tool. Date of Access: 13 Feb. 2016.

Svensson, L.E.O. 1994. Estimating and Interpreting Forward Rates: Sweden 1992–4. *National Bureau of Economic Research*, Working Paper 4871.

Svensson, L.E.O. 2000. The Zero Bound in an Open Economy: A Foolproof Way of Escaping from a Liquidity Trap. *National Bureau of Economic Research*, Working Paper 7957.

Svensson, L.E.O. 2003. Monetary Policy and Real Stabilization. *National Bureau of Economic Research*, Working Paper 9486.

Tabak, B.M., & de Andrade, S.C. 2001. Testing the Expectations Hypothesis in the Brazilian Term Structure of Interest Rates. Banco Central Do Brasil, Working Paper Series 30.

Tabak, B.M., Serra, T.R. & Cajueiro, D.O. 2009. The Expectation Hypothesis of Interest Rates and Network Theory: The Case of Brazil. *Physica A: Statistical Mechanics and its Applications*, 388(7):1137-1149.

Tanas, O. & Andianova, A. 2014. Russia Defends Ruble with Biggest Rate Rise Since 1998. *Bloomberg*, 15 Dec. http://www.bloomberg.com/news/articles/2014-12-15/russia-increases-key-interest-rate-to-17-to-stem-ruble-decline. Date of Access: 17 Aug. 2016.

Taylor, M.P. 1992. Modelling the Yield Curve. *The Economic Journal*, 102(412):524-537.

Taylor, J.B. 1995. The Monetary Transmission Mechanism: An Empirical Framework. *Journal of Economic Perspectives*, 9(4):11-26.

The Economist. 2013. The Origins of the Financial Crisis. 7 Sept. http://www.economist.com/news/schoolsbrief/21584534-effects-financial-crisis-are-still-being-felt-five-years-article. Date of Access: 7 Apr. 2016.

Thornton, D.L. 2000. The Bias in the Conventional Test of the Expectations Theory: Resolving the Anomalies at the Very Short End of the Term Structure. Federal Reserve Bank of St. Louis, Working Paper 2000-003A.

Thornton, D.L. 2006. Tests of the Expectations Hypothesis: Resolving the Campbell-Shiller Paradox. *Journal of Money, Credit, and Banking*, 38(2):511-542.

Thornton, D.L. 2014. Monetary Policy: Why Money Matters (and Interest Rates Don't). *Journal of Macroeconomics*, 40:202-213.

Tintner, G. 1965. Econometrics. New York: John Wiley & Sons.

Tzavalis, E. & Wickens, M.R. 1997. Explaining the Failures of the Term Spread Models of Rational Expectations Hypothesis of the Term Structure, *Journal of Money, Credit and Banking*, 29(3):364-380.

Uesugi, I. & Yamashiro, G.M. 2009. Does the Expectations Hypothesis Hold at the Shortest End of the Term Structure? *Hitotsubashi Journal of Economics*, 50(1):71-85.

Van der Merwe, E., & Mollentze, S. 2010. Monetary Economics in South Africa. 3rd Ed. Cape Town, South Africa: Oxford University Press.

Van der Merwe, E. & Mollentze, S. 2013. Monetary Economics in South Africa. 4th Ed. Cape Town, South Africa: Oxford University Press.

Walsh, C.E. 2003. Monetary Theory and Policy. 2nd Ed, the MIT Press.

World Bank. 2009. Global Commodity Outlook. http://documents.worldbank.org/curated/en/801401468338367459/pdf/938920WP0GCM2009Sep0Box385381B00PUBLIC0.pdf. Date of Access: 15 Sept. 2016.

World Bank. 2015. Commodity Markets Outlook. World Bank Quarterly Report 93951.

World Bank. 2016. Global Economic Prospects – June 2016. Forthcoming.

Wright, J.H. 2006. The Yield Curve and Predicting Recessions. Federal Reserve Board. Finance and Economics Discussion Series, 2006-07.