Measuring the credibility of monetary policy using the term structure of interest rates

STUDENT:
KEITUMETSE MOGODI 677319
SUPERVISOR:
PROFESSOR CHRISTOPHER MALIKANE

Thesis submitted in part of the requirements for the degree of

MASTERS OF MANAGEMENT IN FINANCE AND INVESTMENT

in the

FACULTY OF COMMERCE LAW AND MANAGEMENT

WITS BUSINESS SCHOOL

at the

UNIVERSITY OF THE WITWATERSRAND

DECLARATION

I, Keitumetse Mogodi declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted to fulfil the partial requirements for the Masters of Management in Finance and Investment degree at the University of the Witwatersrand, Johannesburg. This thesis has not, either in whole or in part, been submitted for a degree or diploma to any other institution or university for a similar qualification. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

_____ _____

Signature of Candidate Date

_____ _____

Signature of Supervisor Date

Abstract

The study of the expectations hypothesis has been one which has led to much rejection and acceptance in relation to the term structure of interest rates. This paper seeks to observe how the credibility of central banks is affected by the different regimes and developments over time such as the US sub-prime mortgage crisis. The observation will be conducted in the context of advanced and emerging market economies. Therefore, a measure of central bank credibility is hypothesized and measured using the yield spread where short term rates and tests of significance is used extensively. In addition, the study will go further to test the how the conduct of central banks money supply affect expected rates. This allows us to unfold how a market efficiently responds greatly to unanticipated interest rate movement or policy regime changes rather than central bank announcements

Findings of this study validates that the credibility of central banks is evaluated greatly through the short interest rate as well as previous expected rates. On this basis, the study thus accepts the notion that the yield curve contains information in correspondence to the expectations hypothesis which aid in predicting future expected interest rates. Furthermore, future expected rates decay after a lag for most countries. In practical terms for a successive monetary policy, central banks should carry out an optimal rule-like behaviour bearing in mind to consider unexpected contingencies which could affect its credibility. This is especially in response to current unconventional policies sanctioned post US subprime crisis. Therefore, a recommendation for central banks to be successive would be to strike a good balance between the credibility of its announcements and the flexibility to adjust to unanticipated events.

Contents

Chapter 1: Introduction

This paper investigates the effects of the credibility of monetary policy on central banks in both emerging markets and advanced economies. Kydland and Prescott (1977) argue that for monetary policy to be credible, monetary authority must follow a rule that agents believe is not going to change. King (1995) defines credibility as good reputation, which means that the public must believe that the central bank will follow through its announced commitment. Caprioli and Gnocchi (2009) imply that credibility is the ability of monetary authority to commit and fulfil its promises. As pointed out by Garfinkel and Oh (1995) and Duffy and Heinemann (2014) central banks must strike a balance between credibility and flexibility. A central bank that puts more weight on fluctuations of real economic activity is likely to be less credible as an inflation manager. Conversely, more weight on inflation volatility implies less credibility to manage fluctuations in real economic activity. Central banks are therefore faced with the trade-off between inflation and economic activity in the short run

Monetary policy credibility is important now, especially because interest rates in advanced economies have reached the zero lower bound. Major central banks e.g. the Fed, Bank of England and the ECB, have adopted unconventional policies such as quantitative easing to steer the economy out of the recession. One of the channels through which these policies work is through their effect on long-term interest rates. This is the impact of monetary policy actions on long-term rates depending on short-term market expectations which shape the direction of future policy (Roley and Sellon, 1995). Also, in many emerging market economies, net capital inflows rely on the management of central bank intermediation in its foreign exchange market (Mallick and Sousa, 2012).

The expectation hypothesis articulates that the long-term rate is the sum of the average of current short rate and expected future short-term interest rates plus a term premium (Engsted and Tanggaard, 1994). Numerous studies have proven that the term structure of interest rates contain useful evidence about the movement of future interest rates through the expectations hypothesis. At the same time, some authors have documented to reject the hypothesis. Nonetheless, not much study has focused on the behaviour of expectations of countries which possess a common economic feature. Most research has rather focused on economies either individually or by regional placement (Klau and Mohanty, 2004). Therefore, by measuring the impact of monetary policy credibility through the expectations hypothesis, this work will seek to contribute towards the study of the trade-off relationship between flexibility and credibility over time. Specifically, the economic feature will be in the context of Advanced Economies (AE) and Emerging Market Economies (EME)

The Taylor rule (1993) is a simple monetary policy prescribing how central banks regulates its interest rate instruments in a manner that is systematic to respond to the developments in inflation and other macroeconomic pressures (Rules and Orphanides, 2007). Taylor (1993) viewed the design of monetary policy as either being optimal, in the sense that policy rule is systematic and methodological and therefore a provides a pre-committed solution or being discrete in the sense that an inconsistent and short-sighted change is used as a solution. The former notion described has a greater influence on the idea of how central banks strike a balance between credibility and flexibility. With rule-like behaviour, central banks can combine it with the expectations hypothesis. As the expectations hypothesis is used for predicting short term interest rates, a central bank incorporates it with other policy factors that are appropriate to implement at that period.

Background to the study

Monetary policy is the central banks' activities that influence short term and long term interest rates (Rasche and Williams, 2005). Monetary authority, therefore, controls these interest rates by either supplying or removing money from its economy. Kydland and Prescott (1977) argue that if policymakers rely on policy rules, the subsequent result is the *optimal control theory* where future outcomes are dependent upon current and past policy decisions. This provides some information to agents about the changes policymakers put into action which affects their current decisions and expectations. Further to the information available, agents assess policymakers' decisions that are implemented, as opposed to what is proposed. This creates a perception of how credible central banks are. Thus, the implementation of central bank's credibility places a huge influence how its monetary policy actions affect future variables such as long-term interest rates and other asset prices (Blinder, 1999).

In simple terms, the expectations hypothesis states that the current term spread between a long and short-term interest rate is the expected value of average future changes to the short-term interest rate (Bekaert and Hodrick, 2001). Through econometric studies, Shiller, Campbell and Schoenholtz (1983) and Mankiw and Summers (1984) suggest that long rates over-react to movements in the short rate. This implies that the spread between the long and short rate predicts future changes in the short rate. If the results of the term structure contain predictive information it is said that the slope of the term structure may guide the monetary policy of a country (Mishkin, 1989). For instance, in the late 1990's, many countries adopted the inflation targeting regime where its aim is to stabilize inflation around a set inflation target by central banks (Mishkin, 2007). The regime is however limited by a stable financial market and therefore unexpected shocks may alter inflation expectations and effectively, interest rates.

The use of the expectations theory of policy making is centred around three main reasons. Firstly, it explains how certain representations of the model change out of the sample. Secondly, a good reason for the use of expectation in econometric modelling is that it is a source of identifying restrictions. Thirdly, it places a consensus for economists who believe people will behave in their own interests and therefore this causes *systematic* and *predictable* deviancies (Sargent and Wallace, 1976). Such empirical work also implies that financial markets are *efficient*. In early as 1989, Cook and Hahn presented evidence of the types of announcements by monetary authorities by the US signalled changes in the funds rates and therefore have a strong influence in long term rates.

The bankruptcy of several investment banks bought on much financial instability. Even with the approach of rule-like behaviour, adverse implications revealed by the 2007/2008 US subprime crisis led to the recession of many economies (Blanchard et al, 2010). With the crisis, global imbalances, particularly in the U.S, created a global toxic combination due to the burst of the housing bubble. This impacted on the credibility and management of central banks. Emerging markets appeared to be isolated from these progressions however over time policy developments failed to extensively react to events bought on by the crisis (Dooley and Hutchison, 2009).

Understanding the movements of expectations is important as it provides a basis for economists and others for policy decisions, investment decisions, consumer savings and other factors affecting economic activity. This study will try to fill the gap by examining the effects of credibility within the bond market. Thus, a study of how expected short interest rates are affected over varying short and long periods of time is investigated. The study will furthermore focus on the credibility of central banks in the context of emerging market economies and advanced economies by focusing on the relationship of current expected rates to short term rates and past expected rates

Problem statement

Central bank credibility has various definitions that try to capture the functioning of central bank regarding monetary policy. Empirically, the expectations hypothesis has been overly accepted and rejected due to various reasons. To be exact, acceptance of the hypothesis has only been tested by authors using one country or of similar environments. In addition, to control for market expectations, interest rates, inflation and other variables; central banks propose long-term policies or regimes to control markets. Thus, how are expected rates affected over periods of regime changes?

Since the only information available to agents are past rates and announcements, we can use them for to predict future rates. Thus, we aim to validate the authenticity the hypothesis carries and therefore the credibility by using past long-term and short-term interest rates to substantiate the expectations hypothesis over a ten-year yield. In addition, by doing so we seek to capture a consensus of the bond market on a global scale through advanced economies and emerging market economies and seek to conclude a general view of the future rates of these economies

Significance of study

The effect of monetary policy influences the movement of interest rates to a certain degree. This effect depends on how closely linked short term and long term rates are to each other (Drakos, 2001). Much of the literature has focused on quantifying this effect especially in advanced economies such as the Federal Reserve. Very little attention has been paid to study the time-varying nature of credibility of countries with similar market conditions. This notion also aligns with how central banks are credible over long periods or when a new regime is introduced. This paper aims to investigate how changes arising from monetary policy actions affect the bond market.

By doing so, we may gather the credibility of various countries in the context of countries grouped as Advanced Market Economies (AE) and Emerging Market Economies (EME). The following AE countries are Canada, France, Japan, UK, and USA. The five EME's are Greece, Israel, Mexico, Poland and South Africa. All these countries are chosen since the effect of the crisis is one that is global.

Data and methodology

The strategy addresses issues associated with the bond market in relation to central banks playing a role in controlling the market through interest rates. The approach to study makes use of Ordinary Least Squares (OLS). The approach of this research will take on a deductive approach where past statistics and information from various published materials will aid in identifying the theories and other essential information which will outline a framework for testing data (Saunders, 2011).

The study will follow a longitudinal approach where the data analysed is over a series of time studying the development and progress of how central banks affected the bond over time. The data uses both monthly long-term government bond yields (10-years) and monthly short-term government treasury bills. By analysing five advance economies and emerging market economies, we require countries which are large, fast-growing economies with some significant influence on economic affairs. Assume the countries share a common feature; the monetary regimes experienced which enables us to grade the credibility of central banks

Research questions

1. What is the relationship of expected rates and the spread considering ten-year long-term rates?
2. How has the 2007/2008 subprime crisis affected the credibility of central banks?
3. What is the effect of historical expected rates on the current expected rate?
4. What is the long-run effect of the spread over the monetary policy regimes?

The remainder of the paper will further contextualize credibility covered in the literature review. This is then followed by the research model and design. Thereafter, a presentation of the results and the analysis is discussed followed by a concise conclusion

Chapter 2: Literature review

The role of monetary policy

The plain role of monetary policy should be conducted in accordance with rules, where central bank actions influence the availability and cost of money and credit through its policies (Labonte & Makinen, 2008). Therefore, on the short-run, one of the main objectives of monetary policy is bringing inflation to a level suited to reduce interest rates and increase interest-sensitive spending (Labonte & Makinen, 2008). In the long run, monetary policy must keep at an inflation level that is constant whilst stabilizing fluctuations such as unemployment, output and other macroeconomic variables (Taylor, 2001).

Monetary policy sets regimes that contain a set of rules and constraints that impact the operation of macroeconomic aggregates of a country (Bordo and Schwartz, 1999). The three main regimes which has been exercised by most countries are described in the table below. A nominal anchor is a central feature used in monetary regimes to pin down expectations of agents about the nominal price or intentions of a central banks with respect to achieving a goal (Mishkin, 1999). Central banks also appear to prioritize when there is a need to influence market expectations. Their actions and announcements are implemented on a perpetual or conditional basis. For instance, the Bank of Japan pledged to keep its policy rate at zero but only on the condition that the economy is under deflation (Bernanke et al, 2004).

Table 1

Regime	Function	Disadvantage
Exchange-rate targeting	Fixes the value of domestic currency to a commodity such as gold or to a large and low inflation country.	Country's monetary policy loses its autonomy and accountability or the country is too large to seek a currency to serve as a nominal anchor
Monetary targeting	focuses on the growth rate of a monetary aggregate. Also, it enables a central bank to adjust its monetary policy to cope with domestic considerations unlike exchange-rate targeting	Depends on if the targeted aggregate is well controlled by the central bank. Also, depends on if the there is a strong relation between the goal variable and targeted aggregate.
Inflation targeting	Concentrates on actively shaping and targeting inflation expectations involving several essentials such as public announcement, transparency, credibility etc.	The effect of inflation targeting is more ambiguous. Inflation expectations may not adjust immediately. Policymakers are forced to be forward looking rather than on current conditions

(Mishkin, 1999)

Theories supporting the impact of policy to the bond market

Monetary policy relies on several theories to create a dynamic interrelationship. This means the economy being able to be flexible enough to adjust for and to live up to being credible for its policies implemented. Therefore, a balance between flexibility and credibility must be maintained to for progressive economic activity. Theoretically, we may look at how this relationship is built which will be discussed below

In a mathematical expression, the expectations hypothesis states that the anticipated holding yield for bonds of different maturities should be the same, except for a risk premium (Bulkley et al, 2008). This implies that the term structure contains further information, the term premium. Theoretically, the expectation hypothesis is not viewed in isolation. Some authors view it as the joint hypothesis where investors' rational expectations conform to expectations hypothesis (Froot, 1989).

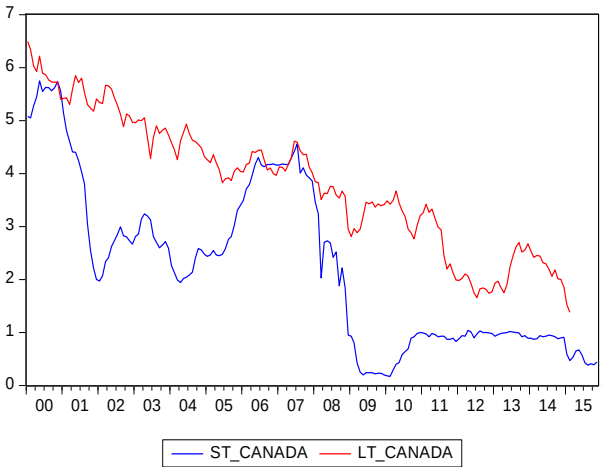
The difference in long rate and short interest rate is called the spread. The spread is used to reflect the predictive information in the term structure and reflects the expected changes in the short rate (Mankiw and Miron, 1986). The yield is also the slope coefficient and measures the degree or extent how central banks are credible at that period. Theoretically, the coefficient equals to one (McCallum, 1994). This is due to large asymptotic standard errors to finite-sample bias (McCallum, 1994). However, empirically, the slope coefficient tends to be below one.

A high yield spread forecasts rising short term rates. An understanding of a high yield spread implies short term rates tend to rise over the life of the long-term rates (Campbell and Shiller, 1991). Concurrently, when the yield spread is high and the yield on the long-term rate tends to fall over the life of the shorter-term bond, this contradicts the expectations hypothesis (Campbell and Shiller, 1991). This implies central banks tightening the supply of money leading to a rise in interest rates in the short run. In addition, given a central bank is credible, longer term rates tend to rise less than short term rates and the spread between these rates declines. This results to the yield curve flattening. The movement between the short rate and long rate exhibiting the yield spread over a span of fifteen years is shown in the illustrations in figure1 and figure 2

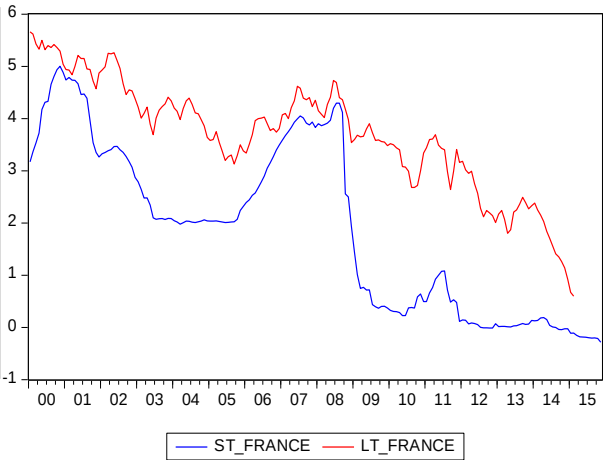
The term premium is the surplus rate that compensates risk averse investors (Dziwura and Green, 1996). Generally, the term premium accounts for uncertainty such as inflation and real activity amongst many other factors (Kim and Orphanides, 2007). Literature has explained that the nature of the term premium is time-varying because the risk is owing to unexpected interest rate movements (Engle et al, 1987).

For a successful monetary policy, monetary authorities must have an accurate timing and effect of policies on the economy. The transmission mechanism is the process through which monetary policy decisions triggers changes such as real GDP and inflation (Taylor, 1995). These mechanisms include interest rate effects, exchange rate effects and other asset price effects and the credit channel. An understanding of the transmission mechanism allows monetary authorities to determine many the factors appropriate for policy building to implement in different business cycles and the trade-off choice between the macroeconomic variables (Taylor, 1995). Therefore, the optimal rule as mentioned earlier, provides a foundation for the various frameworks transmission mechanism used by central banks

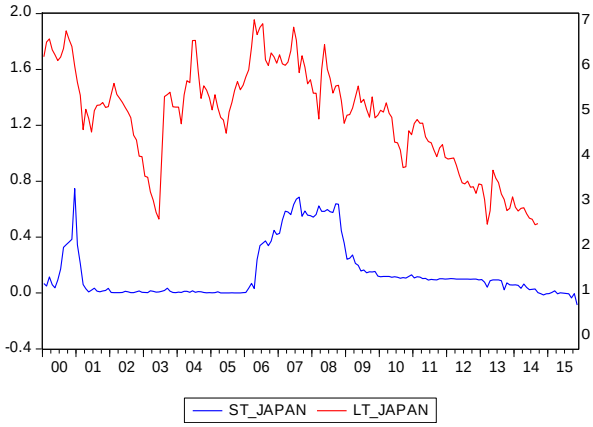
The hypothesis is also accustomed, as described by Muth (1961), on the following three factors 1. Information is scarce which agents do not waste 2. When expectations are formed, it depends on the structure of a relevant system best describing the economy 3. A public prediction, described by Grunberg and Modigliani (1954) has no substantial effect on the operation of the economic system. The reflection of market participants is the slope of the yield curve, the spread between long rates and short rates



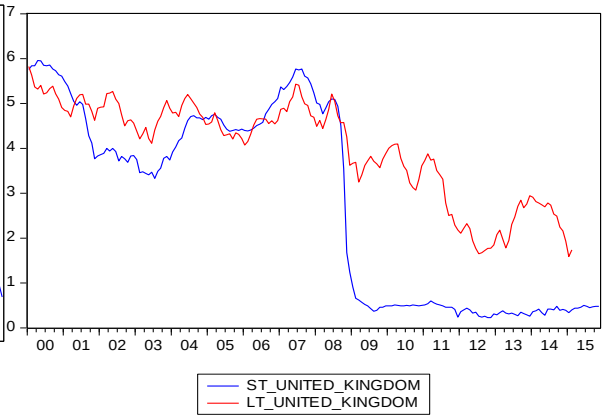
Canada



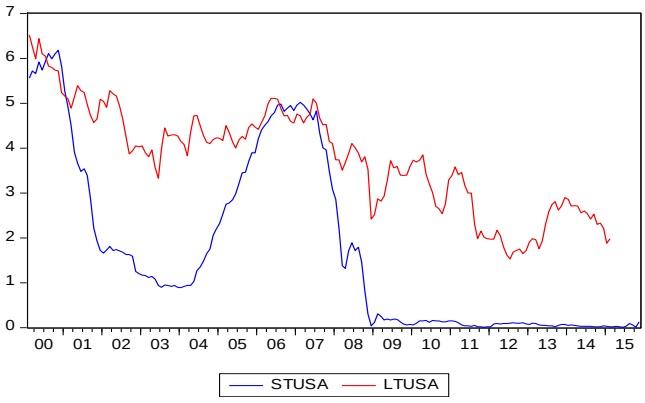
France



Japan



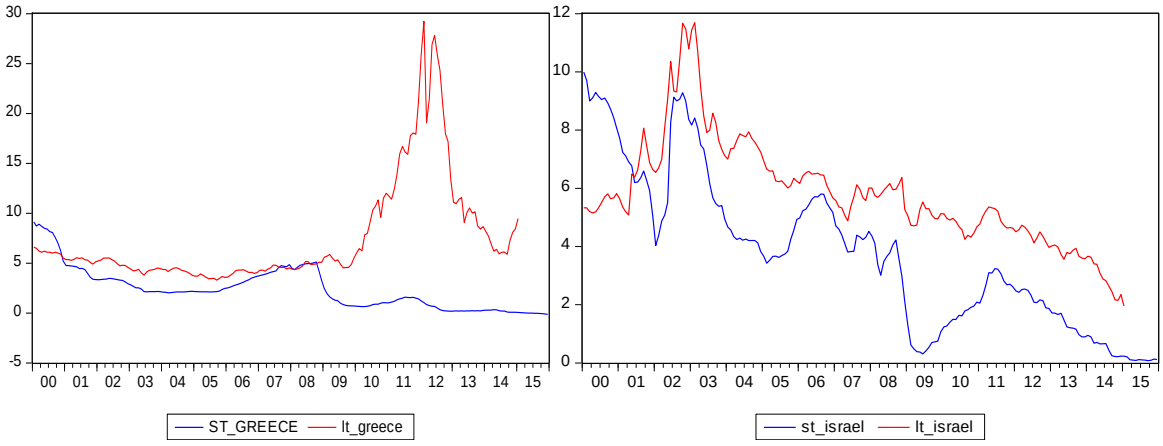
United Kingdom



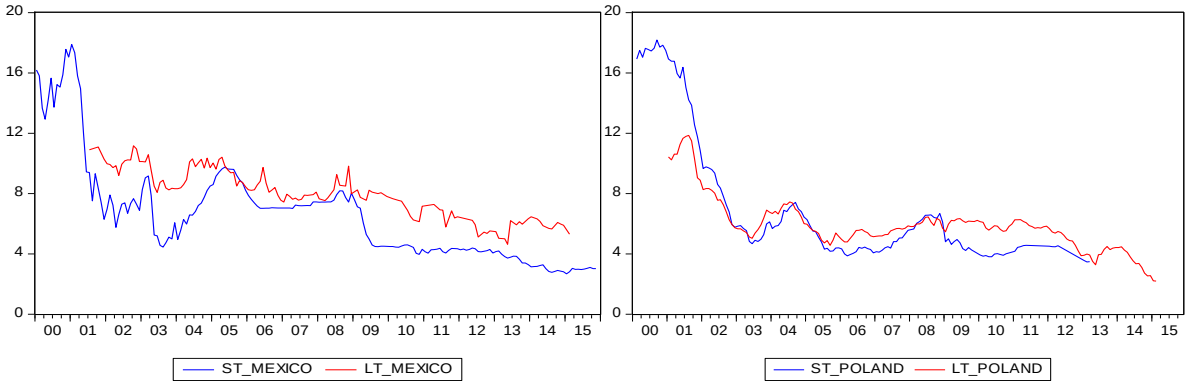
United States of America

Note: ST indicates short-term interest rates. LT indicates long-term interest rates. This is followed by the name of the country

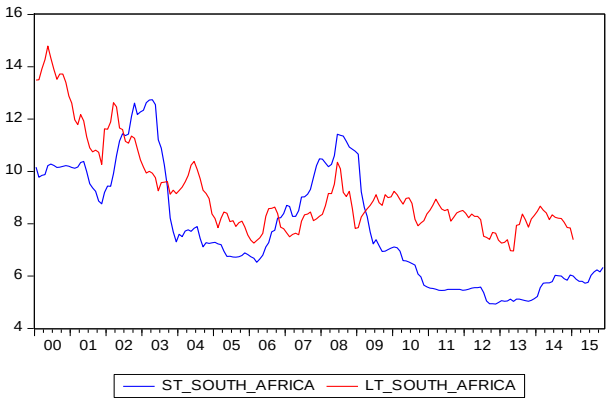
Figure 1: Interest rate spreads of Advanced Market Economies



Greece Israel



Mexico Poland



South Africa

Note: ST indicates short-term interest rates. LT indicates long-term interest rates. This is followed by the name of the country

Figure 2: Interest rate spreads of Emerging market economies

Evidence on the succession and failure of the expectation hypothesis

Over time empirical literature has either rejected or accepted the expectations hypothesis for various reasons. This is due to some factors influencing the term structure. Most are traditional however, studies find a variety of implications relating to the hypothesis. Some factors are due to the changing nature that central banks impose. For instance, many papers have tested the authenticity of the hypothesis on post-war data between three-month and six-month treasury bills and have found no information proving the spread contains forecasting abilities (Rudebusch, 1995). Several papers have also rejected the notion that the spread contains projecting information to forecast changes in interest rates. Mankiw and Miron (1986) proved that the predictive power was not due to the failure of the expectations theory. The failure was rather because the Fed implemented measures to stabilize short term rates thereby influencing the way interest rates moved

Many authors such as Mankiw and Summers (1984), Mankiw and Miron (1986) and Campbell and Shiller (1991) also revealed that the spread of the term structure moves in the wrong direction due to the change of the long rate (Hardouvelis, 1994). However, it was also found that long rates obey the direction of the expectations but movements of the long rate are sluggish relative to the movement of the short rate (Hardouvelis, 1994). Correspondingly, the slope forecasts long term changes in the direction of short rates (Bekaert et al, 1997).

Many studies have observed United States (U.S) data in testing the validity of the hypothesis and find to reject it. However other studies find outside the U.S the behaviour of short rates conforms to the hypothesis such as Canada. A study using Canadian data found the hypothesis is not rejected for most maturities across the money market forward term structure (Paquette and Stréliski, 1998). Many authors are also unable to prove to reject the hypothesis due to the term premia or an expectational error present. It was found that the term premia are biased towards shorter term instruments and the expectational error is more biased to the predictability of the spread (Froot, 1989). Other reasons are due to the interest rate spread prediction; where it does not predict the direction of changes in long term rates and future changes in the short rate is often not correlated with the spread (Campbell and Shiller, 1991)

The study of the expectations hypothesis has gone deeper due to Campbell and Shiller (1991). Their findings conclude that any pair of maturities making the yield, fails to predict the movement of long rates but can forecast short rates. The failure of the expectations hypothesis is also due to the behaviour of the error term. In addition, by using current and lagged short rates data, their results presented the failure of the hypothesis because of the error term. During the period 1952-1987, the paper proved the correlation of the yield spread and past short rates failed to accept the expectations hypothesis (Campbell and Shiller, 1991).

Some research has however not accepted the rejection of the expectation hypothesis from previous literature. The impression of Campbell and Shiller (1991) finds anomalies of expectations hypothesis which has sparked the rejection by many authors. However, other authors argue market participants restore bond yields to equilibrium values required by the hypothesis showing consistent results thus disputing the animality present in the hypothesis (Bulkley et al, 2008).

The expectations hypothesis has been empirically rejected by researchers such as (Roll, 1970; Campbel and Shiller, 1991; Sarno et al, 2007; Buser et al. (1996), Bekaert et al. (1997), Balduzzi et al. (1997), and Backus et al. (1998). The key rejections are well elaborated by Berkaert and Hodrick, (2001) are as follows. The first rejection is that hypothesis justifies its assumption of rational expectations and unlimited arbitrage. This implies rational investors profit from the forecasting errors estimated by irrational investors. The second rejection is the existence of time-varying risk premiums.

This means standard tests of the hypothesis neglect variables accounting the risk premium unless if the variables are correlated with the interest rates. Thirdly, the test itself may contain poor properties leading to fabricated rejections in finite samples. This could be caused by highly persistent variable, measurement error etc.

As one of the functions of central banks is to supply money to the economy, the relationship between money supply and expected rates is puzzling. This is because money, prices, interest rates and monetary policy are all endogenous (Cornell, 1983). Findings empirically have found to be ambiguous (Cornell, 1983). This is due to the constraints on whether markets are efficient and uses all information available in assessing the movements of interest rates. In hindsight, since markets react efficiently to available information, the response of expected rates to money supply can however be biased on unanticipated announcements (Mishkin, 1982). Therefore, the general view of an unanticipated increase in money stock, leads to an unanticipated decline in short rates (Mishkin, 1982).

Testing the credibility of central banks employs linear models through using Ordinary Least Squares (OLS) and carry certain provisions before considering evaluating credibility. Cox, Ingersoll and Ross (1985) modelled interest rates that allowed for desirable properties the properties are 1. Interest rates should be non-negative; 2 they are mean reverting; 3. Heteroskedastic, i.e. variance increases with mean; 4. Interest rates at adjacent points in time are correlated (Aag, 2006). To account for the presence of autocorrelation, autoregressive models are used to approximate autocorrelation at higher orders

Coefficient stability tests are conducted to interpret the stationarity of the interest rate carries. The primary purpose of the test must interpret whether the spread is unbiased to predict the changes of expected interest rate. Therefore, variables expressing the expected rate must be stationary. Also, if the spread is stationary, the relationship between long and short rates are said to be co-integrated (King and Kurmann, 2002). A more powerful test of co-integration is the vector auto-regression (VAR) process. This rigorous test will however not be conducted since the spread is component of the hypothesis and not the whole model which we are focused on

The expected rate is dependent on the short interest rate to capture the predictive power also, when testing the forecast power of the rates uses the changes in rates rather than the level of rates as it removes potential bias in regression (Fama, 1984). A major rule to note is that the predictive value should be significantly different from zero. Otherwise a value closer to zero suggests that the rate has no predictive power.

It is said that regression tests are vastly biased in samples (Bekaert et al,1997). In the case of interest rates, the presence of autocorrelation is detected making it unfavourable to entirely accept the predictive power of the spread as it produces biased results towards the spread (Steeley, 2008). The Durbin-Watson (DW) detects autocorrelation to measure smoothness and measures long-term business conditions (Fama, 1984). If the autocorrelation is positive, the curve may be too stiff and if negative, the curve may be too flexible (Steeley, 2008) Therefore, autocorrelation must decay to avoid a biased measure.

The behaviour of interest rates at different points change over time based on their conditions due to extreme volatility within the market or the variance of the series the change in the policy regime and so on. Much literature assumes that short rates follow an autoregressive progress with the possibility of conditional heteroskedastic errors (Pfann et al, 1996). These changes must therefore be captured through autoregressive (AR) models. Where a linear stationary autoregressive process permits, long term expectations converge around a constant mean (Dewachter and Lyrio, 2008). Furthermore,

empirically market perception of expected rates follows an AR (1) model process that can explicitly model higher moments of the stochastic process which is the weighted average of conditional variance (Johannes, 2004). The AR model is also used to compute discount bonds based on a stochastic short interest rate in such a way where there are no arbitrage opportunities (Ho and Lee, 1986).

Recent impact of monetary policy on bond market

What led to the failure of the recent global financial crisis? How did it affect both the advanced and emerging market economies? This discussion will provide a literary standpoint of occurrences affecting the bond market in relation to monetary policy over time by highlighting major events that led to the crisis and its subsequent effect. Therefore, this will discuss and highlight major years of the bond market pre, during and post the impacting the financial crisis. Most events are relating to the US dollar long-term rates are susceptible to global shocks (Sobrun & Turner, 2015).

To start, huge money injections had been made despite the low historical interest rates in the 1980's. In mid-2002, the U.S aggressively lowered the Federal rate from 6,5% to 1% over 2001 to 2003 (Agbetsiafa, 2011). This fuelled lower housing rates in the economy and encouraged the accumulation of U.S assets in large volumes from developing countries. This allowed U.S to thrive through this period and stimulate growth in other countries (Agbetsiafa, 2011). However, this risk-taking effort was short-lived after the unsustainable US housing prices burst and sub-prime mortgage markets showed significant losses in value. In UK, the rates also lowered down to 2% and near zero for Germany (Boero & Torricelli, 2002). Japanese sovereign yields have been low throughout the period from around 2% in 1997 to zero leaving little room to further reduce its short rate (Bean et al, 2015).

In 2007, many researchers and economists developed a view that the collapse of the credit mechanism was bought by massive banking failures. Where financial uncertainty is high and the bond market is illiquid, a high-risk premium transpires reducing the expectations mechanism (Cukierman, 2013). The impact of low interest rate environment bought several changes with regards to inflation and bond markets. This implication was demonstrated in 2008 through the Lehman bankruptcy, the AIG bailout and other related events which almost brought down the financial system. The U.S economy seemed to have interest rates that are negative in real terms after taking inflation into account. If the interest rate fall below zero central banks face a challenge in stabilizing the economy.

In the context of emerging markets, a study was conducted for emerging market bonds and revealed many characteristics impacting on emerging markets due to the financial crisis. It was found that during this period, the correlation between emerging and developed markets was cyclical but negative to stabilize the exchange rate by changing the interest rate to help stabilize inflation (Klau and Mohanty, 2004). Where the exchange rate depreciates and the economy chooses to absorb the depreciation, this affects increasing the inflation rate leading to a decrease in credibility (Klau and Mohanty, 2004). For instance, in Brazil, inflation rates increased due to currency pressures over different periods all due to external pressures.

Emerging market economies was not fully affected by the crisis (Frank & Hesse, 2009). There were however financial spill-overs which resulted in emerging markets facing real sector problems and these economies suffered within their domestic industrial production and GDP growth (Frank and Hesse, 2009). The extent of the spill-over is due to interbank pressure from the Libor-Overnight Indexed Swap (OIS) and bank solvency from Credit Default Swaps (CDS) spread had become more correlated with emerging market bond, stock and credit markets (Frank and Hesse, 2009). This

became more evident in the beginning of the crisis and in the event where Bear Stearns rescued the Lehman Brothers bankruptcy (Frank and Hesse, 2009)

The crisis has shown how banking system failures can lead to tightening conditions and the need for government intervention in some countries. In response to the crisis, many advanced economies seek for unconventional monetary policy such as quantitative easing. The aim of quantitative easing is to inject money into the economy by making large scale purchases thereby increasing nominal spending and reducing long term rates (Joyce et al, 2011). The purchases operate to reduce rates of different maturities while the short rate is at a zero-bound rate (Curdia et al, 2012). However, this has led to the rebalancing of the portfolio model (Joyce et al, 2011). Other channels have been affected by quantitative easing such as the signalling channel it affects interest rates directly in lowering shorter maturity rates and the liquidity channel where long-term securities are purchased and increasing reserve balances to increase the liquidity of investor and thereby decrease the liquidity premium (Krishnamurthy & Vissing-Jorgensen, 2011)

Large-scale purchases include the Federal Reserve purchasing a total of $1.75 trillion of mortgage-backed securities, agency debt and treasuries in early 2009 (Curdia et al, 2012). In mid-2009, the European Central bank purchased a total of €60 billion of bonds in Euro areas (Curdia et al, 2012). The Bank of Japan established an asset purchase program where ¥5 trillion of assets were purchased (Curdia et al, 2012). Generally, the purchase is over four quarters which holds the balance sheet constant for the coming two years before it gradually winds down over the additional two years (Curdia et al, 2012). Policymakers may change this length depending on economic conditions. The response on macroeconomic variables particularly as GDP and inflation is strong. The result is an inflation response that is twice as large relative to the crisis and GDP being stronger but with on the enhancement to the GDP level (Curdia et al, 2012).

Chapter 3: Research model and design

The expectations hypothesis model was much progressed by Campbell and Shiller in 1991. In this framework, the long-term rates depend on the current short-term interest rate and on future short term interest rate. Letting R_t denote the long-term rate and r_t denote current short rates, we can present the model as follows:

$$R_t = \frac{1}{n} r_t + \frac{1}{n} \sum_{j=1}^{n} E_t r_{t+j} \qquad (1)$$

where r_{t+j} serves to capture economic agents' expectations about short-term rates and *n* represents the time frame of the term structure. We can rearrange equation (1) to obtain the difference between the long rate and short rate and define the yield spread as:

$$R_t - \tfrac{1}{n} r_t = r_t^e \qquad (2)$$

Where $r_t^e = \frac{1}{n} \sum_{j=1}^{n} r_{t+j}$ as shown in (1), the change in the expected short rate. It posits that the change in the expected short rate is related to the slope of the yield curve represented as β (Mankiw and Miron, 1986). The null hypothesis β should be greater than zero but less than one. This indicates the degree of credibility of that a central bank possesses as shown below (Dziwum & Green, 1996). The term ε_t is the white noise error process where $\varepsilon_t = \rho \varepsilon_{t-1} + \varepsilon_v$ such that $\varepsilon_v \sim (0, \delta_v^2)$.

$$r_t^e = \propto + \beta r_t + \varepsilon_t; \;\; \beta > 0 \qquad (3)$$

Thereafter, the subsequent purpose would be to observe the response of the current expected rate based on previous interest rates. We first observe the relation by lagging the short rate as shown below in equation (4). This equation is still basis that $\beta > 0$ should still hold even with the lagged variable

$$r_t^e = \propto + \sum_{j=0}^{n} \beta_j r_{t-j} + \varepsilon_t; \qquad \sum_{j=0}^{n} \beta > 0 \qquad (4)$$

As credibility still holds even with the lag, we now test whether previous expected rates and the short rate prove still carries information which the current expected rate may respond to. Therefore,

$$rt^e = \propto + \sum_{i=1}^{m} \theta_j r_{t-1-j}^e + \sum_{j=0}^{n} \beta_j r_{t-j} + \epsilon_t \qquad (5)$$

We then analyse how expected short rates responds when central banks alter the supply of money which could be caused by unanticipated shocks within the economy. We introduce the impact of the change in money supply and its previous expected rate as a function of the current expected rate. The equation thus is modelled as

$$r_t^e = \alpha + \sum_{i=1}^{m} \theta_j r_{t-1-j}^e + \sum_{\varkappa=0}^{n} \varkappa_j \Delta m_{t-j} + \varepsilon_t \qquad (6)$$

Chapter 4: Results and analysis

Data

All data used in this paper is extracted from St. Louis Fed. The models are tested by using monthly data of the interest rates of treasury bill and ten-year long-term government bonds from 2000M01 to 2015M12. For the sake of simplicity, the monthly data therefore is divided into periods before (2000M06 to 2006M12), during (2007M01 to 2009M12) and after (2010M01 to 2015M02) the financial crisis. In later stages, the board money supply (M3) is used. It is important to note that the use of the data is in conjunction with the desirable properties expressed by Cox, Ingersoll and Ross (1985). Through much econometric substantiation, credibility and money supply are regressed for interpretation

Since the paper focuses on ten-year long rate, the short rate is therefore multiplied by this factor. This is time frame of the term structure had been defined earlier as *n*. Primarily it is imperative to conduct stationarity tests of the short rate, long rate and expected rate variables. The regression uses changes in rates opposed to the actual rates to remove potential bias in regression results. Standard unit root process tests the long rate, short rate and expected rate series by using the Augmented Dickey-Fuller (ADF) test. The null hypothesis of the ADF states a unit root process present. The test is accompanied with the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Further, KPSS is used because of the criticism that ADF tests sometimes misinterprets unit roots with low powers or values with a root close to the non-stationary boundary. In the case of KPSS, the null hypothesis states a stationary process is present. Hence ADF and KPSS contain null hypothesis in contradiction to each other. In this way, testing for stationarity of the series using both ADF and KPSS can, by default prove the series to be precisely stationary

Table 2 and table 3 presents results of the ADF and KPSS tests respectively. The variables are proven to be stationary unless otherwise stated by an asterix placed to indicate at which level of significance to reject. A theoretical finding is greater negative values of the ADF test. A series strongly rejects the hypothesis of a unit root proving a greater effect towards stationarity. In addition, the expected rates are more negative than the other rates. This effect could be attested to its linear dependency on the long and short rate.

Table 2: Augmented Dickey-Fuller (ADF) tests

	Short rate	Long rate	Expected rate
Advanced Market Economy			
Canada	-11.09	-11.44	-11.31
France	-6.06	-18.24	-19.06
Japan	-9.41	-12.19	-18.23
United Kingdom	-21.19	-16.933	-17.24
United States	-4.47	-4.47	-11.2
Emerging Market Economy			
Greece	-8.88	-12.12	-12.14
Israel	-8.90	-10.40	-10.77
Mexico	-6.14	-10.15	-10.61
Poland	-7.53	-8.27	-6.83
South Africa	-14.53	-17.59	-17.97

Notes: unit root testing from 2000 through 2015. The t-statistics of the coefficients are in parenthesis. A *, **, *** denotes rejection at a 1, 5, and 10 percent significance level. The null hypothesis of the test is of a unit root process

Table 3: Kwiatkowski-Phillips-Schmidt-Shin (KPSS)

	Short rate	Long rate	Expected rate
Advanced			
Canada	-12.45	-15.68	-16.05
France	0.04	0.23	0.26
Japan	0.04	0.09	0.11
United Kingdom	0.09	0.33	0.24
United States	0.13	0.07	0.05**, ***
Emerging			
Greece	0.739**,***	0.10	0.09
Israel	0.12	0.25	0.33
Mexico	0.14	0.04	0.03
Poland	0.40***	0.122	0.14
South Africa	0.09	0.35***	0.30

Notes: unit root testing from 2000 through 2015. The t-statistics of the coefficients are in parenthesis. A *, **, *** denotes rejection at a 1, 5, and 10 percent significance level. The null hypothesis of the test is of a stationary process

The next model tests the expected rate to the coefficient which is the spread. The null hypothesis must prove$\beta > 0$ It, is to test the predictive power of the spread i.e.: coefficient stability tests. Table 4 and table 5 present the results. The results are all below one. Findings in most countries exhibits that the coefficient on the short rates is positive and significant. This proves that we may accept the null hypothesis that the predictability of the spread is greater than zero i.e.: $\beta > 0$. This further contributes to the property provided by Cox, Ingersoll and Ross (1985) where interest rates should be non-negative. To be exact, most economies present the impact of the crisis as credibility is weakened during this period (2007-2009). This change in the predictive power is the stochastic nature of the crisis. This is likewise as in Mankiw and Miron (1986) who speculate in the founding of the Federal Reserve bank presented a random walk behaviour which weakened its predictive power (i.e.: credibility).

Table 4: null hypothesis results for advanced market economy

Period	Country	Constant	coefficient	R^2	DW
2000M01-2006M12	Canada	0.04	0.54	0.11	0.08
		(19.49)	(3.25)	(0.10)	
2007M01-2009M12		0.03	0.17	0.59	0.35
		(46.43)	(7.04)	0.58	
2011M07-2015M02		0.01	0.80	0.01	0.09
		(2.77)	(1.60)	(-0.009)	
2000M01-2006M12	France	0.03	0.45	0.50	0.11
		(17.26)	(9.08)	(0.52)	
2007M01-2009M12		0.03	0.11	0.51	0.80
		(60.26)	(5.99)	(0.50)	
2010M01-2015M02		0.02	1.74	0.53	0.7
		(24.11)	(7.56)	(0.53)	
2000M01-2006M12	Japan	0.01	-8.99	0.20	0.27
		(39.92)	(-45.26)	(0.19)	
2007M01-2009M12		0.01	-9.39	0.99	0.91
		(21.45)	(-79.43)	(0.99)	
2010M-2014M09		0.003	-3.15	0.30	0.74
		(4.65)	(-4.84)	(0.29)	
2000M01-2006M12	UK	0.04	0.18	0.14	0.19
		(15.98)	(0.05)	(0.13)	
2007M01-2009M12		0.04	0.17	0.77	0.89
		(55.28)	(0.02)	(0.77)	
2010M-2015M02		0.004	5.76	0.58	
		(1.35)	(0.64)	(0.57)	
2000M01-2006M12	USA	0.04	0.2	0.35	0.21
		(37.04)	(0.03)	(0.34)	
2007M01-2009M12		0.03	0.23	0.66	0.71
		(42.67)	(8.27)	(0.66)	
2011M01-2015M02		0.02	-0.35	0.0005	0.122
		(15.66)	(2.67)	(-0.02)	

Notes: tests of credibility are divided into intervals of 2000-2006, 2007-2009, 2010-2015 in each country. Constant and the short rate are report with its corresponding t-statistics in parenthesis. R^2 is reported with its adjusted R^2 below in parenthesis. Durbin-Watson stat is denoted as DW

Table 5: null hypothesis results for emerging market economy

Period	Country	Constant	Coefficient	R^2	DW
2000M01-2006M12	Greece	0.03	0.28	0.60	0.10
		(33.64)	(10.98)	(0.59)	
2007M01-2009M12		0.05	-0.21	0.43	0.35
		(33.13)	(-5.05)	(0.41)	
2010M02-2015M02		0.09	5.42	0.18	0.14
		(7.71)	(3.55)	(0.16)	
2000M01-2006M12	Israel	0.06	0.05	0.003	0.08
		(10.55)	(0.512)	(-0.009)	
2007M01-2009M12		0.05	0.08	0.13	0.59
		(41.50)	(2.26)	(0.11)	
2010M02-2015M02		0.03	0.76	0.67	0.12
		(20.42)	(11.02)	(0.67)	
2000M01-2006M12	Mexico	0.07	0.18	0.08	0.32
		(12.93)	(2.30)	(0.06)	
2007M01-2009M12		0.07	-0.02	0.002	1.63
		(12.46)	(0.08)	(-0.04)	
2010M02-2015M02		0.04	0.35	0.09	0.56
		(6.17)	(0.18)	(0.07)	
2001M01-2006M12	Poland	0.03	0.42	0.89	0.23
		(17.71)	(0.02)	(0.89)	
2007M01-2009M10		0.04	0.12	0.09	0.32
		(17.97)	(0.07)	(0.06)	
2010M-2015M02		0.004	1.15	0.36	0.09
		(0.32)	(0.37)	(0.33)	
2000M01-2006M12	South Africa	0.04	0.58	0.33	0.052
		(4.79)	(0.09)	(0.32)	
2007M01-2009M12		0.08	0.004	0.00008	0.27
		(10.55)	(0.08)	(-0.03)	
2010M-2015M01		0.05	0.50	0.30	0.36
		(8.77)	(5.07)	(0.29)	

Notes: tests of credibility are divided into intervals of 2000-2006, 2007-2009, 2010-2015 in each country. Constant and the short rate are report with its corresponding t-statistics in parenthesis. R^2 is reported with its adjusted R^2 below in parenthesis. Durbin-Watson stat is denoted as DW

Another outcome occurs in the case of Japan (2000-2015), USA (from 2011-2015) Greece (from 2011-2015) and Mexico (from 2007-2009) as its coefficient is less than zero. We thus fail to accept the hypothesis in this instance. The negative coefficient in these cases occur in periods where interest rates were tending toward a period of the zero lower bound. These are also at points where the events of the financial crisis had occurred. However, Japan presents a negative coefficient from the recent crisis and in its circumstance of the liquidity trap caused by the collapse of its financial institutions. The trap bought a spiral in events of deflation and yet a closer look for modern monetary policy resolution giving rise to quantitative easing. The effect of quantitative easing is strongly evident post crisis as credibility strengthened when large injections of money stimulated nominal spending. Credibility in the beginning is low and the value continues to decrease during the period of the crisis. The negative coefficient however weakens post the storm of crisis and Japan's efforts into quantitative easing presented a more strengthened magnitude of credibility.

R-squared statistics explains the fit of the short rate is to predict the expected rate. The adjusted R-squared appear to further support the predictable power of short rates. Both the R-squared and adjusted R-squared are found to be lower in emerging market economies than advanced economies. A reason for the low values of R-squared in emerging economies is the objectives of central banks during the crisis. Emerging economies suffered financial spill overs from the crisis as opposed to advanced economies where they primarily faced liquidity difficulties. The spill-over initiated bank and currency problems resulting to increased inflation

As table 4 and table 5 present equation (3), it has proven that the expected rate is dependent on the current short rate and justifies the credibility of central banks changes before and during and after the crisis. If the expected rate is dependent on current short rates, we further question if previous short-rates can also interpret the null hypothesis of credibility over the same period (2000-2015) without the ramifications stated above (i.e.: negative coefficient). Thus, the short rates are lagged as in equation (4) and results are presented in table 6 and table 7

Results given in equation (4) show that past short rates do contain explanatory influence on the expected short rate. This is evident as the coefficient of the short rates in all countries tested remain greater than zero as the null hypothesis states. In addition, the probability of the lags in each country proves to be significant.

The null hypothesis of credibility is not true for Japan. The coefficients of the lagged short rate still produce a negative coefficient value at their respective significance values. The same deduction of zero lower bound still justifies for the negative coefficient. Although, the Federal Reserve Bank and the Bank of England had reached its zero lower bound, the overall power of credibility is weaker than France and Canada. A reason to a weaker level of credibility could be due to the crisis primarily existing around these countries. Where interest rates are close or within the proximity of the zero-bound region, a high reliance of government intervention and unconventional policy is interjected

The Durbin-Watson (DW) detects autocorrelation at the first level testing for first order serial correlation and the linear association between the residuals of the regression (Stešević, 2008). Values describe either a positive or negative autocorrelation. The results in equation (4) all display a positive value close to zero indicating autocorrelation. Thus, the increase of the independent variable may lead to an increase in the dependent variable leading to a misinterpretation or biased interpretation of the results. As mentioned empirically regarding interest rates, DW construes long term business conditions. Therefore, the interpretation of the results given for equation (4) is biased toward long-term conditions as the spread is a function of the long-term rate. Due to this indication, the results lead to a biased reaction toward the expected rate results of equation (4)

Table 6: effect of lagging short rates in advanced economy

	Canada	
Variable	Coefficient	probability
Constant	0.024	0.0000
RSTCAN (-1)	0.53	0.0000
R	0.52	
Adj R	(0.52)	
DW		
	France	
Variable	Coefficient	probability
Constant	0.025	0.0000
RSTFRA (-1)	0.48	0.0000
R	0.65	
Adj R	(0.64)	
DW	0.1	
	Japan	
Variable	Coefficient	probability
Constant	0.010863	0.0000
RSTJPN (-2)	-7.213624	0.0000
RSTJPN (-2)	-1.549620	0.0353
R	0.88	
Adj R	(0.88)	
DW	1.33	
	UK	
Variable	Coefficient	probability
Constant	0.026793	0.0000
RSTUK (-1)	0.351434	0.0000
R		
Adj R		
DW		
	USA	
Variable	Coefficient	probability
Constant	0.029	0.0000
RSTUSA (-1)	0.40	0.0000
R	0.67	
Adj R	(0.67)	
DW	0.1	

Notes: the data is presented as follows RST represents the short rate followed by an abbreviation or acronym of the name of the country. This also follows the numbers in lags. R-squared is denoted as R and its adjusted R^2 is denoted as Adj R. DW is the Durbin-Watson

Table 7: effect of lagging short rate in emerging market economy

	Greece	
Variable	Coefficient	probability
Constant	0.098826	0.0000
RSTGR (-1)	-1.032574	0.0000
RSTGR (-1)	0.098826	0.0000
R	0.18	
Adj R	(0.17)	
DW	0.08	
	Israel	
Variable	Coefficient	probability
Constant	0.039192	0.0000
RSTI (-1)	1.012325	0.0005
RSTI (-2)	-0.631562	0.0265
R	0.37	
Adj R	(0.36)	
DW	0.13	
	Mexico	
Variable	Coefficient	probability
Constant	0.041032	0.0000
RSTMEX (-1)	0.545123	0.0000
R	0.52	
Adj R	(0.52)	
DW	0.29	
	Poland	
Variable	Coefficient	probability
Constant	0.033837	0.0000
RSTPOL (-1)	0.374978	0.0000
R	0.84	
Adj R	(0.84)	
DW	0.26	
	South Africa	
Variable	Coefficient	probability
Constant	0.054064	0.0000
Lag 1	0.380694	0.0000
R	0.28	
Adj R	(0.27)	
DW	0.07	

Notes: the data is presented as follows RST represents the short rate followed by an abbreviation or acronym of the name of the country. This also follows the numbers in lags. R-squared is denoted as R and its adjusted R^2 is denoted as Adj R. DW is the Durbin-Watson

equation (3) and (4) has proven the null hypothesis that short rates over short intervals (i.e.: before, during and after) and its lagged short interest rate can measure the credibility of central banks. However, the empirical problem of positive autocorrelation is still present amongst the results. Also, the models presented justify its consistency to measure credibility and how it responds to the impact of the financial crisis in the period of one regime. Yet, is the measure of central bank credibility still precise over different regimes presented by central banks? Equation (5) examines this matter.

We seek to understand the effect of credibility spanning over different regimes by analysing the how current expected rates are affected by its past expected rates and short rates. Correspondingly where the problem of autocorrelation is present, it necessary to rectify and to remove the biased relationship of the long-term effects with expected rates. As pointed out by Cox, Ingersoll and Ross (1985), auto-regression is used to remove the effects of autocorrelation. A linear stationary autoregressive process allows one to interpret higher moments of long term expectations to converge around a constant mean (Aag, 2006). Equation (5) is thus a relationship that proves to find how historic expected rates together with the short rate affect the current or future expected rate

The data is regressed from the period of monetary targeting to inflationary targeting. Majority of the countries resulted a significant combination of short interest rates and the auto-regressed process lagged once. In the results presented, observing the Durbin-Watson values of each country show a result to values closer to two. This implies the effects of autocorrelation from previous models have decayed. The decay, attributable to auto-regression. The fact that the combination of these variables over the regimes are significant, we may accept the relationship as a sound measure over different regimes with accurate of autocorrelation and the lag in the short rate

Table 8: effect of past expected rates in advanced market economy

	Canada	
Variable	Coefficient	probability
C	0.001416	0.0000
RET (1)	1.247393	0.0000
RET (2)	-0.294751	0.0000
RSTCAN (-1)	0.030071	0.0000
R	0.99	
Adj R	(0.99)	
DW	1.90	
	France	
Variable	Coefficient	probability
C	0.000907	0.0005
RET (1)	1.163835	0.0000
RET (2)	-0.197053	0.0000
RSTFRA (-1)	0.023675	0.0003
R	0.99	
Adj R	(0.99)	
DW	1.99	
	Japan	
Variable	Coefficient	probability
C	0.006681	0.0000
RET (1)	0.520359	0.0000
RSTJPN (-1)	-4.274226	0.0000
R	0.99	
Adj R	(0.99)	
DW	2.76	
	United Kingdom	
Variable	Coefficient	probability
C	0.000925	0.0033
RET (1)	1.260390	0.0000
RET (2)	-0.304541	0.0000
RSTUK (-1)	0.033775	0.0000
R	0.99	
Adj R	(0.99)	
DW	1.86	
United States of America		
Variable	Coefficient	probability
C	0.001138	0.0003
RET (1)	1.256274	0.0000
RET (2)	-0.298678	0.0000
RSTUSA (-1)	0.029196	0.0001
R	0.96	
Adj R	(0.96)	
DW	1.94	

Notes: the data is presented as follows RST represents the short rate followed by an abbreviation or acronym of the name of the country. This also follows the numbers of lags RET is the auto-regression process expected short rate. R-squared is denoted as R and its adjusted R^2 is denoted as Adj R. DW is the Durbin-Watson

Table 9: effect of past expected rates in emerging market economy

	Greece	
Variable	Coefficient	probability
C	0.001484	0.4220
RET (1)	0.974701	0.0000
RSTGR (-1)	0.007897	0.7335
R	0.95	
Adj R	(0.95)	
DW	1.77	
	Israel	
Variable	Coefficient	probability
C	0.001607	0.0379
RET (1)	0.977468	0.0000
RSTI (-1)	-0.007618	0.1705
R	0.96	
Adj R	(0.96)	
DW	1.40	
	Mexico	
Variable	Coefficient	probability
C	0.005100	0.1319
RSTMEX (-1)	0.078854	0.0270
AR (1)	0.670075	0.0000
AR (2)	0.202389	0.0381
R	0.87	
Adj R	(0.87)	
DW	1.74	
	Poland	
Variable	Coefficient	probability
C	0.006246	0.0000
RSTPOL (-1)	0.072423	0.0000
AR (1)	1.289576	0.0000
AR (2)	-0.475212	0.0000
R	0.97	
Adj R	(0.97)	
DW	2.08	
	South Africa	
Variable	Coefficient	probability
C	0.001093	0.0188
RET (1)	1.264519	0.0000
RET (2)	-0.294358	0.0000
RSTSA (-1)	0.020405	0.0000
C	0.001093	0.0188
R	0.99	
Adj R	(0.99)	
DW	1.94	

Notes: the data is presented as follows RST represents the short rate followed by an abbreviation or acronym of the name of the country. This also follows the numbers of lags RET is the auto-regression process expected short rate. R-squared is denoted as R and its adjusted R^2 is denoted as Adj R. DW is the Durbin-Watson

What happens to the effect of credibility when central banks add or remove its own currency to the economy? How does it affect the expected rate over the regime changes introduced by central banks? Equation (6) explains the questions at hand. The board money supply is introduced to express the supply or removal of money to the economy. Historical expected rates are also used to account for previous expectations thus carrying some explanatory power for the current expected rate, it is also applied to equation 6.

The money supply measured in this paper is the supply of money which includes currency in circulation, short-term deposits in banks and money market funds of a maturity of less than twenty-four-hours and longer-term time deposits and money market funds with a maturity greater than 24 hours. The is sourced as the log difference of money supply to remove remain within the parameters of computing non-negative values. The period runs from 1975 to 2015 however in some countries, the data is not fully supplied to that extent. Therefore, we consider the period over a minimum of a regime change between the current and one which was previously implemented. The objective of this model is to evaluate whether there is a significant impact of money supply to expected short rates. The results are presented in table 10 and table 11

The results presented in tables 10 and 11 examine the impact of money supply to expected rates. The implication of the money supply present coefficients with probabilities that are insignificant. The DW is still held at values close to two which imply no presence of auto-correlation. The R-squared and adjusted R-squared as mentioned above, is the proportion of variation of the actual yield changes. In the results, the R-squared and adjusted R-squared still hold

Money supply is insignificants to expected rates. This implies the role market efficiency plays with the information available where it can expect the circulation of money supply. As discussed earlier, the variables expected rates and money supply are endogenous and thus its significance to predictability is ambiguous.

Table 10: effect of money supply in advanced market economy

	Canada	
Variable	Coefficient	probability
C	-0.000480	0.1687
RET (-1)	0.995776	0.0000
DLMSCAN (-1)	0.007742	0.0034
R	0.99	
Adj R	(0.99)	
DW	1.45	
	France	
Variable	Coefficient	probability
C	5.47E-05	0.9363
RET (-1)	1.170651	0.0000
RET (-2)	-0.177697	0.0063
DLMSFRA (-1)	0.005790	0.4053
R	0.99	
Adj R	(0.99)	
DW	2.008	
	Japan	
Variable	Coefficient	probability
C	0.000080	0.9453
RET (-1)	1.004993	0.0000
DLMSJPN (-1)	0.000190	0.8783
R	0.99	
Adj R	(0.99)	
DW	2.10	
	United Kingdom	
Variable	Coefficient	probability
C	-6.75E-05	0.8223
RET (-1)	1.293414	0.0000
RET (-2)	-0.448261	0.0000
RET (-3)	0.145298	0.0086
DLMSUK (-1)	0.005090	0.0369
R	0.99	
Adj R	(0.99)	
DW	1.98	
	United States of America	
Variable	Coefficient	probability
C	-0.000190	0.6091
RET (-1)	0.993975	0.0000
DLMSUSA (-1)	0.007921	0.0552
R	0.99	
Adj R	(0.99)	
DW	1.44	

Notes: the data is presented as follows RET represents the lagged expected short rate. DLMS is the log difference of money supply followed by an abbreviation or acronym of the name of the country. R-squared is denoted as R and its adjusted R^2 is denoted as Adj R. DW is the Durbin-Watson

Table 11: effect of money supply in emerging market economy

Greece

Variable	Coefficient	probability
C	0.003829	0.0260
RET (-1)	0.954832	0.0000
DLMSGR (-1)	-0.012493	0.0302
R	0.95	
Adj R	(0.95)	
DW	1.81	

Israel

Variable	Coefficient	probability
C	0.000472	0.7013
RET (-1)	1.348387	0.0000
RET (-2)	-0.587801	0.0000
RET (-3)	0.223279	0.0017
DLMSI (-1)	0.004210	0.4069
R	0.96	
Adj R	(0.96)	
DW	1.99	

Mexico

Variable	Coefficient	probability
C	0.004523	0.2741
RET (-1)	0.938680	0.0000
DLMSMEX (-1)	-0.001910	0.9343
R	0.86	
Adj R	(0.86)	
DW	2.20	

Poland

Variable	Coefficient	probability
C	0.001970	0.1131
RET (-1)	1.396936	0.0000
RET (-2)	-0.435258	0.0000
DLMSPOL (-1)	-0.031231	0.0404
DLMSPOL (-2)	0.031923	0.0328
R	0.97	
Adj R	(0.97)	
DW	1.99	

South Africa

Variable	Coefficient	probability
C	0.000114	0.8300
RET (-1)	1.309374	0.0000
RET (-2)	-0.426229	0.0000
RET (-3)	0.106420	0.0100
R	0.99	
Adj R	(0.99)	
DW	1.98	

Notes: the data is presented as follows RET represents the lagged expected short rate. DLMS is the log difference of money supply followed by an abbreviation or acronym of the name of the country. R-squared is denoted as R and its adjusted R^2 is denoted as Adj R. DW is the Durbin-Watson

Chapter 5: conclusion

Measuring the credibility of central banks relies much on the past information and current announcements of central banks. Particularly, the short rate and historic expected short rates are instruments where future expected rates may be computed. The instrument is evidently under the central banks control used to implement changes in the stance of the policy or regime.

The spread allows one to determine future expected rates and to compute a measure for credibility. Credibility has been proven to be greater than its null hypothesis. However, this is only applicable in cases where central banks have not reached their zero lower bound. It is important to note that credibility must be measured in a way that does not create any biased conditions. Therefore, autocorrelation should not be present as this invites a biased output bought by long-term interest rates. During the crisis, the impact of the crisis weakened the credibility of central banks resulting to weaker reliance on central banks of both markets. This proves that agent's expectations are dependent upon the announcement or actions of central banks.

A consequence to the crisis is how most advanced economies such as the Federal Reserve, Japan, Bank of England other European economies have relied on unconventional policy tools such as quantitative easing where purchases of large-scaled assets. A question arises if it is coping in terms of its flexibility to adjust to any impact? The result is presented from Japan where the impression of the policy requires much planning and precision. This implies that any impact may hinder its policy more resulting to a further weaker magnitude of credibility as proven during the crisis. This constant cash injection to the economy stimulates the economy however jeopardises the solvency of the central bank at risk

The relationship of historic expected rates on the expected rates makes use of autoregressive models. Where the null hypothesis was proven to be stationary, the dependency of historic expected rates proved to affect the expected rate. The effect decays with a lag. This was true for some countries. A stationary autoregressive model further proves the expectations hypothesis that agents are reliant on past events or actions of the central bank. Thus, credibility is proven to be significant and frequent. The changes bought by the financial crisis proves to influence central bank credibility where OLS estimation find that the decrease in monetary actions implies a loss of efficiency

The relationship of money supply and expected rates show that money supply has an impact on expected rates. The reaction also express that money supply decays over time and thus the expected rate is dependent on it. On a more practical note events of the crisis have also presented how fiscal involvement is in advanced economies and emerging market economies. Both of the fiscal involvement are different. In advanced economies, the need for flexibility exists in cases where quantitative easing was introduced under zero lower bound conditions. In emerging market economies, a need for more stringent policies exists to make central banks more credible. This is due to its reliance on central banks in other markets such the foreign exchange market (Mallick and Sousa, 2012). A closer speculation of money supply should be considered as this may affect the bond market's choice to purchase or sell.

In comparison with other studies the results interpreted seem to express the behaviour as in Mankiw and Miron (1986) where a stochastic or a random walk due to the changes of central banks change (or rather) reduce the predicative power. By drastically lowering interest rates in 2002, this action caused a stochastic change that was unfavourable globally and called on the reliance of unconventional policies and government intervention. To recommend, central banks must be able to strike a good balance between the credibility of its announcements and the flexibility to adjust to unanticipated events

Reference list

Aag, H. E. W. (2006). The Report of the Research Working Party on Correlations and Dependencies Among All Risk Sources Part 4 Serial Correlations of Interest and Inflation Rates. In The Casualty Actuarial Society Forum Winter 2006 Edition (p. 255).

Agbetsiafa, D. K. (2011). The recent global financial crisis: Impacts on selected developing regions. The International Business & Economics Research Journal, 10(10), 93.

Balduzzi, P., Bertola, G., Foresi, S., & Klapper, L. (1997). Interest rate targeting and the dynamics of short-term rates (No. w5944). National Bureau of Economic Research.

Bean, C., Broda, C., Ito, T., & Kroszner, R. (2015). Low for long? Causes and consequences of persistently low interest rates. Geneva Reports on the World Economy, 17.

Bekaert, G., & Hodrick, R. J. (2001). Expectations hypotheses tests. The journal of finance, 56(4), 1357-1394.

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.

Bernanke, B., Reinhart, V., & Sack, B. (2004). Monetary policy alternatives at the zero bound: An empirical assessment. Brookings papers on economic activity, 2004(2), 1-100.

Blanchard, O., Dell'Ariccia, G., & Mauro, P. (2010). Rethinking macroeconomic policy. Journal of Money, Credit and Banking, 42(s1), 199-215.

Blinder, A. S. (1999). Central bank credibility: why do we care? How do we build it? (No. w7161). National bureau of economic research.

Boero, G., & Torricelli, C. (2002). The information in the term structure of German interest rates. The European Journal of Finance, 8(1), 21-45.

Bordo, M. D., & Schwartz, A. J. (1999). Monetary policy regimes and economic performance: the historical record. Handbook of macroeconomics, 1, 149-234.

Campbell, J. Y., & Shiller, R. J. (1991). Yield spreads and interest rate movements: A bird's eye view. The Review of Economic Studies, 58(3), 495-514.

Cornell, B. (1983). The money supply announcements puzzle: Review and interpretation. *The American Economic Review*, *73*(4), 644-657.

Cox, J. C., Ingersoll Jr, J. E., & Ross, S. A. (1985). A theory of the term structure of interest rates. Econometrica: Journal of the Econometric Society, 385-407.

Cukierman, A. (2013). Monetary policy and institutions before, during, and after the global financial crisis. Journal of Financial Stability, 9(3), 373-384.

Curdia, V., Ferrero, A., & Chen, H. (2012). The macroeconomic effects of large-scale asset purchase programs. In *2012 Meeting Papers* (No. 372). Society for Economic Dynamics.

Dewachter, H., & Lyrio, M. (2008). Learning, macroeconomic dynamics and the term structure of interest rates. In *Asset Prices and Monetary Policy* (pp. 191-245). University of Chicago Press.

Dooley, M., & Hutchison, M. (2009). Transmission of the US subprime crisis to emerging markets: Evidence on the decoupling–recoupling hypothesis. Journal of International Money and Finance, 28(8), 1331-1349.

Drakos, K. (2001). Monetary policy and the yield curve in an emerging market: the Greek case. Emerging Markets Review, 2(3), 244-262.

Duffy, J., & Heinemann, F. (2014). Central bank reputation, cheap talk and transparency as substitutes for commitment: Experimental Evidence. manuscript, June.

Dziwum, I. R., & Green, E. M. (1996). Interest rate expectations and the shape of the yield curve.

Engle, R. F., Lilien, D. M., & Robins, R. P. (1987). Estimating time varying risk premia in the term structure: the ARCH-M model. Econometrica: Journal of the Econometric Society, 391-407.

Engsted, T., & Tanggaard, C. (1994). Cointegration and the US term structure. Journal of Banking & Finance, 18(1), 167-181.

Fama, E. F. (1984). The information in the term structure. Journal of financial economics, 13(4), 509-528.
Frank, N., & Hesse, H. (2009). Financial spillovers to emerging markets during the global financial crisis (No. 9-104). International Monetary Fund.
Froot, K. A. (1989). New hope for the expectations hypothesis of the term structure of interest rates. The Journal of Finance, 44(2), 283-305.
Garfinkel, M. R., & Oh, S. (1995). When and how much to talk credibility and flexibility in monetary policy with private information. Journal of Monetary Economics, 35(2), 341-357.
Grunberg, E., & Modigliani, F. (1954). The predictability of social events. Journal of Political Economy, 62(6), 465-478.
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.
Ho, T. S., & LEE, S. B. (1986). Term structure movements and pricing interest rate contingent claims. *the Journal of Finance*, *41*(5), 1011-1029.
Ho, T. S., & LEE, S. B. (1986). Term structure movements and pricing interest rate contingent claims. the Journal of Finance, 41(5), 1011-1029.
Johannes, M. (2004). The Statistical and Economic Role of Jumps in Continuous-Time Interest Rate Models. *The Journal of Finance*, *59*(1), 227-260.
Joyce, M., Lasaosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. International Journal of Central Banking, 7(3), 113-161.
Kim, D. H., & Orphanides, A. (2007). The bond market term premium: what is it, and how can we measure it?. BIS Quarterly Review, June.
King, R. G., & Kurmann, A. (2002). Expectations and the term structure of interest rates: Evidence and implications.
Klau, M., & Mohanty, M. S. (2004). Monetary policy rules in emerging market economies: issues and evidence.
Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The effects of quantitative easing on interest rates: channels and implications for policy (No. w17555). National Bureau of Economic Research.
Kydland, F. E., & Prescott, E. C. (1977). Rules rather than discretion: The inconsistency of optimal plans. The journal of political Economy, 473-491.
Labonte, M., & Makinen, G. E. (2008). Monetary policy and the Federal Reserve: current policy and conditions. Congressional Research Service, Library of Congress.
Mallick, S. K., & Sousa, R. M. (2012). Real effects of monetary policy in large emerging economies. *Macroeconomic Dynamics*, *16*(S2), 190-212.
Mankiw, N. G., & Miron, J. A. (1986). The changing behavior 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 interest rates?.
McCallum, B. T. (1994). Monetary policy and the term structure of interest rates (No. w4938). National Bureau of Economic Research.
Mishkin, F. S. (1982). Monetary Policy and Short-term Interest Rates: An Efficient Markets-Rational Expectations Approach. The Journal of Finance, 37(1), 63-72.
Mishkin, F. S. (1989). The information in the longer maturity term structure about future inflation (No. w3126). National Bureau of Economic Research.
Mishkin, F. S. (1999). International experiences with different monetary policy regimes). Any views expressed in this paper are those of the author only and not those of Columbia University or the National Bureau of Economic Research. Journal of monetary economics, 43(3), 579-605.
Mishkin, F. S. (2007). A rational expectations approach to macroeconometrics: Testing policy ineffectiveness and efficient-markets models. University of Chicago Press.

Muth, J. F. (1961). Rational expectations and the theory of price movements. Econometrica: Journal of the Econometric Society, 315-335.
Paquette, J. Y., & Stréliski, D. (1998). The use of forward rate agreements in Canada. Bank of Canada Review, 1998(Spring), 57-71.
Pfann, G. A., Schotman, P. C., & Tschernig, R. (1996). Nonlinear interest rate dynamics and implications for the term structure. *Journal of Econometrics*, *74*(1), 149-176.
Rasche, R., & Williams, M. M. (2005). The effectiveness of monetary policy. FRB of St. Louis Working Paper No.
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, S. K. (1970). Intracranial self-stimulation and wakefulness: effect of manipulating ambient brain catecholamines. Science, 168(3937), 1370-1372.
Rosenberg, I. (2007). Riksbank to introduce own path for the repo rate. *speech on January*, *17*, 2007Schuknecht, L., Hagen, J. V., & Wolswijk, G. (2010). Government bond risk premiums in the EU revisited: The Impact of the financial crisis.
Rudebusch, G. D. (1995). Federal Reserve interest rate targeting, rational expectations, and the term structure. Journal of monetary Economics, 35(2), 245-274.
Rules, O. A. T., & Orphanides, A. (2007). Finance and Economics Discussion Series Divisions of Research & Statistics and Monetary Affairs Federal Reserve Board. Washington, DC, January.
Sargent, T. J., & Wallace, N. (1976). Rational expectations and the theory of economic policy. Journal of Monetary economics, 2(2), 169-183.
Sarno, L., Thornton, D. L., & Valente, G. (2007). The Empirical Failure of the Expectations Hypothesis of the Term Structure of Bond Yields (Digest Summary). Journal of Financial and Quantitative Analysis, 42(1), 81-100.
Saunders, M. N. (2011). Research methods for business students, 5/e. Pearson Education India.
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), 173-223.
Sobrun, J., & Turner, P. (2015). Bond markets and monetary policy dilemmas for the emerging markets.
Steeley, J. M. (2008). Testing term structure estimation methods: Evidence from the UK STRIPs market. *Journal of Money, Credit and Banking*, *40*(7), 1489-1512.
Stešević, I. (2008). Econometric model of interest rates on deposits in Montenegro. Panoeconomicus, 55(3), 383-398.
Taylor, J. B. (1993). Discretion versus policy rules in practice. In Carnegie-Rochester conference series on public policy (Vol. 39, pp. 195-214). North-Holland.
Taylor, J. B. (1995). Monetary policy implications of greater fiscal discipline. Budget deficits and debt: issues and options, 151-70.
Taylor, J. B. (2001). The role of the exchange rate in monetary-policy rules. The American Economic Review, 91(2), 263-267.
Wu, J. C., & Xia, F. D. (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. Journal of Money, Credit and Banking, 48(2-3), 253-291.