INFLATION TARGETING FRAMEWORK AND INTEREST RATES TRANSMISSION IN GHANA

BY

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DECLARATION

I hereby declare that the submission is my own work towards the Master of Philosophy Economics and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text

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DEDICATION

This study is dedicated to my parents, Mr. Simon Mensah, Madam Akua Serwaa and the entire family for their support in diverse ways.

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ABSTRACT

The economy of Ghana has been struggling with high levels of inflation since the 1980's with 1983 recording 123%. The Bank of Ghana (BoG) in order to manage the domestic economy adopted the Inflation Targeting (IT) policy in 2002 focusing on price stability as practiced in some advanced countries. The IT policy has proved successful in a drastic decline of inflation to a single digit over the short term of implementation although the medium term goal of 5% is yet to be achieved. This notwithstanding, the level of interest rates in the economy have stayed relatively high raising questions about the effectiveness of the IT policy on interest rates that directly influences savings, investment, consumption and output. This study examines the transmission of monetary policy to lending, deposit and money market interest rates in the financial market since the adoption of the IT policy in 2002 (i.e., from 2002 to 2010). Co-integration methodology is adopted for the study. Given this, we have used three unit root test (Augmented Dickey-Fuller (ADF) test, Dickey Fuller Generalized Least Squares (DF-GLS) and the Phillips-Perron (PP) test) to determine the unit root properties of the series. The results show that all the series are stationary only after first differencing. Following this, we adopted two co-integration approaches (Johansen and Engle-Granger); all of them indicating that the models estimated are co-integrated. This result is also confirmed when we estimate an error correction model where the error correction term is negative and highly significance for all estimated models. The long run estimates show incomplete pass-through of the prime rate to deposit interest rate, almost complete pass-through in the in the interbank market and over pass-through in the money market interest rates (91-day Treasury bill and 182-day Treasury bill). The relatively high market interest rates against the deposit rates of commercial banks show evidence of crowding out of private investment in the economy. The stickiness of interest rate in the market is highly attributed to information asymmetry and uncompetitiveness of commercial banks. There is the need to improve upon

information flow through public announcement of monetary policy changes by the regular press conferences, publications and commitment by policy makers to achieve the yearly inflation targets. This will improve the confidence of economic agents in the IT policy. Depreciation of the cedi, rising public debt, and supply shocks which play major role in reviewing the prime rate upward in response to inflationary pressures needs attention by the policy makers to stabilize inflation and interest rates. The raising of money market interest rate by policy makers to finance maturing debts and project is responsible for crowding out of private investment in the economy. The market forces should be allowed to determine interest rate to curtail the situation of crowding out private investment in the domestic economy by reducing the Public Sector Borrowing Requirement (PSBR). These measures will improve the performance of the IT policy in Ghana.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Central banks of developing countries are turning formally to inflation targeting as an anchor for monetary policy. For the last two decades, such targets have been introduced by a number of advanced countries, in most cases with relatively good results. Amongst these countries are mentioned; New Zealand, Czech Republic, the United Kingdom, Canada, Israel, Sweden, Turkey etc. As explained by Guy et al. (1998), many of these advanced economies have begun to focus on the inflation rate itself instead of the traditionally used intermediate targets. This approach of controlling inflation through monetary policy is known as Inflation Targeting (IT). Although these countries have followed only inflation targeting, the European Central Bank opted for a more varied approach in which both the inflation and money supply were targeted, with due recognition of an important role for a number of other monetary aggregates emphasized by Stals (1999).

The reliance on the conventional intermediate targets such as money supply, interest rate or exchange rates was due to experience and convenience in most countries to conducting their monetary policy. The use of the money supply as an anchor for monetary policy for example was based on the assumption that there is some stable relationship between changes in the money supply and inflation (Stals, 1999). Monetary policy was thus directed towards controlling the rate of expansion in the money supply as an intermediate objective, with the goal of stabilizing the economy. To achieve the intermediate objective, the central bank uses various operational instruments such as open market operation, cash reserve ratio, prime rate and changes in the discount rate to influence the amount of liquidity in the banking sector and the level of short-term interest rates. The use of inflation to anchor monetary policy focuses on monetary aggregates as the intermediate objective to achieve the ultimate goal which is the inflation target.

Arguments raised by monetary authorities in these advanced countries for the IT policy include the decision to achieve price stability given that low and steady inflation rate contributes more to economic growth. Also, practical experience has demonstrated that short-term manipulation of money supply to achieve other goals: higher employment or perhaps enhance output may conflict with price stability. Central banks often appear to get more public criticism for rising inflation rate than to lower ones, although they are at the same time subject to constant pressure to reduce unemployment and/or increase output. IT policy helps to address this asymmetry by making inflation rather than employment, output, or some other criteria the primary objective of monetary policy (Guy et al. 1998).

The conduct of the IT policy is straight forward in theory. The central bank forecasts the future path of inflation; the forecast is compared with the target inflation rate (i.e., the inflation rate the government believes is appropriate for the economy); the difference between the forecast and the target determines how monetary policy has to be adjusted. Inflation targeting central banks believe the IT policy has the ability to improve the performance of monetary policy compared with the conventional procedures followed by non-inflationary central banks.

Ghana formally adopted an inflation targeting framework for its monetary policy which announced price stability as the central bank's primary objective in May, 2007 although implicit targeting actually started in 2002 (Mauren, 2+008). The Bank of Ghana (BoG) Act 2002 gave operational independence to the central bank, established an implicit (without formal announcement) IT framework and established a Monetary Policy Committee (MPC) for the implementation of the new policy. Under Ghana's IT policy, the monetary and fiscal authorities are jointly committed to price stability as the primary goal of Ghana's monetary policy. The numerical target range for inflation is announced in the annual budget. The goal and decisions of the MPC are communicated on regular basis to the general public. The BoG sets a medium-term goal of 5% inflation within a band of +/- 1

percent, along with some intermediate inflation-reduction targets (Alichi et al. 2009). The transparency of this monetary policy enforces greater degree of accountability on the part of the bank of Ghana in reaching the annual inflation targets.

According to the BoG, the anchor of the new macroeconomic framework was a reduction in domestic debt. This has seen domestic debt to GDP decreased from about 31% in 2001 to 13.5% in 2006. Also the nation saw inflation plunge from about 62% in 2001 to around 12.7% in 2006 (see, Burke, 2008). Ghana's five-year success with implicit inflation targeting encouraged the government to formally adopt the policy in 2007.

The broad objective is to maintain single digit inflation to achieve economic stability to facilitate output growth and employment. The BoG Act made the Bank independent to regulate interest rates through the prime rate. The single digit inflation target is expressed in terms of an annual rate of inflation based on the Consumer Prices Index (CPI). Although the Bank is not bound by law to explain to the Ministry of Finance or to parliament if the target is not achieved, the Governor may be summoned to the Finance Committee of parliament to explain developments within the economy. Though single digit inflation is desired, the economy is subject to shocks that can cause unnecessary uncertainty and volatility. When inflation stays above target for some obvious reasons, the MPC's aim would be to determine the prime rate so that inflation can be brought back to its target level within a reasonable period through other interest rates in the market.

As noted by Ampong (2005), the government manages the economy through the combined action of fiscal and monetary policies. The government keeps control of the public expenditure, since it is the responsibility of the government to create public goods and improve the welfare of society. To ensure that the objectives of the central bank are in line with that of the government for a sustained economic growth, the government sets an inflation target for the monetary policy in the annual budget.

1.2 Statement of the problem

The BoG as part of its role to stimulate economic growth is pursuing policies to reduce interest rate in the financial market. High level of interest rate is a disincentive to borrowing and hence impeding investment. Fluctuation in interest rate creates uncertainty in the business environment reducing the level investment by firms.

The BoG - the regulator of the financial sector in the country- has been appealing to commercial banks to address high interest rates in the economy but no major achievement has been made so far. The reduction would facilitate rapid economic growth and provide a conducive atmosphere for trade, commerce and employment. The BoG reviews the prime rate in response to inflationary pressures under the Inflation Targeting (IT) policy to stabilize the economy but in the past years, interest rates by the commercial banks continue to remain high despite a decline in the prime rate of the BoG.

The BoG lends to the regulated commercials banks at the prime rate and also uses the prime rate to communicate its stance on inflation to the general public. In a liberalized financial system, the central bank can influence market interest rates only through the prime rate. If the BoG reduces its prime rate, commercial banks lending rates are expected to reduce accordingly because funds have become cheaper. This has however not been, quite clearly, the case in Ghana. The problem with the interest rate transmission in Ghana is that, market rates do respond slowly to the prime rate thus questioning the effectiveness of the IT policy. Adjimah (2011) reported that, the prime rate dropped from 27.5% to 12.5% within the period of March, 2003 to August, 2007 since inflation pressures eased down but average lending rate still hovered around 31% during the same period. Lending rates remained in the range of 20 – 35% among commercial banks. On the other hand, the commercial banks are quick to reduce interest rate on deposits following a reduction prime rate. There were fixed deposits paying about 28% when the prime rate was 18.5% but those rates

dropped to about 12% as the prime rate was reduced to 13.5%. These raise a lot of questions on commercial banks lending and deposit rates response to the changes in the prime rate.

Over an appreciable period, inflation declined continuously to single digit of 8.39% from 20.5% within the period of 2009 and 2011 which is supposed to reduce the risk expectation in order to reduce lending rates. However, commercial banks interest rates have not responded to as expected. Despite the considerable fall in the inflation rate and the prime rate, commercial banks lend at high interest rates to investors. This questions the effectiveness of the prime rate in influencing lending rates in the economy.

The reliance on monetary policy as a means of controlling inflation has been considered as good mechanism to reduce interest rate among the advanced economies. The reduction in the prime rate directly leads to the fall in interbank rates leading to a considerable low interest rate in the economy. As noted earlier, the situation has been different in Ghana. The rates on deposit accounts and interbank's rates falls directly with the prime rate but lending rates turns to be sticky downwards. Commercial banks have always attributed these anomalies to default risk associated with loans. For the IT as monetary policy to necessitate investment and facilitate economic growth, it should be effective on movement in financial market interest rates and credit creation in the Ghanaian economy.

Although the implementation of IT policy in Ghana has seen gradual fall of the previously high inflation rate in the Ghanaian economy to single digit, interest rates have not responded to such a degree. There is therefore the need to investigate the responsiveness of financial market interest rates to prime rate in the economy of Ghana.

1.3 Study objectives

The objective of this study is to examine the influence of the IT policy on the financial market interest rates in the Ghanaian economy since its inception. The main variables of interest under such monetary policy are the prime rate, short term money market interest rates, commercial banks base lending and deposit rates. We therefore, measure the responsiveness of these financial market interest rates to the central bank's prime rate. In an attempt to meet the broad objective of the study, the following specific objectives would also be sought:

1) To measure the responsiveness of money market interest rates to the prime rate in an inflation targeting regime.

2) To measure the significance of the prime rate in determining the commercial banks' lending rate and determine the rate of transmission between them.

3) To estimate the responsiveness of the prime rate on retail deposit interest rates of the commercial banks.

(4) To analyse the significance of information asymmetry in the adjustment process of the financial market interest rates in Ghana.

1.4 Hypothesis testing

In view of the tentative questions raised in the problem statement, the following hypotheses will be tested in the study to determine the sensitivity of market interest rates and banks' lending rates to the prime rate under the IT policy regime. The study seeks to validate the following empirical hypotheses:

(1) The Money market interest rates tend to be more responsive to the prime rate with anchored expectations.

(2) The prime rate takes much time in transmission to commercial banks lending rate if it is significant.

(3) The prime rate is not significant in determining the retail deposit interest rate.

(4) Information asymmetry contributes significantly to the stickiness of financial market interest rate in Ghana.

1.5 Justification of the study

Inflation targeting is increasingly seen as the 'best practice' for central bank policy in many economies around the world, including a growing number of developing countries. To date, the IT policy has not made inroads into sub-Saharan African economies, with only Ghana and South Africa having formally adopted this policy regime (Heintz & Ndikumana, 2010). Many empirical studies have focused on advanced countries with results rarely found in developing countries due to few countries adopting the IT policy.

Theoretically, it has been established that inflation causes many distortions in an economy, when prices of consumables increase, real income of households decreases and hence, they cannot buy as much as they used to buy previously. In the long-run, therefore, inflation reduces economic growth and purchasing power because the economy needs a certain level of savings to finance investment projects which stimulate economic growth and improve people's living standards. Consumption, Savings and investment depends on the level and volatility of interest rates in the economy in the inflation targeting regime.

There is a link between the responses of interest rates to changes in monetary policy. The anchoring of inflationary expectations has been an element in the debate in recent times over the desirability of moving to an inflation targeting framework in Ghana. Bernanke (2004) has argued, "The apparently high sensitivity of long-term nominal interest rates to Fed actions suggests some

uncertainty about the Fed's long-run inflation target". Anchoring long-term inflationary expectations reduces its volatility and makes it easier for businesses and investors to draw long-term contracts. One reason for decreased volatility would be that with long-term inflationary expectations anchored by a credible inflation targeting regime, long-term rates would respond by less to monetary policy induced changes in short-term rates (Hakan & Froyen, 2009). Therefore, this study seeks to analyze the response of various financial market interest rates in the IT regime in Ghana.

1.6 Organization of the study

The study is organized under five chapters. Chapter one presents the general background issues and provides an overview of monetary policy and inflation targeting in Ghana. The chapter also provides the problem statement, the objectives and also sets out the hypothess of the study. Again, it offers an introduction to the methods of the study and gives justification to the study. The next chapter presents a review of what various literatures have found with regards to the IT policy. Both theoretical and empirical issues are reviewed in this chapter. Chapter three discusses the methods employed in the study and also presents the description and sources of the data. Chapter four encompasses the presentation and analysis of the empirical results obtained from the regressions. The final chapter, which is chapter five summarizes the main findings of the study, discusses the policy implications and recommendations for Ghana's policy makers. Acknowledgment of the limitations of the study is also included in this chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses relevant definitions, concepts and theories that examine the impact of monetary policy on interest rates. The chapter also takes a look at a number of empirical works done on the impact of the inflation targeting monetary policy variables on interest rates.

2.2 Theoretical review

This section reviews theoretical literature on the IT policy and interest rates. We explore various theories that explain the determination of interest rate in the financial market and give much attention to the inflation targeting as a framework of monetary policy in Ghana. The Taylor rule is used to explain the response function of central banks to inflationary pressures in the economy.

2.2.1 Interest rates determination

Interest rate which is expressed in percentage terms, is a fee paid on borrowed capital. In other words, it is a fee attached to financial instruments (Hemachandra, 2005). Many central banks use the interest rate both as a source of information in determining policies and as an operating instrument for conducting monetary policy. Interest rate mechanism among other instruments is used by central banks in achieving economic and financial stability.

According to classical theory, savings are generally invested through an interest rate mechanism. When savings are equal to investment, the equilibrium rate of interest is determined. It assumes a positive relationship between interest rate and savings and an inverse relationship between the interest rate and investment. One of the major policy instruments in the classical theory is interest rate.

In the Keynesian theory, the interest rate may not be determined by the equilibrium level of saving and investment. The process of interest rate determination was regarded purely as monetary

phenomenon. In this version, low interest rates were advocated to raise national income. A large number of developing countries followed these policies until McKinnon (1973) and Shaw (1973) presented their findings, recognizing high interest rates contributed to growth among some Asian economies.

Liberalization policies which came later did not allow controls on interest rates. McKinnon and Shaw (1973) presented a strong case against the low interest rate policy as advocated by neo-classical and Keynesian paradigms. According to the framework of McKinnon and Shaw (1973), the interest rate is positively associated with the savings, investment and economic growth. They assumed an increase in interest rates stimulates savings, especially bank deposits and thereby provides more investible funds thus leading to economic growth. They advocated the removal of interest rate ceilings but this is however not applicable to economies with poor saving culture due to lower incomes.

Later on, market failure school related equilibrium rate of interest to asymmetry of information. In this version, the government has to intervene to rectify market malpractices. Therefore, market failure school suggests having a government intervention in determining interest rates and efficient allocation of resources.

In the inflation targeting regime, the central bank's main policy instrument is the prime rate. The central bank manages liquidity actively through the prime rate which has direct impact in the money market interest (i.e., interest rate on securities and bonds). Changes in the prime rate influences short-term and long-term interest rate in the financial market. For a tight monetary policy, the prime rate is adjusted upward, thereby increasing the market interest rates and attracting funds from investors. This is to manage liquidity in the economy and control inflation. The prime rate also indicates the rate at which central banks lend to commercial banks when they are in financial stress. The commercial banks base lending rate will follow changes in the prime rate in an

efficient market system. Apart from macroeconomic factors, this base lending rate depends on the banks' costs of funds. Unlike money market interest rates, changes in bank base lending rates are in large part administratively determined, and occur relatively infrequently (Saunders and Schmeits, 2001). It should be recognised that the prime rate is only one facet of the cost of bank borrowing by commercial banks. Additional factors that affect the overall cost of borrowing include fees, transaction and operation cost, collateral, debt and default rate. Commercial banks do lend to themselves in the financial market over a short period of time and charge the interbank's rate. This rate is however influenced by the prime rate determined by central bank and is relatively higher than the prime rate. There is a presumption that the prime rate changes will influence the other short-term rates in the financial market; as changes in the official rate are the first step in the transmission of monetary policy.

2.2.2 Inflation targeting as a framework of monetary policy

Inflation targeting involves a formal declaration of an inflation target by the central bank. This target is most commonly a narrow range (band) of inflation rate or a specified number. Specifying the inflation target involves selecting a price index to define the target, setting the target in terms of the rate of inflation, giving the target a numerical value, deciding whether to define the target as a point or a band. The central bank then uses monetary tools, often the prime rate, in an attempt to keep inflation within the targeted range. The inflation targeting framework stresses on increase accountability of the central banks; the central bank must evaluate its performance in meeting the target and publicly disclose the reasons for any deviation. In some cases, the adoption of formal inflation targeting has also involved institutional and legal changes to increase the independence of the central bank (Epstein & Yeldan, 2008).The approach is characterised, as the name suggests by announcement of official target for inflation rate at one or more horizons and by explicit knowledge that low and stable inflation is the overriding goal of monetary policy as emphasized by Mishkin and Bennanki (1997). This strategy for monetary policy has sparked much interest and debate

among central bankers and monetary economist in recent years concerning their ability to control inflation and regulate interest rate. According to Mishkin (2001), Inflation targeting monetary policy strategy encompasses five main elements:

- The public announcement of medium-term numerical targets for inflation;
- An institutional commitment to price stability as the primary goal of monetary policy to which other goals are subordinated;
- An information inclusive strategy in which many variables, and not just monetary aggregates or the exchange rate, are used for deciding the setting of policy instruments;
- Increased transparency of the monetary policy strategy through communication with the public and the markets about the plans, objectives, and decisions of the monetary authorities; and
- Increased accountability of the central bank for attaining its inflation objectives.

Mishkin (2001) further explains, it entails much more than a public announcement of numerical targets for inflation for the years ahead. This is especially important in developing countries because many of these countries routinely report numerical inflation targets as part of the government's economic plan (budget) for the coming year and yet their monetary policy strategy should not be characterized as inflation targeting, which requires the other four elements for it to be sustainable over the medium term. The case in Ghana can be classified as formal inflation targeting since the Bank of Ghana commits to achieving the targets, communicates its stance on inflation through the prime rate in periodic press conferences.

What distinguishes inflation targeting from other ways of controlling inflation is that the adjustment of policy instruments relies on a systematic assessment of future (rather than past or current) inflation and not on an arbitrary assumption about future inflation. Inflation targeting means that monetary authorities explicitly specify the inflation target and establish precise institutional

arrangements to reach this target. Establishing the institutional arrangements makes it possible to integrate inflation targeting into the overall macroeconomic policy, and develop procedures to ensure its transparency and accountability. As illustrated in Mishkin and Posen (1997) and Bernanke et al., (1999), inflation-targeting central banks have frequent communications with the government, and their officials take every opportunity to make public speeches on their monetary policy strategy. Inflation targeting central banks go further to publish inflation reports to clearly present their views about the past and future performance of inflation and monetary policy.

It is argued, if inflation targets were strictly adhered to, inflation targeting would represent a form of rules-based central banking, in which the scope for discretion is limited. A common justification for limiting the discretionary scope of central banking is that policy makers may in their attempt to reach short-run objectives, increase inflation above a socially optimal level. The literature on the dynamic inconsistency of monetary policy, first advanced by Kydland and Prescott (1977), represents an influential theoretical expression of this argument. Economic agents rationally adapt their expectations in response to discretionary changes in monetary policy, eliminating any long-run impact on the real economy. In this framework, rules are preferable, since they eliminate the possibility that policy makers will respond erroneously to short-run incentives to boost growth or employment above a long-run equilibrium level. A crucial assumption is that individuals can distinguish monetary responses (due to central bank policy) from other economic factors (e.g., inflation due to supply-side shocks) in forming their expectations. In practice, inflation targeting is often not strictly rules-based, and has been referred to as a policy of 'constrained discretion' or as a monetary policy 'framework' (Bernanke et al., 1999, King, 2005). Effectively, this means that the targets represent rules that can be broken, but with a high degree of transparency and accountability. When inflation targeting central banks fail to meet the target, they must explain what happened. There is often a gap between the theory and the practice of inflation targeting, caused by external factors and unexpected changes in the macroeconomic environment.

Another justification for inflation targeting is that every economy needs a 'nominal anchor' which can serve as the basis for making economic decisions (Bernanke et al., 1999). Without an idea of what the average price level in an economy is and will likely be in the future, economic agents cannot accurately discern relative price movements and may make errors in allocating resources in response to changing prices. Historically, devices such as the gold standard provided this anchor. In the absence of a similar absolute standard, monetary policy must play this role and inflation targeting represents one option for establishing a nominal anchor for a market economy (Heintz & Ndikumana, 2010). By forecasting the inflation level for the economy and determining the path for inflation, the monetary authorities are able to manage expectation. Expectations play a central role in the motivation for inflation targeting policies. The central idea is that individual expectations will adapt to the targets announced by the central bank. The hope is that these expectations will then be incorporated into contracts, pricing practices, and collective bargaining agreements. The change in expectations and forward-looking institutional arrangements links the inertial component of inflation (i.e., inflationary pressures derived from previous inflation rates) to the inflation target. Unlike the use of other monetary tools to manage inflation, which often impose real economic costs from higher real interest rates to slower credit growth, the change in inertial inflation would not involve similar costs. Therefore, it is frequently argued that formal inflation targeting allows inflation to be controlled at lower cost than other approaches to monetary policy that focus on reducing inflation thus improving the confidence of economic agents in decisions making. However, whether inflation targeting actually changes expectations in a way which reduces the cost of lowering inflation remains uncertain. Heintz and Ndikumana (2010) emphasized, if inflation targeting does not have a significant impact on expectations, inflation targeting may not be overly distinct compared to monetary policy which simply attempts to reduce inflation, or sustain inflation at low levels as central banks in many African countries have specific inflation targets in their policy statements.

Based on other studies, it is not evident that inflation targeting significantly improves the performance of the real economy (Bernanke et al., 1999; Ball & Sheridan, 2005; Epstein, 2008) although there is some evidence that countries that have adopted inflation targeting have experienced reductions in inflation and lower volatility of inflation (Gonçalves & Salles, 2008). However, these results are sensitive to the controls used to ascertain the impact of inflation targeting and are strongest when inflation-targeting countries are compared to their own pre-targeting experience (Mishkin & Schmidt-Hebbel, 2007). Comparing the pre-targeting period with the post-targeting period may not capture the impact of inflation targeting per se, but rather a re-orientation of monetary policy towards lowering inflation. Comparisons between inflation targeting countries and non-targeting countries are weaker and, again, depend on the control group used. Inflation targeting requires that a decision be made on what price stability means in practice. A widely cited definition of price stability the rate of inflation that is sufficiently low that households and businesses do not have to take it into account in making everyday decisions (Mishkin, 2001). Although some economists such as Feldsteinp (1997) argued for a long-run inflation goal of zero but others such as Akerlof et al., (1996) argued that setting inflation too low produces inefficiency and will result in an increase in the natural rate of unemployment. The Akerlof et al., (1996) provide a stronger argument against setting the long-run inflation target at zero making deflations more likely and deflations can lead to financial instability and sharp economic contractions (Mishkin, 2001). In practice, all inflation targeters have chosen long-run inflation targets above zero, with point targets or midpoints of target ranges between 1 and 3% among industrial countries. Ghana and South Africa have their medium term goal of inflation to be 5% slightly above the advanced countries due to expenditure pattern and larger budget deficits associated with developing countries. Inflation targeters have also made their inflation targets symmetrical with the believe that undershoots of the targets are considered to be as costly as overshoots. Indeed, inflation targeters have argued that symmetrical inflation targeting helps central banks to stabilize real output, because

in the face of a weak economy, central banks can be more flexible in the conduct of monetary policy without being worried that the easing on monetary policy will cause inflation expectations to rise.

The common argument for conducting monetary policy so as to keep inflation in the lower single digits is that inflation is harmful to long-run growth. There are several reasons for this: inflation can raise transactions costs and may contribute to uncertainty about the future (Heintz & Ndikumana, 2010). However, there is no consensus in the literature that maintaining rates of inflation at a typical inflation targeting level (example around 5 percent) necessarily leads to faster growth. One early study of the relationship between inflation and growth across 127 countries found that growth rates declined only when inflation rates moved beyond 20-25 percent and that growth increased as inflation is in the 15-20 percent range (Bruno, 1995). Similarly, Bruno and Easterly (1998) reported that the negative relationship clearly manifests itself only when inflation exceeds 40 percent. These early estimates were based on combined data across all countries. However, the threshold at which inflation reduces growth appears to vary between developed and developing countries. Khan and Senhadji (2001) identify the threshold point at which inflation induces economic growth at 1 to 3 percent for developed economies, but the threshold point for developing countries is around 11 percent. Also, Pollin and Zhu (2006) found that higher inflation is associated with moderate gains in GDP growth up to 15-18 percent inflation, after which growth begins to decline. The results are more robust in developing countries relative to developed economies. Some researchers have found that the threshold at which inflation induces growth is in the single-digits (Ghosh & Phillips, 1998). These arguments explain why most inflation targeting countries prefer to set the range within single digits.

Inflation targeting has several advantages as a medium-term strategy for monetary policy. In contrast to an exchange rate peg and monetary targets, it enables monetary policy to focus on domestic considerations and respond to shocks to the domestic economy. In contrast to monetary

targeting, inflation targeting has the advantage that a stable relationship between money and inflation is not critical to its success: the strategy does not depend on such a relationship, but instead uses all available information to determine the best settings for the instruments of monetary policy. Inflation targeting also has the key advantage that it is easily understood by the public and is thus highly transparent (Mishkin, 2001). Proponents of inflation targeting policy (Bernanke et al., 1999; Nadal De Simone, 2001; Corbo, Landerretche, & Schmidt-Hebbel, 2002; Neumann an von Hagen, 2002; Hyvonen, 2004; IMF, 2005; Vega & Winkerlied, 2005; Mishkin & Schmidt-Hebbel, 2007) demonstrate empirically that inflation targeting is associated with an improvement in overall economic performance. According to these authors the rationale behind this success is that by targeting directly price, inflation target plays a role of explicit and a strong nominal anchor.

2.2.3 Requirement for a successful IT policy

For IT policy to be a success, it is important that certain preconditions be met before a decision is taken to implement this framework. In this regard it is important that a central bank is free to pursue financial stability. The inflation target may be jointly set by the government and the central bank. However, once the target has been determined the central bank should be free to use any instrument to achieve the ultimate objective (Muhanna, 2006). The following preconditions have been stated in theory:

- *Independence of the central bank*

We have stated earlier that for an Inflation targeting policy to be successful, there are some basic requirements that must be adhere to in the implementation process. A fundamental requirement is a central bank's ability to conduct monetary policy with some degree of independence (Guy et al. 1998). No central bank can be entirely independent of government influence, but it must be free in choosing the instruments to achieve the rate of inflation that the government deems appropriate. To

comply with this requirement, a country cannot exhibit symptoms of fiscal dominance (i.e., fiscal policy considerations cannot dictate monetary policy). Freedom from fiscal dominance implies that government borrowing from the central bank is low and that domestic financial markets have enough strength to absorb placements of public debt, such as treasury bills. It also implies that the government has a broad revenue base and does not have to rely systematically and significantly on revenues from seigniorage (i.e., revenues that accrue to the government from having the monopoly on issuing domestic money). If fiscal dominance exists, inflationary pressures of a fiscal origin will undermine the effectiveness of monetary policy by obliging the central bank to accommodate the demands of the government, by easing interest rates to achieve fiscal goals.

- *All other goals should subordinate the IT goal.*

Another requirement for inflation targeting to work is the willingness and ability of the monetary authorities not to target other indicators, such as wages, the level of employment, or the exchange rate. A country that chooses a fixed exchange rate system subordinates its monetary policy to the exchange rate objective and will be unable to operate an inflation-targeting system, especially when capital can move freely in and out of the country. The public will have no assurance that the authorities will give the inflation target precedence over the exchange rate target and the policy will not enjoy the credibility needed for its success. Many researchers have documented the importance of exchange rate pass-through and the price of imports in influencing inflationary dynamics. For example, Oladipo (2007) showed that there was significant although imperfect pass-through for a variety of products in Nigeria. Therefore, changes in the nominal exchange rate will impact inflation. Nell (2004) presents evidence suggesting that inflation dynamics in South Africa have been influenced by imported inflation, particularly after 1987. The importance of exchange rate pass-through suggests that inflation dynamics would differ in countries with a fixed exchange rate regime relative to countries with more flexible exchange rates making it difficult to forecast the path of inflation.

- *Financial markets and the banking system*

The success of inflation targeting monetary policy depends crucially on the mobility of capital and financial market development. Shallow capital markets which are common among developing countries are indication of fiscal dominance. They are often a by-product of government schemes to extract revenue from the financial system through various forms of financial repression, including interest rate ceilings, high reserve requirements, sectoral credit policies, and compulsory placements of public debt (Guy et al, 1998). In some low-income countries, undeveloped capital markets may be as much a cause as a consequence of fiscal dominance. There is an evidence of adverse relationship between financial repression and the development of domestic capital markets and the banking system. For the IT policy to be effective, it is necessary to create efficient financial market that will respond fully to the policy decisions of the central bank. The policy instruments generally used by monetary authorities require effective money, capital and banking system. If financial markets do not react quickly to the instruments applied, it obviously reduces the effectiveness of monetary policy and leads to a delay in influencing interest rate and inflation. Having satisfied these basic requirements, a country can in theory conduct a monetary policy centered on inflation targeting. In practice, the authorities also have to take certain preliminary steps. They must indicate clearly and unambiguously to the public that hitting the inflation target takes precedence over all other objectives of monetary policy. They must set up a model or methodology for inflation forecasting that uses a number of indicators containing information on future inflation. Finally, they must devise a forward-looking operating procedure in which monetary policy instruments are adjusted in line with the assessment of future inflation to hit the chosen target. The monetary authorities must have the technical and institutional capacity to model and forecast domestic inflation, know about the time lag between the adjustment of the monetary instruments and their effect on the inflation rate, and have a well-informed view of the relative effectiveness of the various instruments of monetary policy at their disposal.

2.2.4 Models of interest rate

- *Taylor Rule for interest rate determination*

The approach to policy analysis by central banks start in theory with the specification of the central bank's objective function and then derive the optimal rule for setting the prime rate. The best known rule for the specification f the prime rate is the Taylor Rule (Taylor, 1993a). Taylor showed that the behavior of the central banks in determining the prime rate could fairly be matched by a simple rule of the form

$$i_t = r^* + \alpha_y y_t + \alpha_\pi(\pi_t - \pi^T) + \pi_t \qquad (2.1)$$

where i_t is the short term nominal interest rate proxide by the prime rate, π^T is the target level of average inflation, r^* is the real interest rate at equilibrium, y_t is the output gap and π_t is the rate of inflation. The nominal interest rate (prime rate) deviates from the level consistent with the economy's equilibrium real rate and the target inflation if the output gap is nonzero or if inflation deviates from its target. A positive output gap leads to a rise in the nominal interest as does a deviation of actual inflation above the target. With Taylor's original co-efficient, $\alpha_\pi > 1$ implies the nominal interest rate is changed more than one-for-one with the deviations of the inflation from target. This gives the Taylor principle which states that a greater than one-for-one reaction of i_t ensures that the economy has unique rational expectations equilibrium.

Lansing and Trehan (2001), explores conditions under which the Taylor rule emerges as the fully optimal policy instrument rule under discretionary policy. A large literature has estimated Taylor rule for a variety of countries and time periods with mixed results. For example, Clarida et al., (2000) did so for the Federal Reserve, the Deutsche Bundesbank and the Bank of Japan. In their specification, actual inflation is replaced by expected future inflation so that the central bank is assumed to be forward-looking in setting the prime rate. Estimates for the Unite States under different Federal Reserve Chairmen were reported by Judd and Rudebusen (1997). In general, the basic Taylor rule, when supplemented by the addition of the lagged nominal rate, does better in

matching the actual behavior of the prime rate. However, Orphanides and Norden (2000) found that when estimated using data on output gap and inflation actually available at the time the policy actions were taken (using real time), the Taylor rule does poorly in matching U.S fund rate. Clarida et al. (2000) found that the Fed moved the fund rate less than one-for-one during the period 1960-1979 violating the Taylor principle.

A study by Perez (2001) found out that the when the Fed's reaction function is re-estimated using real time data, the co-efficient on inflation is greater than one satisfying the Taylor principle. Lubik and Shorfheide (2004) estimated a complete Dynamic Stochastic General Equilibrium (DSGE) new Keynesian model of the U.S economy and found evidence that Federal Reserve policy has been consistent with determinacy since 1982 but rather inconsistent prior to 1979. The Taylor rule therefore gives a general rule for the determination of the prime rate by central banks with enough evidence from advanced countries. Taylor rule is a monetary policy rule that stipulates how much the central bank should change the nominal interest rate in response to changes in inflation, output, or other economic conditions. In particular, the rule stipulates that for each one percent increase in inflation, the central bank should raise the nominal interest rate by more than one percentage point.

- *Interest rate rule and the price level*

Monetary policy can affect nominal interest rates, both in the short and long runs but the Fisher relationships links the real, expected inflation and the nominal rate of interest according to Walsh (2010). Targets for nominal interest rates and inflation cannot be independently chosen and controlling the nominal interest rate has important implication for the behavior of the aggregate price level. Walsh developed a simple model of the following form;

$$y_t = y^c + a(p_t - E_{t-1}p_t) + e_t \quad (2.2)$$

$$y_t = \alpha_o - \alpha_0 r_t + \mu_t \quad (2.3)$$

$$m_t - p_t = y_t - ci_t + \varepsilon_t \quad (2.4)$$

$$i_t = r_t + (E_t p_{t+1} - p_t) \quad (2.5)$$

where y, m, and p are natural log of output, the monetary stock and the price level respectively and r and i are the real and the nominal rates of interest, y^c and α_o represents the constants in the aggregate demand and aggregate supply models whilst e_t, μ_t, and ε_t are the error terms in the models respectively. Although central banks closely control the nominal interest i_t by setting the prime rate, it is the expected real interest rate, r that influences consumption and investment decisions and therefore aggregate demand. The distinction has important implication for the feasibility of an interest rate targeting rule. Suppose the central bank conducts policy by setting the nominal interest rate at some targeted value;

$$i_t = i^T \qquad (2.6)$$

The money demand equations (2.4) is no longer relevant because the central bank must allow the nominal money stock to adjust to the level of money demand at the targeted interest rate and the equilibrium level of output. It is worthy to note, the price level only appears in the form of an expectation error as $p_t - E_{t-1}p_t$ in the aggregate supply equation or an expected rate of change as $E_t p_{t+1} - p_t$ in the Fisher Equation implying that the price structure is indeterminate because of expected price in the next period can differ from its forecast. From (2.3), the equilibrium real interest is equal to $(\alpha_0 - y_t + \mu_t)/\alpha_1$. With expected inflation the same under either price sequence, the restriction on the price path is that the expected rate of inflation be such that

$i^T = (\alpha_0 - y_t + \mu_t)/\alpha_1 + E_t p_{t+1} - p_t$ at the equilibrium. The indeterminacy of price level is perhaps even more apparent if (2.2) – (2.5) are written explicitly in terms of the rate of inflation. By adding (p_{t-1}) and subtracting it from the supply function, the equilibrium conditions become

$$y_t = y^c + a(\pi_t - E_{t-1}\pi_t) + et \qquad (2.7)$$

$$y_t = \alpha_o - \alpha_0 r_t + \mu_t \qquad (2.8)$$

$$i^T = r_t + E_t\pi_{t+1} \qquad (2.9)$$

These three equations can be solved for output, the real rate of interest and the rate of inflation. Since the price level does not appear, it is formally indeterminate. In a forward- looking model, an

interest rate setting would also leave the inflation rate indeterminate. The final model expresses the prime rate set by the central bank in term of equilibrium real interest rate and the expected rate of inflation. In an inflation targeting regime the interest rate determines the path of inflation in achieving the goal of the monetary policy.

2.3 Empirical review

There are several empirical studies concerning this area of study. Most of them are concerned about how changes in the prime rate have influenced the behavior of macroeconomic variables, especially inflation, interest rate and bank credit. This is due to the special role prime rate play in managing price stability to ensure economic growth and development. Empirical estimates attempt to ascertain the effect of the prime rate on long term market interest rate, credit of banks, aggregate demand and have commented on the relationships between these variables. There have been diverse views concerning monetary policy transmission under inflation targeting regime.

Examples of such studies have been by Charoenseang and Pornkamol (2007) who investigated monetary policy transmission in an inflation targeting era in Thailand. Using time series data spanning from June 2000 to July 2006, the paper analyzed the relationship between the prime rate and selected interest rates employing Engle-Granger co-integration and the error- correction model. The selected interest rates were regressed on the prime rate set by the Bank of Thailand and its impact examined in a short and long term dynamics. The estimates showed that there is only a small pass-through effect of the prime rate to financial market interest rates. On the average, the commercial banks lending rate tend to adjust lower than the deposit rates. With asymmetric adjustment analysis, the lending rates take more time adjusting comparing with those of deposit rates. Moreover, they found no long-run relationship between the financial companies lending rate and the central bank's prime rate. However, the prime rate shows almost a complete pass-through effect of more than 96% on the interbank rate. This can be attributed to information asymmetry

between commercial banks and borrowers. This is the risk that the borrowers might engage in activities that are undesirable from the lender's point of view. The fear that borrowers will default payment leads to the larger margin between the prime rate and the bank's lending rate, Lender may decide to charge higher interest rate or will rather not make the loan to such borrowers.

The Bank of Zambia (BOZ) in 2010 studied how commercial banks determine lending interest rates in a survey. The objective of the survey was to identify the factors both quantitative and qualitative that commercial banks consider in making decision regarding their base lending rates. The survey used structured questionnaire over the period of 1ST March to 12th March 2010 in an interview between BOZ staff and 18 registered commercial banks. The research revealed that the interbank rate did not play any significant role in determining base lending rates. The prime rate which is expected to influence the interbank rate could not achieve the desire impact on the commercial bank lending rate. Half of the banks considered inflation in determining their base lending rate suggesting that inflation is taken into account. There was evidence of positive relationship between the weighted lending base rate and treasury bill rate with correlation co-efficient of 0.89. This indicates the significant role treasury bill rates play in the determination of the base lending rates.

A more recent work of Kovanen (2011) analyzes interest rate pass-through in Ghana using time series and panel bank-specific data for 20 largest banks. The author highlights linkages between prime rate, wholesale market (short- term money market and treasury bill interest rate) and retail market interest rates, the implication of changes in the monetary authorities' interest rate (prime rate) on short term money market interest rate and the pass-through to retail deposit and lending rate in Ghana during the period of 2005-2010. The author sought to address the concern to policy-makers relating to the apparent lack of responsiveness of retail lending rate to changes in the prime rate. Notwithstanding possible short-term deviations, the money market interest rates are expected

to move together with the prime rate in the long-run. The wholesale retail deposit and lending interest rates are expected to reflect funding cost in the money market and therefore over time respond to changes in the money market interest rates. If the transmission process were to be effective, then changes in the prime rate would transmit to retail lending and deposit interest rate in reasonable short period of time. The focus variables were the interbank market interest rate and 91-day treasury bill interest rate which are expected to be relevant bench mark for pricing of retail lending and deposit rates. A relevant point noted by the author was that at times these two interest rates experience significant and persistent deviations from the Bank of Ghana's prime rate which could indicate unannounced changes in the changes in the monetary policy rate. This creates ambiguity about the monetary authority's stance among the public as realized during the period of 2008-2009 when the interbank and the treasury bill rate were significantly higher than the Bank of Ghana's prime rate for a long period of time suggesting that liquidity conditions in the wholesale market were tighter than implied by the announced policy stance. The findings suggest, the interbank interest rate respond to changes in the Bank of Ghana's prime rate with one month lag in all the models used. However, in the long run, the results suggest that the interbank and prime rate move closely together. Deviations in the interbank interest rate from the prime rate nonetheless suggest the rate may not always have provided an accurate reference point for the interbank rate due to uncertainty.

Also Froyen and Berument (2009) studied long-term interest rate under IT regime in New Zealand. One advantage cited for formal inflation targeting is that by anchoring inflationary expectations, long-term interest rates would become less sensitive to temporary shocks to the economy including policy induced changes in short-term interest rates. The paper examined the experience in this regard for New Zealand, an earlier and strict inflation targeting country. The link between the response of long-term interest rates to changes in the prime rate and the anchoring of inflationary expectations has been an element in the debate in the United States over the desirability of moving

to an IT framework. Bernanke (2004) has argued that, "the apparently high sensitivity of long-term nominal interest rates to Fed actions suggests some uncertainty about the Fed's long-run inflation target". This means that private agents' views of long-run inflation are not strongly anchored by monetary policy. By VAR estimates using monthly data for New Zealand, pre- and post adoption of inflation targeting with the prime rate, long term market interest rates, the exchange rate, and a commodity price measure. Here, the authors looked directly at the impact of innovations in the prime rate on longer-term interest rates. During the period of inflation targeting (1992-2008) both short- and long-term interest rates in New Zealand were lower and less volatile than in the pre-inflation targeting period. Representative impulse response functions from VAR estimates for the IT period (1992-2008) was computed using the method of Pesaran and Shin (1998) for the 1 year treasury bill rate and the 10 year bond rate. The result showed that the 1-year interest rate rises initially in response to a 1 percentage point increase in the prime rate with the response being significant for 9 months. The 10-year rate also rises in response to a rise in the prime rate with response of significant for approximately 3 months but is relatively smaller. These finding were consistent in their earlier studies from VAR analysis using U.S. data. That is the response of longer-term market interest rates to innovations in the federal funds rate (prime rate) is lower in the post-1987 period relative to pre-1979 periods (Berument & Froyen, 2006). These responses decline even more when only the post-1994 period was considered. The Federal Reserve's greater emphasis on their inflation goal post-1979 and thus greater anchoring of inflationary expectations is a possible reason for this decline. A different though related explanation is that decline in the estimated effect on longer-term interest rates from innovations is the Federal funds rate reflects the greater transparency of Federal Reserve policy post-1987 and even more post-1994.

In an earlier paper, Kuttner (2000) investigates the impact of monetary policy actions on treasury bill, notes, and bond yields, using data from the futures market for the U.S. economy. Their procedure was to regress the change in the treasury bill, note and bond rates on the change in the

target Fed funds rate. The response to target rate increases was positive and significant at all maturities, but smaller at the long end of the yield curve. Short-term interest rates tend to move roughly one-for-one with the Funds rate in the long-run; however, it remained something of a puzzle as to why a one percentage point surprise increase in the Fund rate generates only a 50–70 basis point increase in the bill rates. Among the author's explanation was the regression of the change in market interest rates on lagged changes in the Fed funds target.

Hamachandra (2008) examined the relationship between the policy rate and other macroeconomic variables. By empirical estimation, the author finds out how interest rate could be used to manage the macroeconomy of Sri Lanka. A series of Ordinary Least Square (OLS) estimations were carried out to find the relationship between the policy rate and other selected variables: interest rate, saving , investment, inflation etc using monthly data from 1979 to 2008. By the regression, the prime rate was highly significant in determining the 2-year bond interest rates. One percentage point increase in the policy rate increased the Treasury bill rate by 1.20 percentage points. On the relation between the policy rate and the commercial bank deposit rates, he found that current and previous policy rates affect current deposit rate of the commercial banks. One percentage increase in previous prime rate increased the current weighted average deposit rate by 0.69 percentage points significantly. Thus not only current prime rate but historical prime rates will have effect on deposit rates.

Asymmetry in the adjustment appears to be rather common and have been reported for other countries and regions by Sander and Kleinmeier (2006) for the Southern African Customs Union (SACU) region and Kwapil and Scharler (2010) for the U.S. and the euro zone. The authors suggest that only when banks anticipate there will be successive prime rate changes in the same direction in the future, will they have an incentive to adjust their retail interest rates. In the case of Ghana, during periods when the policy interest rate has been falling, the convergence towards the long-term

equilibrium appears to be faster and statistically significant. On the other hand, during periods of rising policy interest rates, the convergence is not statistically significant (Kovanen, 2011).

2.4 Monetary policy framework in Ghana

Monetary policy comprises actions of the central bank that determine the size and rate of growth of money supply, which in turn affects interest rates. Monetary policy is maintained through actions such as increasing the interest rate or changing the amount of money banks need to keep in the vault (bank reserves) to control the level of money supply in the economy. The growth in money supply by the actions of the central bank has a direct influence on inflation and interest rate in the economy. An expansionary monetary policy by the central bank using its available tools leads to decline in the level of interest rate in the economy. This action increases liquidity, giving banks more money to lend to businesses and consumers. If aggregate demand exceeds aggregate supply, inflation will be created in the economy. A contractionary monetary policy will lead otherwise.

The history of monetary management in Ghana can be categorized into two main distinct phases which are, the period associated with monetary controls and that of financial liberalization. Prior to 1983, when major economy reforms in finance, trade and then politics began, the Bank of Ghana operated largely a direct controlled system of monetary management. This entailed the reliance on predominantly direct intervention instruments, prominent among which was direct credit control. This involved the imposition of ceilings, both global and sectoral, on individual commercial banks' lending that had to be consistent with national macroeconomic targets like growth, inflation and external balance. With time these arrangements proved to be ineffective and introduced inefficiencies in various sectors of the economy. These weaknesses inherent in the economy at the time necessitated reforms in the conduct of monetary policy. The direct control system of monetary management had to be abandoned with the advent of financial sector liberalization in 1988 during the Financial Sector Adjustment Program (FINSAP). The liberalization process entailed progressive

de-regulatory measures, culminating in the institutionalization of a market based system of monetary management in early 1992 that focused largely on the use of indirect and market based instruments in the conduct of its monetary policy.

In 2002, the Bank of Ghana Law, Act 2002 was passed by parliament. The law gave the Bank of Ghana the independence in the discharge of its monetary policy. The independence aspect of the law implied that the Bank could use whatever tools available at its disposal in achieving its primary objective of price stability. The Law gave birth to the Monetary Policy Committee (MPC). The conduct of Monetary Policy is vested in the MPC. The decision on the appropriate monetary policy stance is also taken by the MPC. The Committee consists of 7 members: The Governor, two deputy governors, the heads of monetary policy analysis and banking operations of the Bank and two independent members. The Committee normally meets every other month (or six times per year) and had its first meeting in November 2002. The MPC since 2002 has been given the institutional and operational independence to put in structures to facilitate the effective discharge of its functions. Under the IT policy, fiscal and monetary policies are conducted prudently in the management of the economy, (BoG, 2012).

The changes in the prime rate transmit to the economy along the following path. The first stage is that a change in the official interest rate set by the MPC will affect financial market interest rates. Banks and other financial institutions have to react to any official rate change by changing their own savings and loan rates. The change will also affect the prices of many financial assets; bonds, security prices and hence the level of interest rates. Finally there may also be an effect on the expectations of both firms and individuals as they may become more or less confident about the future path of the economy.

The second stage is that all these changes in the financial market interest rates will affect the spending patterns of consumers and firms. In other words there will be an effect on aggregate

demand. Higher interest rates are likely to reduce the level of aggregate demand, as consumers are affected by the increase in interest rates and may look to cut back on spending. There will also be international effects as the level of imports and exports change in response to possible changes in the exchange rate.

The third stage is the impact of the aggregate demand change on GDP and inflation. This will tend to depend on the relative levels of aggregate demand (AD) and aggregate supply (AS). If there is enough capacity in the economy then an increase in AD may not be inflationary. However, if the economy is already at full employment producing as much as it can, then any further AD increase may be inflationary.

Woodford (2003) explains that an optimal monetary policy is the one that could have been designed on a priori grounds to achieve the highest possible degree of social welfare and might well be implemented through procedures that share important features of the inflation-forecast targeting that is currently practiced by central banks. Every economy is subject to exogenous real disturbances of many sorts (including various types of supply shocks) even at the natural rate of output (i.e., the level of output that would occur in equilibrium with fully flexible prices). Optimal monetary policy is the one that maintains completely stable prices in the face of these disturbances instead of allowing real activities to vary. In equilibrium, fluctuations in real allocation of resources would be optimal if only all prices were perfectly flexible and set on the basis of full information. The basic intuition is simple, relative price distortions can completely be eliminated in principle by creating an environment in which economic agents choose a price (full information) consistent with the current price index along the expected path of the inflation target. This is the argument in favour of inflation targeting monetary policy.

CHAPTER THREE

METHOD OF ANALYSIS

3.1 Introduction

This chapter focuses on the model specification and estimation procedures. Emphasis is also given to the nature and sources of data. It further outlines the necessary econometric techniques employed in the empirical analysis in solving the problems of the study. The study estimates long run transmission of the prime rate to the short term money market rates (treasury bill rates), interbank rate, commercial banks lending and deposit rates. It further examines how short run adjustments transmit to the long run thus determining the significance asymmetric information in the adjustment process. The adjustment process helps to estimate the speed of transmission of the prime rate to commercial bank's lending and deposit interest rates as well as short term money market interest rates.

3.2 Model specification

The IT policy is implemented under liberalised financial market free from direct control of the monetary authorities. Therefore, monetary policy assumes that banks operate in a perfect competitive market. This idea according to Ayisi (2011), discards any possibility of asymmetry in bank adjustment of their interest rates to the prime rate. A close study of the banking sector in Ghana defies this assumption. Commercial banks have some form of monopoly in determining their lending and deposit interest rates by their own expectation rather than the BoG. Commercial banks as profit maximizers set their interest rate based on cost of funds and operational expenses. In a perfect competition commercial bank will set their price (interest rates) equal to their marginal costs.

The modeling technique follows the specification of Hahn and cook (1988) and Charoenseang and Manakit (2007). First, the long-run relationship and the degree of transmission were estimated by the Fully-modified Ordinary Least Squares (FMOLS) as follows:

$$I_t = \alpha_0 + \alpha_1 PR_t + \varepsilon_t \quad (3.1)$$

where I_t represents the interest rates (lending rate, deposit rate, Treasury bill rates or the interbank rate) endogenously determined in the financial market, PR_t represent the prime rate which is the BoG monetary policy indicator, ε_t is the stochastic error term with zero mean and constant variance, α_0 measures the constant mark up. The long run parameter α_1, indicates the rate of transmission of the prime rate to respective interest rates. The rate of transmission is expected to be between zero and one. The long-run adjustment is complete when α_1 is equal to one and is incomplete when it is less than one. However, over pass-through will make the value to be greater than one. A complete pass-through means that changes in prime rate is transmitted in equal proportion to the respective interest rate. According to theory, we expect the prime rate to be positively related to the financial market interest rates (money market and commercial banks interest rates). Inflation does not enter the model if economic agents' expectation of inflation coincides with that of the monetary authorities captured by the changes in the prime rate. Economic agents pay little attention to inflation when they believe that monetary authorities will commit to their inflation targets and stability.

The short-run adjustment of the financial market interest rates to changes in the prime rate is examined by following a Vector Autoregressive (VAR) process, the concept of error-correction procedure is applied if the variables are co-integrated. In this case, we estimate the Error-Correction Model (ECM) of the following form;

$$\Delta I_t = \beta_0 + \beta_1 \Delta PR_t + \tau_j \sum_{j=1}^{p} \Delta PR_{t-j} + \gamma_j \sum_{j=1}^{p} \Delta I_{t-j} + \beta_2 ECT_{t-1} + \mu_t \quad (3.2)$$

where β_0 and β_1 are short-run intercept and prime rate coefficients respectively. The prime rate coefficient, β_1 is interpreted as a short-run transmission parameter. Δ denotes first difference operator when the variables are not stationary at the levels. μ_t denotes the error term. According to Kwapil and Scharler (2009), the long run co-efficient is given by

$$\lambda = (\sum_{j=0}^{p} \tau_j) / (\sum_{j=1}^{p} \gamma_j) \quad (3.3)$$

if there is no co-integration among the variables. $ECT_{t-1} = I_{t-1} - \alpha_o - \alpha_1 PR_{t-1}$ captures the disequilibrium at time t -1. β_2 represents the error correction adjustment speed when the interest rates under consideration are away from their equilibrium level and is expected to be negative and statistically significant. The mean adjustment lag (MAL) of a complete transmission can be calculated by $(1 - \beta_1)/ \beta_2$ when the variables are co-integrated. The short-run parameter (β_1) will be different from the long-run transmission (λ) and as such the gap between the two is used as indication of the stickiness of interest rates as emphasized by Kwapil and Scharler (2009) if there is no co-integration among the variable.

The adjustment speed of the interest rate may differ when they are below or above the long-run equilibrium (Chong et al., 2006). The financial market is slow in responding to the monetary policy surprises due to the presence of information asymmetry. Information asymmetry makes commercial banks charge high interest rate rather than reduce loans supply explained by De Bondt (2005). Economic agents will respond fully to changes in the prime rate if they have confidence in the central bank to commit to the low inflation path. Commercial banks will reduce their base rate if they expect continuous decline in the prime rate. Also, the fear that borrowers will default leads to higher constant mark up raising lending rates. Further explanation to asymmetry in is that commercial bank interest rates are administratively determined which respond slowly to small changes in the prime rate (Dutta et al., 1999). They will respond only when they expect the MPC to commit to either reducing or increasing successively. Secondly, investors in financial market are

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less likely to switch to different financial products due to limited information on interest rates (Heffernan, 1997). Thirdly, under imperfect competition financial market interest rates are less likely to swiftly to changes in the prime rate (Hannan and Berger, 1991). All these factors account for stickiness in the financial market interest rates. In testing for the asymmetry in the financial market interest rates when they are above or below their equilibrium levels; the dummy variable (d) is used in the asymmetric adjustment as specified by Chong et al., (2006) shown in equation (3.4).

$$\Delta I_t = \pi_0 + \pi_1 \Delta PR_t + \pi_2 d\, ECT_{t-1} + \pi_3 (1-d)\, ECT_{t-1} + e_t \qquad (3.4)$$

where d = 1 if the residual ECT_{t-1} is positive and 0 for otherwise. To detect the presence of asymmetric information, the standard Wald test is then employed. The presence of information asymmetry validates the market failure school even in the liberalized financial market.

3.2 Estimation procedures

This section presents the estimation procedures employed in the estimation of the transmission of prime rate to financial market interest rates in Ghana. Time series data of macroeconomic variables are used; the section explains the various time series techniques used for the analyses. The estimation procedures are undertaken with the aid of STATA 12 and Eviews 7 software packages.

3.2.1 Unit rooting test

In order to avoid the generation of spurious regression normally associated with time series data, each variable mentioned above requires testing for the existence of unit root. There are several standard tests which are normally employed for unit root testing. The study makes use of the following three unit root testing procedures: Augmented Dickey-Fuller (ADF) test, Dickey Fuller Generalized Least Squares (DF-GLS) and the Philip-Perron (PP) test. Starting with the ADF test, given a time series Y_t in the form;

$$Y_t = \delta_0 + \delta_1 Y_{t-1} + \nu_t \qquad (3.5)$$

where the Y_t is the detrended variable and V_t is the white noise error term. The null and the alternate hypotheses for the presence of unit root in the variable Y_t for the ADF tests are:

$Ho: \delta_1 = 0$

$H_1: \delta_1 < 0$

If the null hypothesis: $Ho: \delta_1 = 0$ (the variable under consideration has a unit root) is not rejected, then it indicates that the variable is non-stationary and if the alternate hypothesis: $H_1: \delta_1 < 0$ is found to be true, then the variable under consideration is stationary. The ADF test assumes that the error terms are independent and identically distributed (iid). The limiting hypothesis will be wrong if this assumption is false. The problem is solved by the Augmented Dicky-Fuller (ADF) test which adds maximum lags of the series to correct possible serial correlation in the series. The ADF test can be modeled in three different ways as follows;

$$Y_t = \delta_1 Y_{t-1} + \theta_i \sum \Delta Y_{t-1} + \nu_t \qquad (3.6)$$

$$Y_t = \delta_0 + \delta_1 Y_{t-1} + \theta_i \sum \Delta Y_{t-1} + \nu_t \qquad (3.7)$$

$$Y_t = \delta_0 + \beta t + \delta_1 Y_{t-1} + \theta_i \sum \Delta Y_{t-1} + \nu_t \qquad (3.8)$$

Equations (3.6), (3.7) and (3.8) are differentiated as pure random walk, random walk with drift and random walk with drift and constant respectively. By estimating these three models, unit root test is conducted and a decision is made on the stationarity of the series.

Elliot, Rothenberg and Stock (1996) proposed an alternative of the ADF test of handling the parameters pertaining to the error term in the ADF-GLS test. It is first estimated by the Generalized Least Square (GLS) before performing ADF test using the GLS residuals. The ADF-GLS test offers greater power than the regular ADF test in the error term. Additionally, the Philip-Perron (PP) test is also conducted. The test addresses the issue that the series might have a higher order of autocorrelation which invalidate the Dickey-Fuller test. The PP test makes non-parametric

correction to the t-test rather than adding lags of the variable as regressors in the test equation. This makes the PP test more robust with respect to unspecified autocorrelation and hetroscedasticity.

3.2.2 Co-integration test

Two or more series having the same trend can reveal long run relationship among the variables and are said to be co-integrated. The series tend to possess a common trend if they are co-integrated. In general and as a rule, if two series are integrated to a different order their linear combination will be integrated to a higher order. Even though the two series may be non-stationary at their levels there may be the existence of long run equilibrium (Gujarati, 2004). Co-integration is based on the principle that in the long run two or more series move closely together. The difference between them will be constant even though the series themselves may be trending. The existence of long run steady state implies the difference between the series is stationary (Hall & Henry, 1989).

The prime rate is assumed to move closely with bank's lending rate and money market interest rates. Therefore, we examine empirically the long run relationships between the variables. If the variables are co-integrated an error correction model is estimated. The research employs the Engle-Granger Two Stages co-integration test, Johansen (1991) and the Error-correction test for co-integration.

The most well know test, suggested by Engle and Granger also known as EG-Test is to run a static regression. It is uniquely applicable to bivariate analysis and goes through only two stages. Given that the series X_t and Y_t are co-integrated, a linear combination must be stationary. This is expressed as

$$Y_t - \beta X_t = \gamma_t \qquad (3.9)$$

By running an Ordinary Least Square (OLS) we obtain the estimate β and γ_t. Followed by a stationarity test on the estimated γ_t series using the ADF and/or the PP test, we test the null hypothesis of no co-integration in the residual obtained from the regression estimates.

The Johansen (1991) test uses the trace statistics and maximum eigen value statistics to make decision on co-integration making it more reliable than other known test. The trace statistic tests the null hypothesis that there are at most r co-integrating relations against the alternate hypothesis of m co-integrating relations when the series are stationary. On the other hand, the maximum eigenvalue statistic tests the null hypothesis that there are r co-integrating relations against the alternative hypothesis there are $r+1$ co-integrating relations.

The last approach to co-integration will be the error-correction based co-integration test popularized by Banerjee et al. (1986), Hendry and Ericson (1991) which uses the t-ratio of the co-efficient on the error-correction term in the dynamic model (3.2) .We test the null hypothesis $\beta_{2=} 0$, interpreted as variables are not co-integrated using the t-statistic. If the null hypothesis is rejected, it indicates there is co-integration among the variables when the error correction term is negative and highly significant. The error-correction based co-integration uses available information more efficiently (Kremer et al. 1992) compared to the other approaches.

3.2.3 Granger causality test

An important question that needs to be answered in the analysis is whether or not the prime rate is able to predict financial market interest rates. The underlying assumption is that changes in the prime rate influences the financial market interest rates. Granger (1969) proposes causality test to investigate such a relationship. We examine whether lag information of prime rate provides any statistically significant information about financial market interest rates.

$$I_t = c + \sum \beta_i I_{t-i} + \sum \alpha_i PR_{t-i} + \ell_t \qquad (3.10)$$

$$PR_t = c + \sum \beta_i PR_{t-1} + \sum \alpha_i I_{t-1} + \ell_t \qquad (3.11)$$

H_0: $\alpha_1 = \alpha_2 = \alpha_3 ..... = \alpha_p$

H_1: $\alpha_1 \neq \alpha_2 \neq \alpha_3 ..... \neq \alpha_p$

Accepting the null hypothesis implies (PR) does not granger-cause (I_t). Hence the prime rate cannot predict the future values of respective interest rates.

3.3 Data

The paper uses monthly data on financial market interest rates obtained from the database of the Bank of Ghana within the period of Jan, 2002 to Aug 2010. The interest rates consist of 91-day Treasury bill rate (TBILLN), 182-day Treasury bill (TBILL), prime rate (PR), interbank rate (INTBR), commercial banks base rate (LINTR), 12-month time deposit (TWMTH) and 3-month time deposit rate (TMNTH). The treasury bill rates are the interest rates offered in the open market in order to attract funds from the general public. It is the major source of government borrowing to finance maturing debt and projects.

Lending rates are charged by commercial banks on loans advanced to the private investors and consumers. Different charges are imposed depending on sector of the economy, whether agriculture, export trade, manufacturing, mining and quarrying or construction. Lending rate is proxied with the commercial banks base rate which forms the basis for determining all other sector interest rates. Deposit rate is the interest rate paid to savers by commercial banks. Commercial banks charge different rate on deposits depending on how long savers are willing to keep their funds under different conditions. Depositors being rational will choose the rate competitive to the government treasury bill rate which offers inflation premium. The rates on the 3-month and 12-month time deposit are chosen to represent deposit rate because they offer returns competitive to Treasury bill rates.

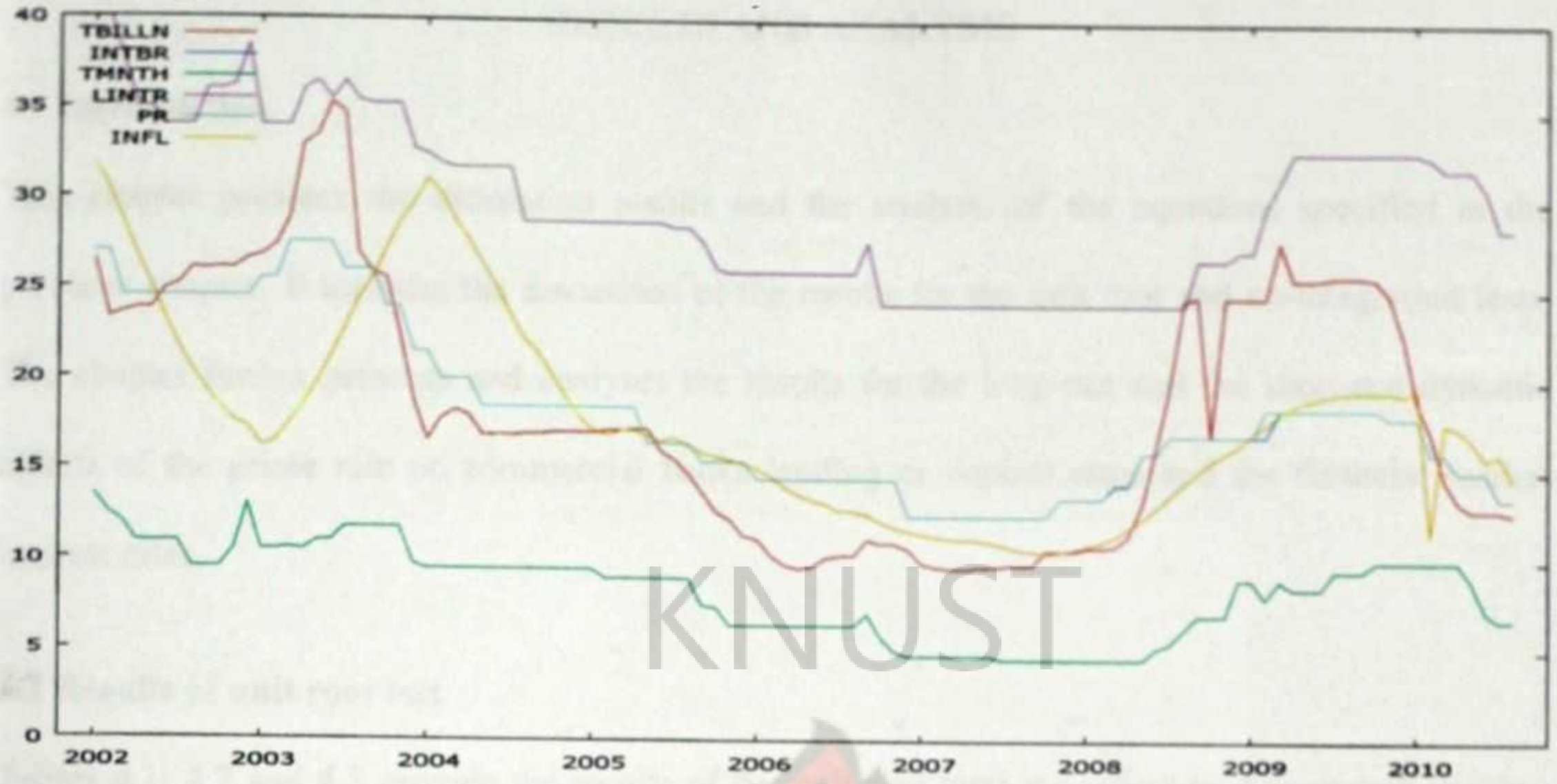
3.4 Descriptive and correlation analysis

All the series trend downwards during the period of Inflation Targeting (IT) Policy as shown in figure 3.1. The period before 2002 saw high and unstable inflation in Ghana, as high as 41.9% in March, 2001 but inflation has averaged 17.8% between 2002 and 2010 with maximum of 31.8%

indicated in table 3.1. With inflationary pressures firmly anchored by the prime rate changes, there has been decline of inflation rate to single digit. Although the yearly target is hardly achieved, inflation has stayed below 10% since June, 2010 till 2012 indicating the success of the policy. This comes with the downward prime rate, treasury bill rate, lending rate and deposit rate shown in figure 3.1. The trend of the financial market interest as indicated in figure 3.1 shows that deposit rate (three months time deposit) are relatively low compared to the lending rates which indicates disincentive to private savings and high cost of borrowing to private investors. There is high spread between the deposit and lending rate of commercial banks in financial market. Inflation rate has always exceeded the deposit rate yielding negative real deposit rate to savers according to the trend analysis in figure 3.1. The 91-day treasury bill rate (TBILLN) stayed higher compared to deposit rate of the commercial banks over the period indicating crowding out of private investment in the economy.

There is a high correlation 0.8886 of the lending rate (LINTR) compared to 0.8582 of the deposit rates (TMNTH) with the prime rate. The treasury bill rate is found to be 0.8576 correlated with the prime rate almost equal to the three month deposit rate co-efficient. The interbank rate shows near-perfect correlation of 0.9995 with the policy rate making it most responsive to monetary policy surprises.

Figure 3.1 Trends in prime rate and financial market interest rates: 2002- 2010



Data source: Bank of Ghana statistics

Table 3.1 Descriptive statistics of prime rate and financial market interest rates

	INFL	INTBR	LINTR	PR	TBILL	TBILLN	TMNTH	TWMTH
Mean	17.783	18.197	29.718	18.212	19.466	18.321	8.2608	12.689
Median	17.05	17	28.75	17.5	17.9	17.1	9	13.315
Maximum	31.8	27.5	40	27.5	36.9	35.3	13.5	22.5
Minimum	10.5	12.5	24.25	12.5	10.3	9.6	4.55	7.25
Std. Dev.	5.5038	4.4738	4.5089	4.4715	7.3892	6.9867	2.4024	3.4818
Skewness	0.7782	0.6740	0.3291	0.6654	0.3316	0.3860	-0.1504	0.2113
Kurtosis	2.9071	2.3201	1.9400	2.3150	1.8973	2.0385	1.9678	2.0819
Jarque-Bera	10.53	9.878	6.7461	9.7079	7.1757	6.5885	5.0082	4.4270
Probability	0.0051	0.0071	0.0342	0.0077	0.0276	0.0370	0.0817	0.1093
Sum	1849.5	1892.5	3090.7	1894.1	2024.5	1905.4	859.13	1319.6
Sum Sq. Dev.	3120.1	2062	209.	2059	5623	5027.8	594.49	1248.7
Observations	104	104	104	104	104	104	104	104

Source: Author's elaboration

CHAPTER FOUR

RESULTS AND ANALYSIS

4.1 Introduction

This chapter presents the estimation results and the analysis of the equations specified in the previous chapter. It includes the discussion of the results for the unit root and co-integration tests. The chapter further presents and analyses the results for the long-run and the short-run dynamic effects of the prime rate on commercial banks lending or deposit rates and the financial market interest rates.

4.2 Results of unit root test

Tables 4.1, 4.2 and 4.3 provide the results of the unit root tests according to Augmented Dickey-Fuller, Dickey-Fuller Generalized Least Square and the Phillips-Perron tests respectively. The three methods are used to ensure that the problem of unit root is properly addressed to avoid spurious regression analysis. The relevance of the unit root testing is to determine the order of integration of the variables.

The null hypothesis which states that the variable under consideration has a unit root is rejected in favor of the alternate hypothesis of no unit root if the test statistic obtained is greater than the critical value in absolute terms. According to the results reported in Tables 4.1, 4.2 and 4.3, all the variables can be said to be integrated of order one or I (1) at 5% level of significance. That is, all the variables can be said to be stationary after the first difference at 5% significance level in all the different tests used. In this case the PP test becomes superior in taking decision due to its robust in solving autocorrelation and heteroscedasticity associated with time series analysis. The next step is to test whether there is evidence of a long-run relationship between the prime rate and other financial market interest rates used for the analysis.

Table 4.1 ADF test

	Levels		First Difference	
Variables	No Trend	Trend	No Trend	Trend
INTBR	-1.1018	-1.4067	-5.5350***	-5.4490***
LINTR	-2.3817	-2.0246	-11.0797**	-11.2146***
PR	-1.0969	-1.3999	-5.5327***	-5.4463***
TBILLN	-1.4821	-1.4789	-9.1375***	-9.08745***
TMNTH	-2.1999	-1.9471	-10.0964**	-10.1016***
TWMTH	-1.8660	-1.8669	-5.9621***	-5.8752***
TBILL	-1.8250	-1.9860	-5.3803***	-5.3501**

Note: ***, **indicates rejection of the null hypothesis of unit root at the 1% and 5% Plevel respectively.

Table 4.2 DF-GLS test

	Levels		First Difference	
Variables	No Trend	Trend	No Trend	Trend
INTBR	0.2051	-1.3727	-5.5098**	-5.5608**
LINTR	-0.6074	-1.3891	-11.0912**	-11.1944**
PR	0.2071	-1.3666	-5.5074**	-5.5585**
TBILLN	-0.7824	-1.4048	-2.1234**	-7.2995**
TNMTH	-0.4472	-1.4109	-2.4863**	-8.6170**
TWMTH	-0.5361	-1.6442	-0.6896	-1.6488
TBILL	1.4035	-2.0346	-3.1646**	-4.3412**

Note: ** and * indicates rejection of the null hypothesis of unit root at the 5% and 10% level respectively.

Table 4.3 PP test

Variables	Levels		First Difference	
	No Trend	Trend	No Trend	Trend
INTBR	-1.7185	-1.6528	-10.6904***	-10.7246***
LINTR	-2.3641	-1.9664	-11.0920***	-11.3491***
PR	-1.7143	-1.6480	-10.6933***	-10.7267***
TBILLN	-1.7945	-1.8314	-9.3002***	-9.2562***
TNMTH	-2.2057	-1.9642	-10.0971***	-10.1051***
TWMTH	-3.0365**	-2.9674	-11.6718***	-11.5639**
TBILL	-1.7491	-2.9674	-11.6718***	-11.5639***

Note: ***, **indicates rejection of the null hypothesis of unit root at the 1% and 5% level respectively.

4.3 Results of co-integration test

There is evidence that all the series are integrated of the same order I (1), co-integration test is conducted for the series. This is to establish evidence of long run relationship between the prime rate (PR) and the other interest rates under consideration (INTBR, LINTR, TBILLN, TBILL, TWMTH and TMNTH).The study employed Johansen (1991), Engle-Granger tests test as well as the Error Correction Based test for co-integration according to Banerjee et al. (1986). The evidence of co-integration validates the use of the Error Correction Model (ECM) for the analysis. The Engle-Granger test in Table 4.4 shows evidence of co-integration between the PR and LINTR, INTBR, TMNTH, TWMTH respectively at 5% significant level indicated by the PP and ADF test. TBILLN and PR are co-integrated at 10% significant level but TBILL and PR are not co-integrated according to the Engle-Granger test. Following the Johansen co-integration test, there is evidence of co-integration in all the variables in both the trace and eigenvalues at 5% significant level except the TWNTH as represented in Table 4.5. A further examination of the error correction term proves

that they are all negative and highly significant for co-integrated variables. This is shown in Table 4.9 by the co-efficient of the error- correction term (β_2).

Table 4.4 Results of Engle-Granger co-integration test

Residuals Test	ADF-Test	PP Test
ET of LINTR and PR	-3.349122**	-3.140290**
ET of INTBR and PR	-10.15096**	-10.15096**
ET of TBILLN and PR	-2.876509*	-2.697673*
ET of TMNTH and PR	-3.028414**	-2.948437**
ET of TBILL and PR	-2.066201	-2.246009
ET of TWMTH and PR	-3.180284**	-3.180284**

Note: ***, ** and * indicates evidence of co-integration at 1%, 5% and 10% significance level respectively.

Table 4.5 Johansen Co-integration test

Paired Variables	Trend	No Trend
LINTR and PR	YES	NO
INTBR and PR	YES	YES
TBILLN and PR	NO	YES
TBILL and PR	YES	YES
TMNTH and PR	YES	YES
TWMTH and PR	NO	NO

Note: YES indicates evidence of co-integration at 5% significance level in both the Trace and Eigen statistic whiles NO means otherwise

4.3 Result of Granger causality test

The essence of the Granger causality test is to examine the ability of the prime rate to predict future values of other interest rate. In the IT policy, financial market interest rates are directly influenced by the prime rate to manage aggregate demand and the inflation. The success of the IT policy

depends on the responsiveness of financial market interest rates to the Prime rate. The results are shown in Table 4.6. The results from the granger causality tests reveal a bi-directional causal relationship between The PR and the treasury bill rates (TBILLN and TBILL) as well as the LINTR. The prime rate Granger-causes the interbank rate (INTBR) but there is no evidence of causality running from the interbank rate to the prime rate. There is a two-way causal relationship between the prime rate and the 3-month deposit rate (TMNTH), however there is no evidence of causality whatsoever between the prime rate and the 12-month deposit rate (TWMTH) showing the poor prediction of the prime rate on long term deposit rate.

Table 4.6 Pair-wise Granger causality test results

Null Hypothesis	F-Statstic /Probability	Decision
PR does not Granger cause TMNTH	6.3529 (0.0026)	PR Granger causes TMNTH
TMNTH does not Granger cause PR	4.5204 (0.0133)	TMNTH Granger causes PR
PR does not Granger cause TBILLN	13.589 (0.0000)	PR Granger causes TBILLN
TBILLN does not Granger cause PR	5.0726 (0.0080)	TBILLN Granger causes PR
PR does not Granger cause LINTR	6.6349 (0.0019)	PR Granger causes LINTR
LINTR does not Granger cause PR	3.6955 (0.0284)	LINTR Granger causes PR
PR does not Granger cause INTBR	5.8283 (0.0175)	PR Granger causes INTBR
INTBR does not Granger cause PR	0.0769 (0.7820)	INTBR does not Granger cause PR
PR does not Granger cause TWMTH	1.8350 (0.1786)	PR does not Granger causes TWMTH
TWMTH does not Granger cause PR	0.0016 (0.9681)	TWMTH does not Granger causes PR
PR does not Granger cause TBILL	6.9129 (0.0003)	PR Granger causes TBILL
TBILL does not Granger cause PR	2.8507 (0.0415)	TBILL Granger causes PR

Note: Values in parenthesis are the probabilities

4.5 Long run transmission of the prime rate

The long run estimates were obtained by regressing the selected interest rates on the PR as specified in equation (3.1). All the interest rates are positively related to the prime rate and highly significant according to the Fully Modified Ordinary Least Square (FMOLS) estimate which is more robust in the presence of serial correlation and hetereoscedasticity usually associated with time series data. The FMOLS provides optimal estimates of co-integration regression (Phillip, 1995). We obtain the FMOLS estimates after determining the stationarity status of the series. The long run estimates show the responsiveness of the financial market interest rates to the monetary surprises of the central bank. The short term money market interest rates depicts an over pass-through as indicated by of 1.3728 and 1.4119 in the TBILLN and TBILL co-efficients respectively. Thus, the 91-day treasury bill rate and the 182-day treasury bill rates respond more than a proportionate change to changes in the prime rate. The high responsiveness of the money market interest rates proves its competiveness than the other interest rates as explained by Ayisi (2011). This result further reflects the effectiveness of central bank in the management of credit to control inflation in the open market. However, regular interventions by the monetary authorities to raise interest rate to finance maturing debt can also result in the over-pass-through. There is complete pass-through in the interbank rate (INTBR) showing almost one-on-one response to the prime rate with pass-through co-efficient of 0.9998. This is consistent with the findings of Charoenseang and Manakit (2006) with almost complete pass-through co-efficient of 0.96 in Thailand for the interbank rate. The lending and deposit rates of the comercial banks show incomplete pass-through co-efficient of 0.44701 for the 3-month deposit rate, 0.47077 for the 12-month deposit rate and 0.84920 for the lending rate consistent with the finding of Acheampong (2005). However, Ayisi (2011) found over pass-through in the savings deposit rate, interbank rate, and the lending rate. These differences can be attributed to diferent sample periods and variables that were used in the various studies.

Table 4.7 Long run transmission of the prime rate

PR is the independent variable

Dependent Variables	(α_0)	(α_1)	Standard Error	T-ratio
TBILLN	-6.6433	1.3728	0.1407	9.7566•••
TBILL	-6.2019	1.4119	0.1668	8.4652•••
INTBR	-0.0126	0.9998	0.0031	319.3257•••
TMNTH	0.10699	0.447	0.0428	10.4457•••
TWMTH	4.0602	0.4708	0.1101	4.2738•••
LINTR	14.2339	0.8492	0.0718	11.8638•••

Note: ••• indicates 1% significant level by the Fully-modified Ordinary Least Square (FMOLS).

4.8 Short run adjustment process

The short run estimates show that short term money market interest rates are highly significant with probability less than 5%. This confirms that the money market rates are highly responsive to changes in the prime rate both in the short and the long run making the short term rates an effective instrument to managing domestic credit (demand) and hence inflation. As shown in Table 4.9, it takes less than a month (0.8625) that is about 26 days for the 91-day Treasury bill (TBILLN) to respond completely to the prime rate making it very competitive in the financial market. The 182-day treasury bill (TBILL) takes 6-7 months (6.17410) to respond to policy surprises indicating its slow adjustment to long run equilibrium compared to the 91-day Treasury bill. Following the 91-day treasury bill is the interbank rate which takes about 27 days (0.8803) for complete transmission. This implies commercial bank depend highly on the interbank market for short term borrowing. However, the lending rates of commercial banks respond fully within 3-4 months (3.7504). The length of time between the interbank rate and the lending rate shows the stickiness of commercial banks lending rate to the prime rate. The deposit rates are the most sluggish in adjusting to long run

equilibrium. The 3-month deposit rate (TMNTH) takes 5-6 months (5.23088) for complete transmission while the 12-Month deposit rate is the stickiest taking 10-11 months (10.3726) to adjust completely. In the short run, the prime rate is not significant in determining deposit rates, interbank rate and lending rate suggesting information asymmetry in the financial market.

Table 4.8 Short-run error correction results

ΔPR is the independent variable

Variables	β_1	β_2	Mean Adjustment Lag (MAL)
ΔINTBR	0.2188 (0.65)	-1.3846 (0.046)	0.8803
ΔLINTR	0.1839(0.32)	-0.2172 (0.000)	3.7584
ΔTBILL	0.5198(0.00)	-0.0071 (0.005)	6.1741
ΔTBILLN	1.9384(0.00)	-0.1085 (0.012)	0.86525
ΔTMNTH	0.0071(0.93)	-0.1898 (0.000)	5.23088
ΔTWMTH	0.1277(0.39)	-0.0841(0.038)	10.3726

Note: β_1 is the short run transmission parameter of the prime rate and β_2 is the co-efficient of the error correction term. The values in parenthesis are the probabilities.

4.9 Asymmetric short run adjustment process

The standard Wald test is used to test the speed of adjustment when the rate of transmission is above or below equilibrium in the presence of information asymmetry. The null hypothesis states $\pi_2 = \pi_3$, no difference in the adjustment speed against the alternate hypothesis of $\pi_2 \neq \pi_3$ means otherwise when the prime rate transmission is either above or below equilibrium (Chong et al., 2006). The adjustment speed differs in the INTBR, LINTR and TBILLN as their probability values are less than 5%. The interbank market rate takes less than a month (0.006 and 0.009) for complete transmission whether the rate is above or below equilibrium because it shows almost complete pass-through. The LINTR adjust faster (less than a month, 0.8631) when it below equilibrium than when it is above equilibrium. In the presence of the asymmetric adjustment the TBILLN takes less time

(3-4 months) when it is above equilibrium than when it is below equilibrium, thus 6-7 months. The TBILLN is very effective instrument for the open market if is above equilibrium compared to the TBILL since it takes less time to adjust to long run equilibrium. The Wald test is not significant for the TBILL, TMNTH and the TWMTH showing that information asymmetry play little role in their adjustment process.

Table 4.9 Asymmetric short run adjustment results

Variables	π_1	π_2	π_3	MAL^+	MAL^-	Wald Test
ΔINTBR	1.0065(0.00)	0.7206(0.89)	1.0218(0.00)	0.009	0.006	48.04(0.00)
ΔLINTR	0.5768(0.00)	-0.007(0.94)	0.4903(0.00)	60.45	0.8631	6.39(0.00)
ΔTBILLN	0.4517(0.07)	0.1583(0.06)	0.0792(0.62)	3.46	6.92	3.17(0.03)
ΔTBILL	0.665(0.00)	0.0375(0.54)	0.1085(0.41)	8.93	3.09	1.44(0.24)
ΔTMNTH	0.1049(0.28)	0.1914(0.04)	-0.069(0.57)	4.68	12.84	2.24(0.11)
ΔTWMTH	0.049(0.75)	0.0346(0.59)	0.1521(0.17)	27.4	6.25	1.89(0.16)

Note: $MAL^+ = (1- \pi_1)/ \pi_2$ is the mean adjustment lag when the degree of transmission is above equilibrium whiles $MAL^- = (1- \pi_1)/ \pi_3$ represents otherwise. The values in parenthesis are the probability.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the main findings as well as discussion of their policy implications. It further offers the main conclusion and a number of recommendations for policy makers and finally acknowledges the limitations of the study.

5.2 Summary of findings

The objective of the study was to examine the monetary policy transmission to interest rates under the current IT policy framework. The effectiveness the IT policy depends on the responsiveness of interest rate to the prime rate in order to manage liquidity and stabilize inflation. Secondly, the level of interest rate tends to affect savings, consumption and investment thereby influencing the level output. The study therefore examined the rate of transmission from the Prime rate to lending rates, deposit rates and the short term money market rates. The rate at which the prime rate transmits to other interest rates differs in the financial market. The response of the financial market to the prime rate depends on the credibility of the monetary policy stance on inflation. The financial market rates deviates from the prime rate indicating that monetary policy stance on inflation does not always coincide with economic agents' expectation (Kovanen, 2011). There is almost complete pass through in the interbank market rate taking less than a month for complete pass-through. The short-term money market rates are the most competitive in the financial market showing over pass-through however, the 182-day treasury bill rate happened to be stickier than the 91-day treasury bill. The 91-day treasury bill rate takes less than one month for complete transmission whiles the 182-day treasury bill takes more than 5 months for complete transmission. Liquidity preference accounts for the differences in the competitiveness of the money market interest rate since investor prefer short term rate to longer term ones with the same risk. The stickiest are the commercial bank deposit and lending rates. The lending rates takes 3-4 months, the 3-month deposit takes 5-6 months

with the 12-months deposit being the most sluggish taking 10-11 months in adjusting to the monetary policy.

The short run estimates show the prime rate is not significant on interbank rate, lending rate and the deposit rates except the short term money market rates. In the long run, the prime rate is highly significant on all the interest rates. It takes some time for interest rates to adjust to periodic announcement by the Monetary Policy Committee due to asymmetric information in the adjustment process. The further test for the significance of information asymmetry was conducted in the asymmetric short run adjustment model. Although information asymmetry play a major role in the transmission process as it has widely been accepted in the literature it was not significant in the deposit rates and the 182-day treasury bill rate.

The deposit rates (3-months and 12-month deposit rates) are uncompetitive. Evidence from sub-Sahara African countries show that the banking system is uncompetitive and inefficient resulting in the stickiness of lending and deposit rates. This is supported by Buch and Mathisen (2005) findings that the banking system in Ghana portrays monopolistic competition. Larger banks with large assets do not rely on the central bank and the interbank market for funds and therefore will not respond quickly to the changes in the prime rate. Also information on commercial banks lending and deposit rates are not fully available making it difficult to compare the rates in the market tying people to particular banking products.

The stickiness of lending rates is widely attributed to collusion among commercial banks, bank size, profitability, information asymmetry and competition in the financial market. Commercial banks in Ghana have always associated their unresponsiveness to the prime rate with high default rate and operating expenses. In the presence of collateralization of loans it is expected that default risk reduces for banks to respond effectively to monetary policy formulation.

The saving rate are relatively low, sticky and highly uncompetitive. The deposit rates in the country pose some disincentive to saving in commercial banks. It is interesting to note that investors rather prefer lending to the government than to private investors since it is risk free and offer inflation premium. This situation results in crowding out in the Ghanaian economy as fund are diverted from the private sector into government borrowing. Another implication for crowding out is seen where commercial banks decide to buy treasury bills for higher returns instead of lending to private businesses. The crowding out effect also account for high lending rates in the economy.

The 91-day and 182-day treasury bill rates exhibit over pass-through showing competitiveness of the money market in Ghana. The interest rates channel through the open market is most effectiveness for monetary policy in stabilizing inflation and the economy. However, over-reliance on bonds and the treasury bills to finance maturing debt and project could result in the over pass-through since policy maker will have to interfere in with the prevailing money market rates.

5.3 Conclusion

The success of the IT policy which has the ultimate goal of price stability depends highly on the speed of transmission of the prime rate to the financial market rates. A competitive and efficient financial system is a necessary requirement in order to reduce the stickiness of market interest rates and achieve complete pass-through. The relatively low inflation rate which has been achieved in recent years is as a result of the competitiveness of the money market rates in managing liquidity. The commercial banks credit channel is the weakest link in the prime rate transmission mechanism in Ghana. The lending and deposit rate adjust slowly due to low competition among commercial banks.

The study used average monthly data from the Bank of Ghana statistics for the commercial banks lending and deposit rate. A more appropriate data is a cross-sectional data of all commercial banks in the country which could show how the individual banks respond to the prime rate. Lack of

comprehensive data for large sample restricted the study to the use of the average monthly values of interest rates retrieved from the Bank of Ghana database.

The model is specified under the assumption that economic agents' expectation will always coincide with the monetary authorities expectation and hence, they will not consider inflation in their decision making processes. This is not usually the case since monetary authorities do not always achieve the yearly inflation target.

Commercial banks consider other factors such as default rate, profitability, operating expenses and many other factors in addition to the prime rate in determining lending and deposit rates. The model could not address these other variables due to the use of monthly data for the study but were captured in the constant mark up. The study proposes that further works should examine the independent impact of these variables on lending rates in Ghana.

5.4 Policy recommendations

The IT policy is still young in its implementation in developing countries like Ghana and hence the challenges facing monetary authorities. Based on the findings and their implications reported in the preceding section, the study recommends the following policy measures to help government achieve the desired economic growth in Ghana.

The effectiveness of the IT policy depends greatly on the communication of the policy by the Bank of Ghana. The annual inflation target as well as periodic monetary committee decisions on the prime rate should be effectively communicated through press releases and publications in the dailies and the media to the general public. Economic agents will factor these policies in their decisions if they are fully aware and understand the policies better. The central bank should be committed to steering the economy along the inflation path that it sets for the economy. This will make the policy more credible and instill the confidence of the public in anchoring expectations. The reliance on the money market to finance maturing debt and projects accounts for high lending

rates which result in crowding out of private investment. Regular intervention in the money market rates to raise funds for government projects and maturing debt curtails private investment. Therefore, there is the need to enhance independence of monetary policy from the influence of fiscal policy. On the same issue of crowding out, commercial banks should be encouraged to set competitive fixed deposit rates that are attractive to savers to mobilize funds for private investors. To ensure competition among commercial banks in the country, regular publishing of lending and deposit rates is needed to allow the public make informed decision on borrowing and saving. This should be done regularly as the prime rate is reviewed to make customers switch or bargain for interest rate. In addition, there should be collaboration between commercial banks and Credit Reference Bureau who collect credit score of individuals and institutions to be able to address the problem of default rate.

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APPENDIX A: Long run FMOLS output

Dependent Variable: INTBR

Method: Fully Modified Least Squares (FMOLS)
Date: 03/08/13 Time: 15:16
Sample (adjusted): 1961 2063
Included observations: 103 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	0.999899	0.003150	317.4547	0.0000
C	-0.019318	0.058743	-0.328860	0.7429

R-squared	0.998874	Mean dependent var	18.11165
Adjusted R-squared	0.998863	S.D. dependent var	4.409594
S.E. of regression	0.148719	Sum squared resid	2.233857
Durbin-Watson stat	2.016493	Long-run variance	0.019658

Dependent Variable: LINTR

Method: Fully Modified Least Squares (FMOLS)
Date: 03/08/13 Time: 15:19
Sample (adjusted): 1961 2063
Included observations: 103 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	0.874797	0.080918	10.81092	0.0000
C	13.53162	1.509140	8.966445	0.0000

R-squared	0.776053	Mean dependent var	29.61913
Adjusted R-squared	0.773835	S.D. dependent var	4.413978
S.E. of regression	2.099145	Sum squared resid	445.0475
Durbin-Watson stat	0.396694	Long-run variance	12.97405

Dependent Variable: TBILL
Method: Fully Modified Least Squares (FMOLS)
Date: 03/08/13 Time: 15:24
Sample (adjusted): 1961 2063
Included observations: 103 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	1.402902	0.185120	7.578325	0.0000
C	-5.739039	3.452542	-1.662265	0.0996

R-squared	0.691681	Mean dependent var	19.39272
Adjusted R-squared	0.688629	S.D. dependent var	7.386416
S.E. of regression	4.121668	Sum squared resid	1715.803
Durbin-Watson stat	0.132761	Long-run variance	67.90382

Dependent Variable: TBILLN
Method: Fully Modified Least Squares (FMOLS)
Date: 03/08/13 Time: 15:29
Sample (adjusted): 1961 2063
Included observations: 103 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	1.364998	0.156146	8.741817	0.0000
C	-6.175906	2.912161	-2.120730	0.0364

R-squared	0.728855	Mean dependent var	18.24175
Adjusted R-squared	0.726170	S.D. dependent var	6.973550
S.E. of regression	3.649171	Sum squared resid	1344.962
Durbin-Watson stat	0.274613	Long-run variance	48.31110

Dependent Variable: TMNTH
Method: Fully Modified Least Squares (FMOLS)
Date: 03/08/13 Time: 15:30
Sample (adjusted): 1961 2063
Included observations: 103 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	0.446915	0.047390	9.430640	0.0000
C	-0.078079	0.883829	-0.088341	0.9298

R-squared	0.715637	Mean dependent var	8.210000
Adjusted R-squared	0.712822	S.D. dependent var	2.357266
S.E. of regression	1.263235	Sum squared resid	161.1720
Durbin-Watson stat	0.300667	Long-run variance	4.449928

Dependent Variable: TWMTH
Method: Fully Modified Least Squares (FMOLS)
Date: 03/08/13 Time: 15:32
Sample (adjusted): 1961 2063
Included observations: 103 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PR	0.472751	0.122504	3.859051	0.0002
C	3.931262	2.284739	1.720661	0.0884

R-squared	0.353800	Mean dependent var	12.59398
Adjusted R-squared	0.347402	S.D. dependent var	3.359979
S.E. of regression	2.714310	Sum squared resid	744.1155
Durbin-Watson stat	0.171981	Long-run variance	29.73648

APPENDIX B: Short run ECM output

Vector Error Correction Estimates
Date: 02/27/13 Time: 21:27
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
INTBR(-1)	1.000000
PR(-1)	-0.999360 (0.00316) [-316.123]
C	0.004059

Error Correction:	D(INTBR)	D(PR)
CointEq1	-1.384671 (0.68265) [-2.02839]	-0.357751 (0.70256) [-0.50921]
D(INTBR(-1))	0.168015 (0.47208) [0.35590]	0.156779 (0.48585) [0.32269]
D(PR(-1))	-0.218872 (0.48575) [-0.45058]	-0.201932 (0.49992) [-0.40393]
C	-0.139084 (0.07104) [-1.95792]	-0.138329 (0.07311) [-1.89210]
R-squared	0.061245	0.003853
Adj. R-squared	0.032508	-0.026641
Sum sq. resids	48.66340	51.54384
S.E. equation	0.704674	0.725229
F-statistic	2.131196	0.126368
Log likelihood	-106.9894	-109.9222
Akaike AIC	2.176263	2.233768
Schwarz SC	2.279203	2.336708

Mean dependent	-0.132353	-0.132353
S.D. dependent	0.716415	0.715758
Determinant resid covariance (dof adj.)		0.011296
Determinant resid covariance		0.010427
Log likelihood		-56.73400
Akaike information criterion		1.308510
Schwarz criterion		1.565860

Dependent Variable: D(INTBR)

Method: Least Squares

Date: 02/27/13 Time: 21:29

Sample (adjusted): 1962 2063

Included observations: 102 after adjustments

D(INTBR) = C(1)*(INTBR(-1) - 0.9993601516*PR(-1) +
0.004058597986) + C(2)*D(INTBR(-1)) + C(3)*D(PR(-1)) + C(4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-1.38467	0.682646	-2.028388	0.0452
C(2)	0.168015	0.472083	0.355900	0.7227
C(3)	-0.21887	0.485752	-0.450585	0.6533
C(4)	-0.13908	0.071037	-1.957920	0.0531

R-squared	0.061245	Mean dependent var	0.132353
Adjusted R-squared	0.032508	S.D. dependent var	0.716415
S.E. of regression	0.704674	Akaike info criterion	2.176263
Sum squared resid	48.66340	Schwarz criterion	2.279203
Log likelihood	-106.989	Durbin-Watson stat	1.846219

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	6.108892	Probability	0.003182
Obs*R-squared	11.51580	Probability	0.003158

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 02/27/13 Time: 21:30

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.703952	0.523617	-1.344402	0.1820
C(2)	0.454064	0.360115	1.260885	0.2104
C(3)	-0.56424	0.371546	-1.518653	0.1321
C(4)	-0.00339	0.068181	-0.049855	0.9603
RESID(-1)	0.045963	0.103032	0.446100	0.6565
RESID(-2)	0.310958	0.098926	3.143349	0.0022

R-squared	0.112900	Mean dependent var	3.94E-16
Adjusted R-squared	0.066697	S.D. dependent var	0.694130
S.E. of regression	0.670582	Akaike info criterion	2.095681
Sum squared resid	43.16931	Schwarz criterion	2.250091
Log likelihood	-100.879	Durbin-Watson stat	1.751472

White Heteroskedasticity Test

F-statistic	1.573124	Probability	0.143493
Obs*R-squared	12.15768	Probability	0.144306

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 02/27/13 Time: 21:31

Sample: 1962 2063

Included observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.991020	2.358973	0.420107	0.6754
INTBR(-1)	104.1097	95.56548	-1.089407	0.2788
INTBR(-1)^2	2.940469	2.692670	1.092027	0.2776
PR(-1)	103.6739	95.55925	1.084918	0.2808
PR(-1)^2	-2.92581	2.692486	-1.086660	0.2800
INTBR(-2)	-102.873	97.78615	-1.052021	0.2955
INTBR(-2)^2	2.904760	2.754962	1.054374	0.2944
PR(-2)	103.1811	97.93076	1.053612	0.2948
PR(-2)^2	-2.91429	2.757779	-1.056756	0.2934

R-squared	0.119193	Mean dependent var	0.477092
Adjusted R-squared	0.043425	S.D. dependent var	1.158754
S.E. of regression	1.133316	Akaike info criterion	3.172269
Sum squared resid	119.4496	Schwarz criterion	3.403884
Log likelihood	-152.785	F-statistic	1.573124
Durbin-Watson stat	2.193438	Prob(F-statistic)	0.143493

Vector Error Correction Estimates
Date: 02/26/13 Time: 15:58
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1

LINTR(-1)	1.000000	
PR(-1)	-0.742851 (0.10468) [-7.09628]	
C	-16.13061	
Error Correction:	D(LINTR)	D(PR)
CointEq1	-0.217152 (0.06035) [-3.59820]	-0.098911 (0.03498) [-2.82735]
D(LINTR(-1))	-0.068430 (0.09627) [-0.71078]	0.111712 (0.05581) [2.00170]
D(PR(-1))	0.183948 (0.18276) [1.00649]	-0.174083 (0.10594) [-1.64318]
C	-0.096114 (0.12057) [-0.79714]	-0.142798 (0.06989) [-2.04306]
R-squared	0.174323	0.092835
Adj. R-squared	0.149047	0.065065
Sum sq. resids	139.6895	46.93963
S.E. equation	1.193903	0.692081
F-statistic	6.896833	3.342972
Log likelihood	-160.7686	-105.1501
Akaike AIC	3.230758	2.140198
Schwarz SC	3.333698	2.243138
Mean dependent	-0.112745	-0.132353
S.D. dependent	1.294244	0.715758
Determinant resid covariance (dof adj.)		0.666435
Determinant resid covariance		0.615191
Log likelihood		-264.6865
Akaike information criterion		5.386009
Schwarz criterion		5.643360

Dependent Variable: D(LINTR)
Method: Least Squares
Date: 02/26/13 Time: 16:04
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments

D(LINTR) = C(1)*(LINTR(-1) - 0.7428505683*PR(-1) - 16.13060967) +
C(2)*D(LINTR(-1)) + C(3)*D(PR(-1)) + C(4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.21715	0.060350	-3.598202	0.0005
C(2)	-0.06843	0.096275	-0.710778	0.4789
C(3)	0.183948	0.182761	1.006493	0.3167
C(4)	-0.09611	0.120574	-0.797135	0.4273

R-squared	0.174323	Mean dependent var	-0.11274
Adjusted R-squared	0.149047	S.D. dependent var	1.294244
S.E. of regression	1.193903	Akaike info criterion	3.230758
Sum squared resid	139.6895	Schwarz criterion	3.333698
Log likelihood	-160.768	Durbin-Watson stat	1.970283

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	25.78573	Probability	0.000000
Obs*R-squared	35.64571	Probability	0.000000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/26/13 Time: 16:19
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.397047	0.061160	6.491906	0.0000
C(2)	-0.39530	0.082443	-4.794929	0.0000
C(3)	0.434905	0.158091	2.750975	0.0071
C(4)	0.047558	0.099027	0.480246	0.6321
RESID(-1)	-0.25293	0.093356	-2.709376	0.0080
RESID(-2)	-0.17721	0.094708	-1.871182	0.0644

R-squared	0.349468	Mean dependent var	-4.35E-17
Adjusted R-squared	0.315586	S.D. dependent var	1.176038
S.E. of regression	0.972928	Akaike info criterion	2.840009
Sum squared resid	90.87254	Schwarz criterion	2.994419
Log likelihood	-138.840	Durbin-Watson stat	1.375908

White Heteroskedasticity Test:

F-statistic	1.688412	Probability	0.111478
Obs*R-squared	12.93568	Probability	0.114082

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 02/26/13 Time: 16:21

Sample: 1962 2063

Included observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13.53862	19.49010	0.694641	0.4890
LINTR(-1)	-1.41877	1.927796	-0.735959	0.4636
LINTR(-1)^2	0.031774	0.030903	1.028195	0.3065

PR(-1)	-1.28506	1.836953	-0.699561	0.4859
PR(-1)^2	0.013051	0.044622	0.292487	0.7706
LINTR(-2)	-0.07137	1.771106	-0.040301	0.9679
LINTR(-2)^2	-0.00490	0.028055	-0.174782	0.8616
PR(-2)	2.120765	2.016208	1.051858	0.2956
PR(-2)^2	-0.03413	0.049218	-0.693580	0.4897

R-squared	0.126820	Mean dependent var	1.369505
Adjusted R-squared	0.051708	S.D. dependent var	2.989147
S.E. of regression	2.910839	Akaike info criterion	5.058857
Sum squared resid	787.9877	Schwarz criterion	5.290473
Log likelihood	-249.001	F-statistic	1.688412
Durbin-Watson stat	1.740862	Prob(F-statistic)	0.111478

Vector Error Correction Estimates
Date: 02/26/13 Time: 16:27
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
TBILL(-1)	1.000000

PR(-1)	-1.630455	
	(0.23958)	
	[-6.80553]	
C	10.17512	
Error Correction:	D(TBILL)	D(PR)
CointEq1	-0.077761	0.025291
	(0.02678)	(0.01640)
	[-2.90403]	[1.54260]
D(TBILL(-1))	0.519826	0.146711
	(0.07862)	(0.04814)
	[6.61201]	[3.04776]
D(PR(-1))	0.598838	-0.136692
	(0.16251)	(0.09950)
	[3.68490]	[-1.37373]
C	0.039274	-0.130739
	(0.11180)	(0.06845)
	[0.35128]	[-1.90986]
R-squared	0.457286	0.126002
Adj. R-squared	0.440673	0.099247
Sum sq. resids	120.6277	45.22349
S.E. equation	1.109457	0.679312
F-statistic	27.52467	4.709467
Log likelihood	-153.2863	-103.2506
Akaike AIC	3.084044	2.102952
Schwarz SC	3.186984	2.205892
Mean dependent	-0.109804	-0.132353
S.D. dependent	1.483465	0.715758
Determinant resid covariance (dof adj.)		0.509416
Determinant resid covariance		0.470245
Log likelihood		-250.9839
Akaike information criterion		5.117331
Schwarz criterion		5.374682

Dependent Variable: D(TBILL)
Method: Least Squares

Date: 02/26/13 Time: 16:29
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
D(TBILL) = C(1)*(TBILL(-1) - 1.630455482*PR(-1) + 10.1751204) +
C(2)*D(TBILL(-1)) + C(3)*D(PR(-1)) + C(4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.07776	0.026777	-2.904030	0.0046
C(2)	0.519826	0.078618	6.612011	0.0000
C(3)	0.598838	0.162511	3.684901	0.0004
C(4)	0.039274	0.111801	0.351284	0.7261

R-squared	0.457286	Mean dependent var	-0.10980
Adjusted R-squared	0.440673	S.D. dependent var	1.483465
S.E. of regression	1.109457	Akaike info criterion	3.084044
Sum squared resid	120.6277	Schwarz criterion	3.186985
Log likelihood	-153.286	Durbin-Watson stat	2.040390

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	22.82085	Probability	0.000000
Obs*R-squared	32.86782	Probability	0.000000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/26/13 Time: 16:30
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.107836	0.025488	4.230830	0.0001
C(2)	0.296238	0.065606	4.515393	0.0000
C(3)	-0.07344	0.148808	-0.493555	0.6227
C(4)	-0.00347	0.093597	-0.037152	0.9704

RESID(-1)	-0.16052	0.093830	-1.710838	0.0903
RESID(-2)	-0.28317	0.090476	-3.129776	0.0023

R-squared	0.322234	Mean dependent var	-1.94E-16
Adjusted R-squared	0.286933	S.D. dependent var	1.092856
S.E. of regression	0.922843	Akaike info criterion	2.734308
Sum squared resid	81.75739	Schwarz criterion	2.888718
Log likelihood	-133.449	Durbin-Watson stat	2.536285

White Heteroskedasticity Test:

F-statistic	3.215476	Probability	0.2863
Obs*R-squared	22.10027	Probability	0.4733

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/26/13 Time: 16:32
Sample: 1962 2063
Included observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.04028	8.376094	-0.124197	0.9014
TBILL(-1)	1.174033	0.884150	1.327866	0.1875
TBILL(-1)^2	-0.01780	0.017250	-1.032381	0.3046
PR(-1)	1.214777	1.856622	0.654294	0.5145
PR(-1)^2	-0.04411	0.043891	-1.005093	0.3175
TBILL(-2)	-1.84058	0.852929	-2.157953	0.0335
TBILL(-2)^2	0.036199	0.016398	2.207565	0.0297
PR(-2)	-0.50029	1.916223	-0.261082	0.7946
PR(-2)^2	0.027570	0.045672	0.603658	0.5475

R-squared	0.216669	Mean dependent var	1.182624
Adjusted R-squared	0.149286	S.D. dependent var	3.013555
S.E. of regression	2.779527	Akaike info criterion	4.966536
Sum squared resid	718.4965	Schwarz criterion	5.198151
Log likelihood	-244.293	F-statistic	3.215476
Durbin-Watson stat	2.061687	Prob(F-statistic)	0.002863

Vector Error Correction Estimates
Date: 02/27/13 Time: 20:38
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
TBILLN(-1)	1.000000
PR(-1)	-1.600621 (0.22273) [-7.18638]
C	10.79129

Error Correction:	D(TBILLN)	D(PR)
CointEq1	-0.108462 (0.04504) [-2.40821]	0.037267 (0.01892) [1.96942]
D(TBILLN(-1))	0.089473 (0.09253) [0.96696]	0.083922 (0.03888) [2.15869]
D(PR(-1))	1.093847 (0.23082) [4.73898]	-0.082163 (0.09698) [-0.84723]
C	0.052782 (0.16449) [0.32088]	-0.132038 (0.06911) [-1.91050]
R-squared	0.234558	0.109646
Adj. R-squared	0.211126	0.082390
Sum sq. resids	260.9815	46.06981
S.E. equation	1.631894	0.685638
F-statistic	10.01019	4.022845
Log likelihood	-192.6450	-104.1962
Akaike AIC	3.855785	2.121494
Schwarz SC	3.958725	2.224434
Mean dependent	-0.103922	-0.132353
S.D. dependent	1.837333	0.715758
Determinant resid covariance (dof adj.)		1.148547
Determinant resid covariance		1.060231
Log likelihood		-292.4463

Akaike information criterion	5.930319
Schwarz criterion	6.187669

Dependent Variable: D(TBILLN)
Method: Least Squares
Date: 02/27/13 Time: 20:43
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
D(TBILLN) = C(1)*(TBILLN(-1) - 1.600621174*PR(-1) + 10.79128831)
+ C(2)*D(TBILLN(-1)) + C(3)*D(PR(-1)) + C(4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.10846	0.045038	-2.408208	0.0179
C(2)	0.089473	0.092531	0.966956	0.3359
C(3)	1.093847	0.230819	4.738975	0.0000
C(4)	0.052782	0.164493	0.320876	0.7490

R-squared	0.234558	Mean dependent var	-0.10392
Adjusted R-squared	0.211126	S.D. dependent var	1.837333
S.E. of regression	1.631894	Akaike info criterion	3.855785
Sum squared resid	260.9815	Schwarz criterion	3.958725
Log likelihood	-192.645	Durbin-Watson stat	2.196349

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	14.33264	Probability	0.000004
Obs*R-squared	23.45367	Probability	0.000008

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/27/13 Time: 20:46
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C(1)	0.224994	0.045245	4.972819	0.0000
C(2)	-0.13443	0.083050	-1.618703	0.1088
C(3)	0.552383	0.223842	2.467739	0.0154
C(4)	-0.00900	0.146712	-0.061409	0.9512
RESID(-1)	-0.31017	0.099113	-3.129514	0.0023
RESID(-2)	-0.19199	0.096736	-1.984753	0.0500

R-squared	0.229938	Mean dependent var	1.18E-16
Adjusted R-squared	0.189831	S.D. dependent var	1.607475
S.E. of regression	1.446879	Akaike info criterion	3.633717
Sum squared resid	200.9720	Schwarz criterion	3.788127
Log likelihood	-179.319	Durbin-Watson stat	1.938558

White Heteroskedasticity Test:

F-statistic	3.010287	Probability	0.0757
Obs*R-squared	20.98007	Probability	0.07201

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/27/13 Time: 20:47
Sample: 1962 2063
Included observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.84752	25.30066	0.507794	0.6128
TBILLN(-1)	-2.81889	2.307923	-1.221400	0.2250
TBILLN(-1)^2	0.035645	0.049245	0.723823	0.4710
PR(-1)	6.897077	5.582319	1.235522	0.2197
PR(-1)^2	-0.18628	0.133452	-1.395867	0.1661
TBILLN(-2)	3.758140	2.244502	1.674376	0.0974
TBILLN(-2)^2	-0.03824	0.047363	-0.807410	0.4215
PR(-2)	-8.73782	5.720769	-1.527387	0.1301
PR(-2)^2	0.205531	0.137554	1.494185	0.1385

R-squared	0.205687	Mean dependent var	2.558642
Adjusted R-squared	0.137359	S.D. dependent var	9.206919
S.E. of regression	8.551245	Akaike info criterion	7.214128
Sum squared resid	6800.513	Schwarz criterion	7.445743
Log likelihood	-358.920	F-statistic	3.010287
Durbin-Watson stat	1.103746	Prob(F-statistic)	0.004757

Vector Error Correction Estimates
Date: 02/27/13 Time: 20:57
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
TMNTH(-1)	1.000000
PR(-1)	-0.404100 (0.05913) [-6.83462]
C	-0.880795

Error Correction:	D(TMNTH)	D(PR)
CointEq1	-0.189808 (0.05178) [-3.66561]	-0.149239 (0.05938) [-2.51343]
D(TMNTH(-1))	0.040254 (0.09393) [0.42854]	0.257029 (0.10771) [2.38629]
D(PR(-1))	0.007138 (0.09084) [0.07857]	-0.149307 (0.10417) [-1.43332]
C	-0.052764 (0.06097) [-0.86547]	-0.135105 (0.06991) [-1.93258]
R-squared	0.140478	0.097709
Adj. R-squared	0.114166	0.070088
Sum sq. resids	35.50615	46.68743
S.E. equation	0.601920	0.690219
F-statistic	5.338935	3.537487
Log likelihood	-90.91311	-104.8753
Akaike AIC	1.861041	2.134811
Schwarz SC	1.963982	2.237751
Mean dependent	-0.056373	-0.132353
S.D. dependent	0.639532	0.715758
Determinant resid covariance (dof adj.)		0.172604
Determinant resid covariance		0.159332
Log likelihood		-195.7883

Akaike information criterion	4.035065
Schwarz criterion	4.292415

Dependent Variable: D(TMNTH)
Method: Least Squares
Date: 02/27/13 Time: 21:00
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
D(TMNTH) = C(1)*(TMNTH(-1) - 0.4040995307*PR(-1) - 0.8807951957
) + C(2)*D(TMNTH(-1)) + C(3)*D(PR(-1)) + C(4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.18980	0.051781	-3.665614	0.0004
C(2)	0.040254	0.093931	0.428542	0.6692
C(3)	0.007138	0.090843	0.078575	0.9375
C(4)	-0.05276	0.060966	-0.865468	0.3889

R-squared	0.140478	Mean dependent var	-0.05637
Adjusted R-squared	0.114166	S.D. dependent var	0.639532
S.E. of regression	0.601920	Akaike info criterion	1.861041
Sum squared resid	35.50615	Schwarz criterion	1.963982
Log likelihood	-90.9131	Durbin-Watson stat	2.008705

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	22.12411	Probability	0.000000
Obs*R-squared	32.18093	Probability	0.000000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/27/13 Time: 21:01
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.317697	0.049671	6.395993	0.0000
C(2)	-0.22047	0.075127	-2.934702	0.0042
C(3)	0.247238	0.079381	3.114575	0.0024
C(4)	0.030230	0.051326	0.588978	0.5573
RESID(-1)	-0.25920	0.092757	-2.794423	0.0063
RESID(-2)	-0.18154	0.090067	-2.015618	0.0466

R-squared	0.315499	Mean dependent var	-5.82E-17
Adjusted R-squared	0.279848	S.D. dependent var	0.592913
S.E. of regression	0.503157	Akaike info criterion	1.521192
Sum squared resid	24.30398	Schwarz criterion	1.675602
Log likelihood	-71.5807	Durbin-Watson stat	1.728865

White Heteroskedasticity Test:

F-statistic	3.129670	Probability	0.3540
Obs*R-squared	21.63561	Probability	0.5638

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/27/13 Time: 21:04
Sample: 1962 2063
Included observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.24786	2.174512	-0.573858	0.5674
TMNTH(-1)	-1.81925	0.760114	-2.393396	0.0187
TMNTH(-1)^2	0.119478	0.039214	3.046821	0.0030
PR(-1)	0.1496	0.525794	0.284675	0.7765
PR(-1)^2	-0.00049	0.012699	-0.039060	0.9689
TMNTH(-2)	1.307436	0.643971	2.030271	0.0452
TMNTH(-2)^2	-0.08415	0.032760	-2.568778	0.0118
PR(-2)	0.184284	0.604655	0.304775	0.7612

PR(-2)^2	-0.00753	0.014447	-0.521541	0.6032

R-squared	0.212114	Mean dependent var	0.348099
Adjusted R-squared	0.144339	S.D. dependent var	0.904015
S.E. of regression	0.836232	Akaike info criterion	2.564275
Sum squared resid	65.03335	Schwarz criterion	2.795890
Log likelihood	-121.778	F-statistic	3.129670
Durbin-Watson stat	1.598764	Prob(F-statistic)	0.003540

Vector Error Correction Estimates
Date: 02/27/13 Time: 21:05
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
TWMTH(-1)	1.000000
PR(-1)	-0.390225 (0.26301) [-1.48371]
C	-5.532934

Error Correction:	D(TWMTH)	D(PR)
CointEq1	-0.084090 (0.04015) [-2.09448]	-0.021936 (0.02674) [-0.82030]
D(TWMTH(-1))	0.004088 (0.08562) [0.04775]	0.146250 (0.05703) [2.56438]
D(PR(-1))	0.127776 (0.14818) [0.86229]	-0.041765 (0.09870) [-0.42316]
C	-0.046343 (0.10668) [-0.43440]	-0.121033 (0.07106) [-1.70328]
R-squared	0.056434	0.065725
Adj. R-squared	0.027549	0.037125

Sum sq. resids	108.9653	48.34240
S.E. equation	1.054462	0.702346
F-statistic	1.953765	2.298062
Log likelihood	-148.1006	-106.6519
Akaike AIC	2.982365	2.169645
Schwarz SC	3.085305	2.272585
Mean dependent	-0.063725	-0.132353
S.D. dependent	1.069294	0.715758

Determinant resid covariance (dof adj.)	0.548266
Determinant resid covariance	0.506108
Log likelihood	-254.7322
Akaike information criterion	5.190827
Schwarz criterion	5.448177

Dependent Variable: D(TWMTH)
Method: Least Squares
Date: 02/27/13 Time: 21:07
Sample (adjusted): 1962 2063
Included observations: 102 after adjustments
D(TWMTH) = C(1)*(TWMTH(-1) - 0.3902248102*PR(-1) - 5.532934234
) + C(2)*D(TWMTH(-1)) + C(3)*D(PR(-1)) + C(4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.08409	0.040148	-2.094483	0.0388
C(2)	0.004088	0.085624	0.047746	0.9620
C(3)	0.127776	0.148182	0.862290	0.3906
C(4)	-0.04634	0.106684	-0.434396	0.6650

R-squared	0.056434	Mean dependent var	-0.06372
Adjusted R-squared	0.027549	S.D. dependent var	1.069294
S.E. of regression	1.054462	Akaike info criterion	2.982365
Sum squared resid	108.9653	Schwarz criterion	3.085305
Log likelihood	-148.100	Durbin-Watson stat	2.010469

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	11.25472	Probability	0.000041
Obs*R-squared	19.37367	Probability	0.000062

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 02/27/13 Time: 21:08

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.162917	0.043692	3.728746	0.0003
C(2)	0.106607	0.089230	-1.194738	0.2351
C(3)	0.081989	0.142851	0.573952	0.5673

C(4)	0.028809	0.097665	0.294978	0.7686
RESID(-1)	0.183760	0.107274	-1.712998	0.0899
RESID(-2)	0.101858	0.102713	0.991680	0.3238

R-squared	0.189938	Mean dependent var	4.35E-17
Adjusted R-squared	0.147747	S.D. dependent var	1.038684
S.E. of regression	0.958887	Akaike info criterion	2.810936
Sum squared resid	88.26863	Schwarz criterion	2.965346
Log likelihood	137.3577	Durbin-Watson stat	1.759104

White Heteroskedasticity Test:

F-statistic	0.691023	Probability	0.698493
Obs*R-squared	5.722980	Probability	0.678230

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/27/13 Time: 21:09
Sample: 1962 2063
Included observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	-2.83320	7.954384	-0.356181	0.7225
TWMTH(-1)	-0.48101	1.340509	-0.358832	0.7205
TWMTH(-1)^2	0.029815	0.046723	0.638126	0.5250
PR(-1)	1.871147	1.921094	0.974001	0.3326
PR(-1)^2	-0.03357	0.046498	-0.722050	0.4721
TWMTH(-2)	-0.17288	1.106648	-0.156226	0.8762
TWMTH(-2)^2	-0.00397	0.036207	-0.109673	0.9129
PR(-2)	-1.07003	1.913182	-0.559297	0.5773
PR(-2)^2	0.014372	0.045958	0.312720	0.7552

R-squared	0.056108	Mean dependent var	1.068287
Adjusted R-squared	-0.02508	S.D. dependent var	3.002778
S.E. of regression	3.040211	Akaike info criterion	5.145828
Sum squared resid	859.5881	Schwarz criterion	5.377443
Log likelihood	-253.437	F-statistic	0.691023
Durbin-Watson stat	2.005032	Prob(F-statistic)	0.698493

APPENDIX C: Short run asymmetric output

regress d.intbr d.pr dum_1 ndum_1

Source	SS	df	MS	Number of obs = 102
				F(3, 98) = 727.58
Model	49.6108252	3	16.5369417	Prob > F = 0.0000
Residual	2.22741014	98	.022728675	R-squared = 0.9570
				Adj R-squared = 0.9557
Total	51.8382353	101	.513249854	Root MSE = .15076

D.intbr	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pr						
D1.	1.006466	.0216586	46.47	0.000	.9634855	1.049447

dum_1	.7206328	5.166069	0.14	0.889	-9.531264	10.97253
ndum_1	1.021853	.1279647	7.99	0.000	.7679117	1.275795
_cons	.0014693	.1079035	0.01	0.989	-.2126617	.2156002

. test dum_1 ndum_1

(1) dum_1 = 0

(2) ndum_1 = 0

F(2, 98) = 48.04

Prob > F = 0.0000

regress d.lintr d.pr dum_2 ndum_2

Source	SS	df	MS	Number of obs = 102
				F(3, 98) = 5.75
Model	25.3126716	3	8.43755721	Prob > F = 0.0012
Residual	143.86916	98	1.46805265	R-squared = 0.1496
				Adj R-squared = 0.1236
Total	169.181831	101	1.67506764	Root MSE = 1.2116

D.lintr	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pr						
D1.	.5768285	.1812313	3.18	0.002	.2171809	.9364761
dum_2	-.0067697	.09611	-0.07	0.944	-.197497	.1839575
ndum_2	.4902754	.1492367	3.29	0.001	.19412	.7864308

_cons	.3103734	.2032117	1.53	0.130	-.0928936	.7136405

. test dum_2 ndum_2

(1) dum_2 = 0

(2) ndum_2 = 0

F(2, 98) = 6.39

Prob > F = 0.0025

regress d.tbilln d.pr dum_3 ndum_3

Source	SS	df	MS	Number of obs =	102
				F(3, 98) =	3.78
Model	35.3239282	3	11.7746427	Prob > F =	0.0130
Residual	305.631279	98	3.11868652	R-squared =	0.1036
				Adj R-squared =	0.0762
Total	340.955207	101	3.37579413	Root MSE =	1.766

D.tbilln	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pr						
D1.	.4516789	.2461498	1.83	0.070	-.0367973	.940155
dum_3	.1583236	.0829742	1.91	0.059	-.006336	.3229832
ndum_3	.0792123	.1577469	0.50	0.617	-.2338313	.392256
_cons	-.1255425	.3648407	-0.34	0.732	-.849557	.5984721

```
 test  dum_3 ndum_3

 ( 1)  dum_3 = 0

 ( 2)  ndum_3 = 0

       F(  2,    98) =    3.71

            Prob > F =    0.0281
```

```
regress d.tbill d.pr  dum_4 ndum_4
```



```
      Source |       SS       df       MS              Number of obs =     102
-------------+------------------------------           F(  3,    98) =    4.85
       Model |  28.7287399     3  9.57624663            Prob > F      =  0.0035
    Residual |  193.538859    98  1.97488632            R-squared     =  0.1293
-------------+------------------------------           Adj R-squared =  0.1026
       Total |  222.267599   101  2.2006693            Root MSE      =  1.4053

------------------------------------------------------------------------------
     D.tbill |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          pr |
         D1. |   .6649752   .1971457     3.37   0.001     .2737461    1.056204
     dum_4 |   .0374472   .0611363     0.61   0.542    -.0838759    .1587702
    ndum_4 |   .1084872   .1322158     0.82   0.414    -.1538908    .3708652
     _cons |   .1093665   .3309681     0.33   0.742     -.547429    .7661619
------------------------------------------------------------------------------
```

```
. test  dum_4 ndum_4
```

(1) dum_4 = 0

(2) ndum_4 = 0

F(2,   98) =   1.44

  Prob > F =   0.2425

regress d.tmnth d.pr dum_5 ndum_5

Source	SS	df	MS	Number of obs =	102
Model	2.04439882	3	.681466274	F(3, 98) =	1.70
Residual	39.2647592	98	.400660809	Prob > F =	0.1718
Total	41.3091581	101	.409001565	R-squared =	0.0495
				Adj R-squared =	0.0204
				Root MSE =	.63298

D.tmnth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pr |						
D1.	.1048929	.0961614	1.09	0.278	-.0859364	.2957221
dum_5	.1914132	.092371	2.07	0.041	.008106	.3747204
ndum_5	-.0697455	.1243999	-0.56	0.576	-.3166131	.177122
_cons	-.1873224	.113466	-1.65	0.102	-.412492	.0378473

. test dum_5 ndum_5

(1) dum_5 = 0

(2) ndum_5 = 0

F(2, 98) = 2.24

Prob > F = 0.1114

regress d.twmth d.pr dum_6 ndum_6

Source	SS	df	MS	Number of obs =	102
				F(3, 98) =	1.27
Model	4.31422652	3	1.43807551	Prob > F	= 0.2897
Residual	111.168148	98	1.13436886	R-squared	= 0.0374
				Adj R-squared	= 0.0079
Total	115.482375	101	1.14338985	Root MSE	= 1.0651

D.twmth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pr |						
D1.	.049241	.1544067	0.32	0.750	-.2571741	.355656
dum_6	.034564	.0641941	0.54	0.592	-.0928271	.161955
ndum_6	.1521	.1123462	1.35	0.179	-.0708474	.3750473
_cons	.0537839	.1931974	0.28	0.781	-.3296101	.4371779

. test dum_6 ndum_6

(1) dum_6 = 0

(2) ndum_6 = 0

F(2, 98) = 1.89

Prob > F = 0.1560

APPENDIX D: Correlation matrix

Correlation Coefficients, using the observations 2002:01 - 2010:08

5% critical value (two-tailed) = 0.1927 for n = 104

PR	TBILLN	TBILL	INTBR	TMNTH	
1.0000	0.8576	0.8350	0.9995	0.8582	PR
	1.0000	0.9916	0.8544	0.7673	TBILLN
		1.0000	0.8318	0.7593	TBILL
			1.0000	0.8585	INTBR
				1.0000	TMNTH

TWMNTHD	LINTR	
0.6379	0.8886	PR
0.7572	0.7953	TBILLN
0.7805	0.7826	TBILL
0.6355	0.8884	INTBR
0.7983	0.9324	TMNTH
1.0000	0.8048	TWMNTH
	1.0000	LINTR

APPENDIX E: Data son financial market interest rates from BoG Statistics

MONTH	INTBR	TBILLN	TBILL	TMNTH	TWMTH	LINTR	PR	INFL
Jan, 02	27	26.5	27.1	13.5	22.5	40	27	31.8
Feb,02	27	23.3	24.3	12.5	16	40	27	30.4
Mar,02	24.5	23.6	24.2	12	16	37.5	24.5	28.6
Apr,02	24.5	23.8	24.6	10.9	14.75	35	24.5	26.8
May,02	24.5	23.8	24.6	10.9	14.75	35	24.5	25.1
Jun,02	24.5	24.9	25.8	10.9	14.75	34	24.5	23.4
Jul,02	24.5	25.2	26.6	10.9	14.75	34	24.5	21.8
Aug,02	24.5	26.1	26.9	9.5	15.75	34	24.5	20.4
sep,02	24.5	26	26.7	9.5	15.75	36	24.5	19.3
Oct,02	24.5	26.1	26.9	9.5	15.75	36	24.5	18.4
Nov,02	24.5	26.1	27	10.5	15.75	36.25	24.5	17.6
Dec,02	24.5	26.6	27.2	13	18	38.5	24.5	17.3
Jan, 03	25.5	26.8	27.6	10.5	13.75	34	25.5	16.2
feb,03	25.5	27.4	28.2	10.5	13.75	34	25.5	16.5
mar,03	27.5	28.9	29.2	10.6	13.75	34	27.5	17.5
apr,03	27.5	33	33.9	10.5	13.5	36	27.5	18.5
May,03	27.5	33.5	34.7	11	14	36.5	27.5	19.8
Jun,03	27.5	35.3	36.9	11	14	38	27.5	21.2
jul,03	26	34.8	36.3	11.75	14.25	35.5	26	22.8
aug,03	26	27	30.2	11.75	15.5	38	26	24.4
sep,03	26	25.9	28	11.75	15.25	35.25	26	25.6
oct,03	24	25.6	27.1	11.75	15.25	35.25	24	27.2
nov,03	24	22.5	25	11.75	15.25	35.25	24	28.7
dec,03	21.5	18.7	20.3	9.75	14.25	32.75	21.5	29.8
jan,04	21.5	16.6	18.5	9.5	14.25	32.5	21.5	31.1
feb,04	20	17.8	19	9.5	14.25	32	20	30.3
mar,04	20	18.3	19.1	9.5	13.75	31.75	20	28.8
apr,04	20	18	18.8	9.5	13.75	31.75	20	27.7
may,04	18.5	16.9	17.6	9.5	13.75	31.75	18.5	26.4
jun,04	18.5	16.9	17.8	9.5	13.75	31.75	18.5	25.1
jul,04	18.5	16.9	17.8	9.5	13.75	31.75	18.5	23.6
aug,04	18.5	17	17.8	9.5	13.25	28.75	18.5	22.3
sep,04	18.5	17	17.8	9.5	13.25	28.75	18.5	21.5

oct,04	18.5	17.1	17.8	9.5	13.25	28.75	18.5	20.3
nov,04	18.5	17.1	17.9	9.5	13.25	28.75	18.5	19.1
dec,04	18.5	17.1	17.9	9.5	13.25	28.75	18.5	18
jan,05	18.5	17.1	17.9	9.5	13.25	28.75	18.5	17.2
feb,05	18.5	17.2	17.9	9	10.5	28.75	18.5	17
mar,05	18.5	17.2	18	9	10.5	30.75	18.5	17.2
apr,05	18.5	17.3	18	9	10.5	30.75	18.5	17.2
may,05	16.5	17.3	18	9	10.5	30.75	16.5	16.9
jun,05	16.5	16.1	18	9	10.5	25	16.5	16.6
jul,05	16.5	15.6	16.5	9	10.5	25	16.5	16.8
aug,05	16.5	14.8	15.7	9	10.5	25	16.5	16.4
sep,05	15.5	13.8	15	7.5	9.85	25	15.5	16
oct,05	15.5	12.7	13.9	7.38	7.75	26.25	15.5	15.8
nov,05	15.5	12.3	13.6	6.38	7.75	26	15.5	15.6
dec,05	15.5	11.4	12.8	6.38	7.75	26	15.5	15.4
jan,06	14.5	11.2	12.5	6.38	9.25	26	14.5	15.1
feb,06	14.5	10.3	11.6	6.38	9.25	26	14.5	14.7
mar,06	14.5	9.8	11	6.38	9.25	26	14.5	14.1
apr,06	14.5	9.6	10.9	6.38	9.25	26	14.5	13.7
may,06	14.5	9.7	11.3	6.38	9.25	26	14.5	13.4
jun,06	14.5	10.19	11.21	6.38	9.25	26	14.5	13.2
jul,06	14.5	10.3	11.1	6.38	9.25	26	14.5	12.8
aug, 06	14.5	10.3	11.1	6.38	9.25	26	14.5	12.8
sep,06	14.5	11.2	11.2	7.05	9.88	27.75	14.5	12.6
oct,06	14.5	11	11	5.75	7.5	24.25	14.5	12.2
nov,06	14.5	11	11	5	7.25	24.25	14.5	11.9
dec,06	12.5	10.7	10.7	4.75	8	24.25	12.5	11.7
jan,07	12.5	9.9	10.5	4.75	8.25	24.25	12.5	11.5
feb,07	12.5	9.7	10.6	4.75	8.5	24.25	12.5	11.4
mar,07	12.5	9.6	10.6	4.75	9	24.25	12.5	11.3
apr,07	12.5	9.6	10.4	4.75	9	24.25	12.5	11.2
may,07	12.5	9.7	10.3	4.75	9	24.25	12.5	11.2
jun,07	12.5	9.7	10.4	4.75	9	24.25	12.5	11.1
jul,07	12.5	9.8	10.4	4.55	9	24.25	12.5	10.9
aug,07	12.5	9.8	10.4	4.55	9	24.25	12.5	10.7
sep,07	12.5	9.8	10.4	4.55	9	24.25	12.5	10.6
oct,07	12.5	10.6	10.4	4.55	9	24.25	12.5	10.5
nov,07	13.5	10.6	10.5	4.55	9.05	24.25	13.5	10.6
dec,07	13.5	10.6	10.8	4.55	9	24.25	13.5	10.7
jan,08	13.5	10.8	11	4.55	9	24.25	13.5	10.9
feb,08	13.5	10.8	11.1	4.55	9	24.25	13.5	11.1
mar,08	14.25	10.88	11.51	4.55	9	24.25	14.3	11.4
apr,08	14.25	11.44	11.86	4.55	8	25.38	14.3	11.9
may,08	16	13.19	13.86	4.55	8	25.38	16	12.4
jun,08	16	16.3	16.71	5.2	8.22	25.38	16	13

jul,08	17	19.8	20.5	5.45	8.43	25.38	17	13.7
aug,08	17	24.6	26.1	6.25	13.25	24.25	17	14.4
sep,08	17	24.8	26.4	7	13.38	26.75	17	15
oct,08	17	17	24.8	7	16.38	26.75	17	15.6
nov,08	17	24.7	26.3	7	16.38	26.75	17	16.1
dec,08	17	24.7	26.2	9	16.38	25.38	17	16.5
jan,09	17	24.7	26.2	9	16.38	27.25	17	17.1
feb,09	17	24.7	26.4	8	15.13	29.75	18.5	17.7
mar,09	18.5	27.8	27.8	9	15.13	31.25	18.5	18.2
apr,09	18.5	25.7	28	8.5	15.3	32.75	18.5	18.7
may,09	18.5	25.7	28.2	8.5	17.5	32.75	18.5	19
jun,09	18.5	25.8	28.6	8.5	17.5	32.75	18.5	19.2
jul,09	18.5	25.9	28.9	9.5	17.5	32.75	18.5	19.4
aug,09	18.5	25.9	28.9	9.5	17.5	32.75	18.5	19.5
sep,09	18.5	25.9	28.9	9.5	17.5	32.75	18.5	19.5
oct,09	18.5	25.8	28.7	10	17.5	32.75	18.5	19.5
nov,09	18	24.9	28	10	19	32.75	18	19.5
dec,09	18	22.5	25.3	10	19	32.75	18	19.3
jan,10	18	18.9	21.2	10	19	32.75	18	19.64
feb,10	16	17.2	17.9	10	17.88	32.5	16	11.55
mar,10	16	14.6	15.3	10	17.38	31.83	16	17.7
apr,10	15	13.4	13.9	10	14.4	31.83	15	17.46
may,10	15	12.9	13.4	9	14.88	31.83	15	16.82
jun,10	15	12.9	13.4	7.25	11.75	30.63	15	15.76
jul,10	13.5	12.9	13.4	6.75	10.75	28.5	13.5	16.05
Aug,10	13.5	12.7	13.1	6.75	9.5	28.5	13.5	14.64